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Exploring bias in incident investigations: An empirical examination using construction case studies

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ABSTRACT

Introduction: Incident investigation is a foundational tool of safety management. Determining the causal factors of any incident underpins organizational learning and subsequent positive change to processes and practices. Research of incident investigation has largely focused on what information to collect, how to analyze it, and how to optimize resultant conclusions and organizational learning. However, much less attention has been paid to the process of information collection, and specifically that of subjective information obtained through interviews. Yet, as all humans are biased and can't help being so, the information collection process is inevitably vulnerable to bias. *Method:* Simulated investigation interviews with 34 experienced investigators were conducted within the construction industry. *Results:* Common biases were revealed including confirmation bias, anchoring bias, and fundamental attribution error. Analysis was also able to unpack when and how these biases most often emerged in the interview process, and the potential consequences for organizational learning. *Conclusions:* Being biased to a certain degree will remain inevitable for any individual, and therefore, efforts to mitigate the effects of biases is necessary. Practical Applications: Increased awareness and insights can support the development of processes and training for investigators to mitigate its effects and thus enhance learning from incidents in the field prevent reoccurrence.

1. Introduction

Conducting effective incident investigations has long been recognized as a vital means of improving safety within organizations. Investigations are necessary to ensure learning from incidents and to prevent reoccurrence by making continuous systemic improvements (Jacobsson, Ek, & Akselsson, 2012). Typically, the investigative process consists of collecting information, determining contributory factors by analyzing that information, developing corrective measures, communicating the findings and, finally, implementing and following-up on the implemented measures and assessing their effectiveness (Lindberg, Hansson, & Rollenhagen, 2010).

Despite the perceived importance of incident investigation in high-hazard industries, much research to date has focused on studying why organizations fail to effectively learn from incidents (c.f. Drupsteen & Hasle, 2014; Gillman & Pillay, 2017; Stemn, Hassall, & Bofinger, 2020). Barriers to such learning include, amongst others, the lack of a culture of trust within an organization, time constraints and production pressures to complete the investigation, and a focus on single-loop learning (no feedback potential), rather than double-loop learning, which provides scope for providing feedback on the lessons learnt (*ibid*). To overcome these barriers, studies have often sought to develop new analytical techniques/methodologies that aid investigators to look for multiple causal factors leading to an incident (Baysari, McIntosh, & Wilson, 2008; Woolley, Goode, Salmon, & Read, 2020), improve the culture around conducting incident investigations (Dekker, 2009; Khatri, Brown, & Hicks, 2009), and develop models to successfully learn from incidents (Jacobsson et al., 2012; Lukic, Littlejohn, & Margaryan, 2012).

However, this body of work, whilst supporting the development of sophisticated analytical techniques and learning models, has actually paid much less attention to the very first step in the process: The collection of incident information itself. The information collection phase can involve obtaining objective and subjective data, including but not limited to photographs, training records, video evidence, witness statements, and interviews (Abdul Majid & Shariff, 2020; Thallapureddy et al., 2022). Yet, this information is not homogenous and collecting objective evidence (such as

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photos and training records) is arguably much more straightforward than the collection of information from interviews, which is inevitably subjective in nature.

Interviews with injured parties, witnesses, and other colleagues are critical for soliciting reliable and high-quality information about an incident (Vrij, Hope, & Fisher, 2014), but the way an interview is conducted often entirely depends on the interviewing skills of the investigator (interviewer). Consequently, the quality of the information collected is influenced by the fallibilities of cognitive processing: we are all biased (Tversky & Kahneman, 1974). This is true whether the individual is a layperson or a subject-matter expert (such as incident investigators; Kahneman & Klein, 2009). Indeed, MacLean (2022) has recently highlighted the potential problems bias inevitably brings to workplace investigations, noting the lack of literature on this subject and the need for further research in this area.

Interviews are inevitably subjective in nature, and so have the potential to be influenced by many different cognitive biases (Ryan, Hutchings, & Lowe, 2010; Novatsis & Wilkinson, 2016; MacLean, 2022). Bias can be defined as the systematic deviation from making a rational judgment (Kahneman, 2011). Bias can manifest in many ways during an interview, for example, through asking leading questions (Novatsis & Wilkinson, 2016), asking questions around a specific factor to elicit a confession (Rassin, Eerland, & Kuijpers, 2010), or making judgments based on personality or character (Strauch, 2017). When biases are present in an interview they can skew the conversation, thereby impacting the quality of the information obtained. This in turn then leads to poor quality analysis (i.e., garbage in = garbage out) with the potential to then lead to ineffective investigation outcomes, incorrect conclusions drawn, and a lack of optimal organizational learning.

Yet, despite authors suggesting that investigations are susceptible to bias, there is a lack of empirical research within any high-hazard industry able to provide insights around which biases most commonly emerge during the incident interview process, when they are likely to emerge, and how. This work addresses this gap specifically, focusing entirely on information collection from incident investigation interviews. The aim of the research is to determine which different biases commonly emerge during the information collection stage of incident investigations and how. Analysis of simulated interviews enabled the different biases common within incident investigation interviews to be revealed, with further insights of how and when they can hinder the investigative process at the information collection stage. Enhanced understandings of biases in this first stage of the investigative process can inform the training and education of investigators (as called for by MacLean, 2022) and thus enhance the process as a whole, leading to optimal organizational learning, more effective changes to work methods, and a reduction in repeat incidents in practice.

2. Literature review

2.1. Information collection

Incident investigation and learning is a familiar concept in safety research, and there is a wealth of literature to support effective incident investigations. According to Carter and Menckel (1990:125), 'Most accident prevention efforts are based on knowledge gained from accidents and, consequently, it is important to learn as much as possible from each accident.' However, as noted above, most of the associated literature focuses on the deficiencies associated with ineffective learning at the end of the investigative process, rather than ineffective action at the start. Yet as Drupsteen and Hasle (2014) point out, one of the greatest bottlenecks that hinders effective learning is the *quality* of the information obtained after an incident occurs.

Although the information collection phase of the process serves as the foundation for all subsequent stages of an investigation, research of this first step is limited. Studies focus on the types of data to be collected (Abdul Majid & Shariff, 2020; Stemn & Joe-Asare, 2021), guidance on the types of questions to be asked (MacLean, Stinson, Kelloway, & Fisher, 2011; Reinach, Viale, & Green, 2007; Wu & Steckelberg, 2012), and strategies for conducting interviews (Fisher & Geiselman, 1992; Ryan et al., 2010). MacLean et al. (2011) provide a little more guidance, for example encouraging the use of open-ended questions in interviews that are broad in nature, as investigators can secure more accurate information than by using a closed questioning approach. Fisher and Geiselman (1992) concluded that asking questions in a non-leading way and not interrupting the interviewees was also helpful in eliciting high quality information, and the interview process should always start by building rapport with the interviewees. Without applying such strategies, interviews can turn into a police interrogation (Kelloway, Stinson, & MacLean, 2004). This is highly problematic as the goal of a police interview is often to secure a confession or find the guilty party, rather than to comprehensively understand what led to the incident and make continuous systemic improvements. Whilst Ryan et al. (2010) point out the importance of *unbiased* approaches to interviews, they do not explore in depth what biases are most common in the process, and where vulnerabilities to bias emerge. The constructions-specific work of Heraghty, Dekker, and Rae (2021) also raises concerns of the influence of different biases within investigations, including during the interview process where confirmation bias is to be overcome by open-ended questions and neutral framing, yet this remains theoretical within Heraghty et al.'s (*ibid)* wider considerations of a restorative justice approach to incident investigation as a whole. That bias is a key issue in incident investigations has most been recently raised by MacLean (2022), who explores this concept through the first detailed overview of the problems bias has the potential to cause in investigations in occupational environments, with suggestions for mitigation including bias management strategies, standardized approaches, and investigator training.

2.2. Cognitive biases

It is widely acknowledged and accepted that as human beings, we all are biased (Tversky & Kahneman, 1974). We often tend to believe that we are rational and consciously aware of the decisions that we make in our everyday life, but that is simply not the case. Unconscious cognitive biases are unavoidable for all human beings.

Having biases is not *de facto* a bad thing but being able to recognize them is often the key to saving ourselves from making any unfavorable decisions as a result of their influence. Humans often use mental shortcuts (also called heuristic strategies) to make decisions or judgments (Gilovich, Griffin, & Kahneman, 2002; Kahneman, Slovic, Slovic, & Tversky, 1982). Often, these heuristics are useful to make predictions or solve problems quickly and efficiently, with minimal mental effort. However, overreliance on heuristics can lead to systematic and predictable errors in judgment, known as cognitive biases (Kahneman, 2011; Tversky & Kahneman, 1974). Since the initial work by Tversky and Kahneman (1974), over 180 biases have been identified that interfere with how we process data, think critically, and perceive reality. In recent years, a number of studies have examined biases that are known to influence decision-making processes across different domains including aviation maintenance (Illankoon & Tretten, 2020), medical practice (Buckingham & Adams, 2000), and criminal investigations (O'Brien, 2009), to name a few. Experts

are susceptible to biased cognitive processing (i.e., evaluations and judgments) as they seek to find patterns and apply existing knowledge to find reasonable and plausible solutions (Kahneman & Klein, 2009).

2.3. Bias in investigations

As all humans are prone to bias, those undertaking incident investigations are also vulnerable to their inevitable influence. These biases can form through conscious and subconscious thought processing (Gilovich et al., 2002). Thus, as incident investigations are unavoidably susceptible to bias from the very first stage of information collection, the quality of the outcomes obtained from the investigation are also questionable (Ryan et al., 2010; MacLean, Brimacombe, & Lindsay, 2013) and can ultimately hinder optimal organizational learning. Despite a general acceptance of the need to collect information in an unbiased manner, and the recent concerns around bias specifically in incident investigations raised by MacLean (2022), there has been a lack of empirical work exploring this phenomenon. In fact, to the authors' knowledge, there has been no empirical study carried out to identify the most commonly emerging biases during interviews specifically within the industrial incident investigation domain.

The wider literature does, however, suggest some biases that will likely have influence on the incident investigation process. For example, Fundamental Attribution Error (FAE; Nisbett, Caputo, Legant, & Marecek, 1973) is a bias through which the investigator could use character-based evidence to make judgments regarding the cause of an incident. When an investigator falls prey to FAE, they tend to attribute a person's behavior to a personal characteristic, rather than trying to understand any external situational factors that made them behave the way they did at the time of the incident. When FAE is considered alongside the endurance of 'unsafe acts' as a casual factor in incidents (Smith, Sherratt, & Oswald, 2017), and thus the continued prominence of error and even blame in investigations, some interesting considerations emerge around the influence of this bias (and likely others – see MacLean, 2022 who adopts the term 'human error bias') on investigative practice.

Another bias of potential influence is hindsight bias, which is the tendency for investigators to believe that the incident would have been avoided if only person X had taken action Y (Henriksen & Kaplan, 2003). Hindsight bias often results in investigators expecting people to anticipate the event in foresight (Henriksen & Kaplan, 2003). As a result of hindsight bias, investigators can be prone to draw easy conclusions about an incident, usually focusing on an individual at fault, whilst ignoring the interactions between myriad alternative factors that could also have contributed to the incident.

Investigators might also show confirmation bias, a tendency to look for information that supports their preconceived notions about an incident (Nickerson, 1998; O'Brien, 2009). Confirmation bias influences investigators to seek information based on what they already believe to be true, and thus inevitably end up finding 'causal factors' that confirm their beliefs. In fact, Lundberg, Rollenhagen, and Hollnagel (2009) coined the term 'What You Look For Is What You Find' to highlight this specific phenomenon within the field of incident investigation. Experience bias is another associated bias, through which investigators make judgments based predominantly on their previous experience (Koriat, Goldsmith, & Pansky, 2000). Experience bias can result in investigators to stop looking for information when they think they have found enough evidence to determine the causal factors based on their own experiences of similar situations, however as each incident is unique this often results in the neglect of alternative information that might also have relevance to the present incident.

2.4. Biases in industrial incident investigations

Among the relatively few studies that have contributed to the literature on biases that impact incident investigations is the work of Burggraaf and Groeneweg (2016). In their study they were able to identify outcome bias, hindsight bias, and the 'curse of knowledge' by re-evaluating nine incident analysis reports. The investigation involved studying the original facts from the incident reports, applying the tripod method to identify the causation trees, and iteratively developing criteria for conducting a quality incident analysis.

Sampling undergraduates and professional investigators, MacLean et al. (2013) found that participant's decision-making abilities were impacted by 'tunnel vision.' In this study, participants underwent a simulated exercise to identify the root causes of an incident, wherein the incident was introduced to them through a slide show and the participants had to determine what happened. In this randomly controlled experiment, a sample of the participants also received tunnel vision education and upon the completion of the slide show, all participants completed a survey to rate their confidence levels, supportiveness of additional information, investigative conclusions, and the influence of safety reports in coming up with the direct causes. Although the authors concluded that tunnel vision impacted incident investigations, there was no further exploration around how the various biases that contribute to 'tunnel vision' emerged at the information collection phase, and if there were also other biases that could impact investigations.

Woodcock, Drury, Smiley, and Ma (2005) reviewed several 'case study' experiments to explore the use of simulations in accident investigation research, one of which was focused on the exploration of biases in causal determination by $n = 15$ investigators. Interestingly, they found no indication of consistent biases within the process. A quantitative, reductionist approach was made to the data, with % proportions of factors noted by the investigators acting as a proxy for their rigor. However, the *process* of information elicitation was not examined – likely due to the focus of the paper itself which was firmly methodological. Indeed, the authors note that analyzing '. . .indications of bias in the investigator's lines of inquiry was cumbersome' which may have been influenced by the ultimate quantification of the qualitative data, which would make such nuance hard to unpack.

The notable recent work by MacLean (2022), although theoretical, provides a comprehensive overview of bias within incident investigation. MacLean unpacks the potential sources of bias throughout an investigative process including those based in human nature, in the local environment, culture and experience, and from case-specific information. She discusses how bias could become embedded at the different stages of an investigation, with brief notes on which biases may have most influence in the process. This work is broad in scope and so is unable to focus in depth on any particular stage of the investigative process.

MacLean (2022) does, however, highlight the role and importance of specific workplace contexts in the emergence of bias in investigations. The training provided, the base-rates of different incidents and the case-specific information all have the potential to bias investigations in different industries in very different ways. This highly situated nature of incident investigations puts demands on those seeking to research bias within such processes; notably that any empirical investigation should also itself be specific and situated. Our area of interest is the construction industry, which remains one of the most dangerous in the world and results in many serious injuries and fatalities year on year. It is also a complex space, fundamentally peripatetic with relatively unique working conditions incorporating high-hazard activities undertaken by long subcontracted supply chains (Sherratt, 2016). That incident investigations in this industrial space are as effective as possible to support effective organizational learning is therefore critical.

Illumination and enhanced understanding of the role of bias at the information collection stage is therefore a robust first step in improving investigative processes overall to support the reduction of accidents on jobsites.

3. Methodology

Fundamentally, this research adopts a realist ontology and post-positivistic epistemological position in order to avoid philosophically 'overcomplicating' the human interaction that occurs during an incident investigation interview. As the existing body of knowledge around bias within incident investigations is small, this approach is most appropriate for exploratory research of this phenomenon, as it enables the identification and explanation of the biases that emerged from the data at their most elementary level, through their most common manifestations and contexts. Post-positivism requires the acceptance of an objective truth and thus that the participants in the study were also 'telling the truth' throughout their interactions. The data are therefore considered to be 'the truth' and analyzed as such without further interpretation. As a result of this objective position, bias within the research design itself was carefully considered through adherence to the clearly defined experimental protocol explicated below and was mitigated as far as possible within the study. There do, however, inevitably remain limitations to this methodological approach, which are discussed at the conclusion of this paper.

3.1. Approach

To secure insights of the role of bias in incident investigation interviews in the construction industry, a role-play simulation method was adopted in which industry practitioners with experience in incident investigations participated in two mock case-study incident interviews as if they were investigating a real incident on site.

The simulation method is a technique that reproduces a real-life situation under experimentally controlled conditions. Within the body of behavioral and psychological research, especially the legal domain, the simulation method has been adopted as a research tool to study decision-making and judgment amongst jurors (Bornstein, 1999; Devine, 2012). In this field, the simulation method is widely applied as it has a number of advantages as it allows for an understanding of both processes and outcomes, a high degree of experimental control is ensured, thereby leading to a higher internal validity, and thus can be used as a "stand-in" method for studying real world behavior (Bornstein & McCabe, 2004). Woodcock et al. (2005:11) also concluded that simulations are also a robust approach to research, and of incident investigations specifically, and that experienced investigators were happy to participate, stating that '. . .their approach to simulations resembled a real investigation' thus ensuring ecological validity within what is otherwise inevitably situated work.

In this study, during each simulation the participant investigated one of two different incidents within the simulation setting, with the goal of determining the contributory factors of the incident by interviewing the injured person (IP) and the witness. The investigators were randomly assigned to an incident and tasked to determine the contributory/causal factors of the incident presented to them.

3.2. Sample

A total of 34 practitioners participated in this study, each taking the role of investigator. The sample represented various specific fields within the construction industry: oil and gas (n = 11), service and utility work (n = 11), heavy civil construction (n = 4), nuclear (n = 2), and industrial construction (n = 6). The investigators on an average had 20 years of experience either conducting or participating in incident investigations within their respective organizations, resulting in a total of over 300 years of experience within the sample. This purposive sampling approach enhanced the ecological validity and to a certain extent generalizability of the findings presented here, due to the composition and experience of the sample as a whole.

3.3. Simulation incidents

In the footsteps of Woodcock et al. (2005:4), an incident story was developed for use by the actors in the simulated interviews. Actual court depositions provided the information to develop the incident scenarios, with details surrounding the incidents modified to ensure anonymity of those involved. Keeping the main story of the incidents intact (i.e., type of incident, how it happened, the people involved), the names of those involved, any personal and location details were censured for ethical purposes. The two incidents were *The Staircase Incident* and *The Concrete Form Incident*.

Both incidents had two actors, an Injured Person (IP) and a witness, with each role-played by a student. To enhance reliability and internal validity, the same two students participated in one acting role for all 34 simulations. A script was developed for both the incidents and was used by the students to maintain consistency in their descriptions of the incidents and interactions with the interviewers. Although it was impossible to anticipate all potential questions in advance, the script was developed in such a way to provide the students with proscribed responses to the most common questions, yet also enabled them to improvise consistently in all other instances. Any unplanned answers and questions were added to the scripts after each simulation interview, to maintain consistency in future simulations, should anyone ask them again. To enhance internal and ecological validity, the students underwent three trial runs with experts from the field who provided feedback on response strategy, demeanor and tone, and experimental setup.

3.3.0.1. The Staircase Incident

This incident involved a superintendent (IP) and a carpentry foreman (witness) working on a residential construction project. In one of the homes, the foreman was completing a staircase running up from the basement to the first floor. The superintendent reported there was nothing out of the ordinary about the day other than a client visit scheduled for the afternoon, and there was pressure to complete the work beforehand. The foreman was running behind schedule on the staircase because their crew had been recently fired by the superintendent for safety violations, meaning the foreman was working alone on the stairs. The incident occurred early afternoon when the foreman was near the staircase cutting lumber, and as the superintendent descended the stairs to the basement they collapsed. The superintendent alleged that the staircase simply 'gave out,' and they fell approximately 9 ft. to the basement floor. The foreman stated that the stairs that collapsed under the superintendent had temporary supports that should still have held the superintendent – and indeed the stairs had been used in that state earlier in the day by other workers. As a result of the incident, the superintendent sustained injuries to the hand and had two broken legs.

3.3.0.2. The Concrete Form Incident

This incident involved a superintendent (IP) and a laborer (witness) working on an industrial construction project. The laborer was stripping round concrete shuttering forms for light pole base installations. The typical process of stripping consists of slicing

the cardboard forms using a utility knife or an electrical saw, which means the form can then be peeled back from the cured concrete. The laborer had only been working on the site for a month but had been trained by their employer to perform this task using the utility knife method. During this period, the laborer had cut themselves with the knife, resulting in an injury requiring 2 stitches. On the day of the incident, there were two laborers in the area stripping the forms ahead of a concrete pour later that day, but the laborer in question was running behind schedule and was under pressure to speed up their work. The incident occurred in the afternoon when the superintendent suggested that they should use a hammer to release the form instead of the knife, stating it was a quicker and safer method of work. When the superintendent was assisting the laborer with this new method, the laborer hit the superintendent's hand with the hammer. After the incident, the superintendent required five operations to correct the damage done to their hand.

3.4. Simulation protocol

Prior to each simulation interview, a 2-minute video describing the basic details of the allocated incident was sent to the investigators to provide an initial outline briefing – similar to the phone call that would be made following an incident in real life. The use of a video ensured consistency of information provided, and thus reliability in this stage of the process. A survey accompanied the video and asked participants for their initial opinions of the contributing factors of the incident, based on the details provided via the video. These initial survey responses were useful in evaluating the lines of questioning followed during the interview, and to compare the conclusions made initially with those ultimately drawn at the end.

Due to Covid-19, the simulated interviews were conducted via Zoom, during which the investigator interviewed both the victim and the witness individually in turn, with the opportunity to ask any follow-up questions to either of them as many times as they liked. At the start of the simulation, the participants were given brief instructions to their task (i.e., to investigate the incident provided to them by interviewing the people involved). To avoid any demand characteristics (e.g., observer-expectancy effects), the aim of this simulation (i.e., the study of biases) was not revealed to the participants beforehand. The order of the interviewees was randomized, to avoid any undue ordering effects that can themselves embed bias in the experimental process. The lead researcher observed each simulation and upon completion of the interviews to the satisfaction of the interviewer, asked additional questions of their perceptions of the contributing factors of the incident, as well as any other additional details they wished to share. Some of the questions asked to aid this conversation included:

- What are your general thoughts on what may have happened?
- What analysis do you make of the people involved in the incident?
- Was there anything surprising or unexpected piece of information?

All the simulation interviews, and responses to the surveys, were subsequently transcribed for further analysis.

3.5. Method of analysis

Descriptive qualitative analysis allows for an exploration of a research topic that is limited in literature (Creswell & Poth, 2016). To illuminate and better understand the different types of biases that investigators are prone to, an inductive and thematic approach was made to the transcribed simulation interview generated data. Following Braun and Clarke (2006), the key steps in the thematic analysis undertaken were: becoming familiarized with the data, generating initial codes, determining the common themes, and reviewing and defining the themes. Thematic analysis allows for an inductive examination of data, with themes derived by identifying patterns across the data (Braun & Clarke, 2006), the iterative approach enabling new themes/ categories to emerge from the data as they are revealed.

An initial set of codes were generated by searching for patterns in the line of questioning, representing known biases. The data were coded in such a way that each theme consisted of a series of questions to show how the bias emerged from the conversation. For instance, in the staircase incident, if an interviewer repeatedly asked questions about the structural configuration of the stairs, all the questions related to the structural components/configuration asked were coded together under the theme "Fixation to a specific aspect" which itself was associated with anchoring bias (a bias in which the individual becomes fixated within a situation, the anchor becoming the 'frame' for subsequent enquiry; Tversky & Kahneman, 1974). Once the initial set of themes were identified, the process of searching for additional themes was revised and reiterated to account for any more nuanced themes identifiable in the data. A constant comparison approach (Silverman, 2019) was taken to the data, with repeated passes made of the data until no new themes emerged. Taking this approach allowed for a 'bird's eye view' of the patterns emerging from the data (Aronson, 1995) and ensured the analysis reached saturation. All coding and analysis were conducted using NVivo qualitative data analysis software.

In addition to the thematic analysis, the results from the pre-simulation survey were used to compare the results to the interview data. A spreadsheet was created to organize the conclusions drawn for the incidents by each participant. This enabled detailed analysis of whether the lines of questioning followed during the interview were based on preconceived notions about the incident generated by the initial video, or more associated with the eventual findings generated from the interviews. For example, if a participant stated unstable stairs to be the contributory factor in the initial survey, this was noted in the spreadsheet and evaluation made with the transcripts to determine if they had asked most of the questions around this factor, and ultimately arrived at the same conclusion after the interviews.

Holistically, the analysis of the survey data, the simulated interviews and subsequent questioning of the interviewers, revealed the manifestations of various biases throughout the process. The approach to analysis enabled the most common and prominent biases that emerged throughout the process to be highlighted, with the associated data informing when and how they most frequently influenced the process. The findings have been presented here in a way that contextualizes the biases within the investigative process itself, and thus also enables discussion of how they emerged and potential consequences for practice. Where quotes are used, they are exemplars that reflect the theme as a whole.

3.6. Limitations

As with all research, this study has a number of limitations.

The small sample from a specific industry limits generalizability. However, the purposive nature of the sample and experience consequently contained therein enhances the ecological validity of the work, which in turn supports external generalization to some extent. Although the sample was specific to the construction industry, and thus the discussion is also somewhat sited, the findings remain both applicable and relevant to any other industry in which incident investigations are undertaken.

The methodological foundations for the work, and the use of simulated interviews raise further limitations. There is the potential for the 'Hawthorn Effect' to manifest resulting in a change in

behavior by those who know they are under scrutiny. However, the work of Woodcock et al. (2005) and others reassures that simulation mitigates this effect as participants become more engaged in the activity they are undertaking, and thus the Hawthorn effect is less impactful in simulations as it is in other forms of research such as participant observation within a real-life setting (e.g., Oswald, Sherratt, & Smith, 2014). The practical ability to undertake this research without a simulation should also be considered, as to undertake this work using real-life incident investigations would raise considerable ethical challenges for both the researchers, participants, and firms involved.

A further bias-related challenge was the potential for confirmation bias within the research team itself – we were looking for biases and therefore we found them. Whilst this possibility cannot be fully designed out of the analytical process, it was mitigated through the use of a robust and fully explicated experimental protocol and a highly systematic, rigorous, and repeated approach to the analysis. Taking an inductive approach to the data allowed the different biases to emerge from within the data as a whole, and this was supplemented by discussions amongst the research team at regular points throughout the analysis to provide some measure of inter-reader reliability in the process. Another potential bias could have resulted from the use of the same two students role playing the IP and witness in all cases. This raises the potential for bias in the participants to have resulted from something specific, a trait or characteristic of one of the students, that consistently affected the interviews – thus resulting in something of a 'false positive' throughout the data in terms of a resultant bias. However, this must be balanced with the need for consistency in the stories and responses to questions during the role play, and across the experiment as a whole. Different students role-playing the IP and witness would have added more confounding factors to the experiment, and thus potentially added further bias to the experiment. On balance, the decision was made for consistency, and use the same two students throughout, albeit within two different simulation incidents, in order to minimize impact on the study as a whole.

Adopting a post-positivist methodological position necessitated an awareness of bias within the research in a number of different ways that were mitigated to best efforts as noted above. However, this early work into bias in incident investigation interviews specifically adopted this methodological position to provide a firm foundation for further work to adopt more nuanced methodological approaches to continue to unpack these different biases in greater depth. For example, adopting a constructionist epistemology could provide greater insight and understandings of the emergence and interaction of biases in a way that would overcome some of these limitations, although inevitably also raise others as a result.

4. Findings and discussion

4.1. What you look for is what you find: Confirmation bias

Findings showed that approximately 30% of participants (n = 10 investigators) structured their interviews based on the initial presumptions they had stated in their pre-simulation surveys. Their questioning focused on the contributory factor(s) they had mentioned in their surveys, with considerable proportions of the interview time – in some cases the entire interview – devoted to their examination and a quest for proof that their initial ideas were correct. The initial presumptions also mirrored the conclusions drawn post-interviews. For example, in the staircase incident, an interviewer noted the structural instability of the stairs as a contributory factor to the incident. Throughout the interview, most of their questioning focused only on this specific aspect, and in the debrief session they concluded that the incident occurred due to the stairs being unstable to use. Repetition was commonplace, as the interviewer circled back to the stairs in their questioning:

> *'How was, um, how was their structural stability? Did you find them shaking?'.*
> *'So, when were those stairs erected?'.*
> *'So, the stairs…were under construction?'.*

And when the interviewee raised other potential issues, for example: *'The stairs had temporary bracings…And* again, *there was no visual or verbal warnings……..'* The interviewer focused on the structural rather than the procedural aspects of the situation thus: *'Are these temporary braces that…they were installed?'* This indicates presence of confirmation bias, where people seek out information to confirm their preexisting beliefs, even when there are other potential factors to explore (Nickerson, 1998). While the questions on face value do not confirm presence or absence of confirmation bias, the series of questions asked by participants seeking to acquire particular evidence is suggestive of confirmation bias. Equally important, most participants did not ask questions to challenge their personal notions of what may have happened, which strengthens the evidence of confirmation bias.

According to Nickerson (1998), confirmation bias can manifest in many ways, including selective attention to a particular piece of information, grounded in strongly held beliefs about an event. Confirmation bias was to a large extent expected within the simulation, as it has been found in studies in other domains (e.g., Hill, Memon, & McGeorge, 2008; O'Brien, 2009) that also illustrate how people are selective towards seeking out information that they perceive to be true, useful, and credible. Even when there are other alternative explanations available, people tend to stick with their original hypothesis – making this situation the manifestation of "What You Look For Is What You Find," as coined by Lundberg et al. (2009).

Some participants (n = 10) also asked leading questions during the interview. This is another form of confirmation bias, wherein the specific framing of the question leads the interviewee to confirm what the interviewer wants them to confirm. For example, within the staircase incident the questions (verbatim) *'so how did you feel working on the stairs? Did you feel rushed at all? Did you feel any frustration because it seemed like you were the only one working on the stairs and also she wanted it done? It was on the critical path. Did that affect you, or did you feel like it might have?'* directing the interviewee to answer in the positive, thus enabling production pressures to be included in the list of causal factors. Within the concrete form incident, a similar cause was sought, with the interviewer asking: *'you know, talking to the laborer as well, there seemed to be a little bit of feeling of being rushed. And, you know, she said that you were frustrated that she was behind…you were letting her know you weren't very happy with that. Is that accurate?'* adding production pressures to other potential causes, albeit in a more accusatory way. Production pressure is an almost constant problem for construction safety management (e.g., Oswald, Sherratt, & Smith, 2019), but although it is therefore likely to have some influence on any incident on site, it should not be 'forced' into an investigation as a matter of course.

When questions are asked in such a way as to elicit a 'confession' from the people involved, an interview becomes more typical of a criminal investigation than an industrial investigation (Vrij et al., 2014). Although asking leading questions may be necessary at times to clarify information further or echo what the interviewee has said for confirmation, overreliance on such types of questions can be problematic. Embedding presumption in the interview limits enquiry and prevents the investigator from obtaining information on other aspects or factors of relevance in the incident.

The inevitable timing of information flow in an incident, from the first phone call no-one wants to receive, to some extent embeds confirmation bias in the process and paves the way for pre-conceived notions about the potential causes of the incident. Confirmation bias cannot be avoided; however, investigators could be trained to be aware of the impacts of this bias in their decision-making, that the first phone call can create a vulnerability in the process, and to be cautious in taking lines of questioning to confirm presumed facts.

4.2. That's why they did that: Fundamental attribution error

Most interviewers ($n = 21$) stated in the post-interview that they felt that the personal characteristics of the people involved, and subsequent associated behaviors, contributed to the incident. These interviewers relied on character as evidence to make judgments of what led to the incident occurring.

For example, in the concrete form incident one of the interviewers commented on the superintendent thus: *'I could tell her she could possibly be one of those personalities that could get abrasive and strong. . .and that fact that she thought it was a good idea to put her hands in an area where somebody's swinging a hammer.'* In this example, the interviewer has directly associated a 'strong personality' with what could be described as impulsive or arrogant behavior, ascribing causality to inherent traits. Yet this conclusion neglected to acknowledge explicitly stated time pressures previously noted by both the IP (superintendent) and witness (laborer) in this incident case due to a scheduled concrete pour later that day.

This is an example of Fundamental Attribution Error; the superintendent's behavior attributed to personality, rather than considering the situational context of the work surroundings. It has been shown that people rely on character-based evidence in interviews, because it is easier to explain and something that quickly comes to mind (Sanchirico, 2001). Such judgments are often reasonable observations on the surface, only revealed as bias when (or if) the misplaced prioritization of explanations becomes apparent as events unfold. For example, in court environments, character-based evidence is often used by juries to form judgments on guilt, and conviction of the defendant (Kurland, 2014). This finding is therefore consistent with legal research, but also has wider connotations in the construction industry where 'blame the worker' has been historically problematic in safety management (Frederick & Lessin, 2000). Incident investigations should not be undertaken to blame individuals, despite the lure of the relatively simple remedial actions that can result (i.e., dismissal) compared to the much more complicated task of addressing external situational factors that might have led to the undesired behavioral outcome (Dekker, 2009).

4.3. 'Nothing surprises me anymore': Past experience bias

People make judgments by relying on and interpreting their past experiences (Ghattas, Soffer, & Peleg, 2014), however, over-reliance can result in past experience bias. In the context of incident investigations, analysis showed that investigators can and do make decisions based on their previous experiences, where they perceive the current situation to be similar to an incident that occurred in the past. Past Experience Bias was identified in some of the interviews ($n = 7$), where it limited questioning and thus learning to the scope of the investigators' own experiences.

For example, an interviewer in the concrete form incident noted *'I think a lot to do with this is that, and I've seen this before, uh, actually we've had, I've been involved with serious accidents where a superintendent has come in and changed their complete plan in the field without notifying his foreman or, or, or supervisor under him, and then really bad things happen.'* Whilst this is a valid point in the construction industry, where 'workarounds' have been found to be a causal factor in many incidents (Sherratt, 2016), insights and information from this particular incident are lost if the interviewer concludes this to be the only root cause. All incidents are unique with multiple causal factors, yet experience can mean investigators constrain their questioning to confirm the re-emergence of their own past experiences and stop there, rather than approaching the situation as a tabula rasa.

4.4. Getting stuck somewhere: Anchoring bias

When collecting information via interviews, it is essential to consider a wide variety of factors to fully understand the complexity of the work involved (Dekker, Cilliers, & Hofmeyr, 2011). In construction, these factors include human, process, and technical aspects of the work, all of which require different approaches in questioning to elicit meaningful information. However, the data revealed that many interviewers ($n = 18$) fixated on just one aspect of the incident, as anchoring bias (Tversky & Kahneman, 1974) directed their questioning, to the detriment of the process as a whole.

Within the data, various factors provided the anchor, missing foreman (concrete form), schedule pressures (concrete form), the lack of a spotter (staircase), and structural instability of the stairs (staircase). Except for structural instability of the staircase, all of these were contributory factors to the incidents, yet they were amongst many others. By anchoring to one factor alone, the interviewers often failed to explore any alternatives or even additional causes. Leaving conclusions at just one 'root cause' means learning is lost about the wider context and situation and is unhelpful when seeking to prevent recurrence and make systemic improvements to practice. Within the data most interviewers ($n = 18$) demonstrated this phenomenon, asking questions to search for further information and explanations on the factor they had become anchored to.

As an example, all the following questions were asked by one interviewer in the staircase incident.

'What's a spotter's role?'.
'Was there anything special about this day where you didn't have a spotter?'.
'. . .how did you feel about not having a spotter?'.
'. . .this member of the crew being fired, were there other occasions where you were working without a spotter in a situation like this?'.
'. . .would you feel comfortable enough with [name] if you didn't feel comfortable with not having a spotter. Did you mention it or were there any discussions at all? There's no spotter. Is this okay, anything like that?'.
'Did you, uh, or right before the incident, did you notice whether there was a spotter, uh, at that location?'.
'. . .so it's, it's yeah, so that confirmed that there was no spotter at the location.'.

This interviewer became anchored to the fact that a spotter was not present on site on the day of the incident. They learnt of the spotter from the witness early in their first interview – as the first quote demonstrates this was new information for them as they sought to clarify the role – which then led to their return to the spotter, or more specifically the lack of a spotter, throughout both interviews. Whilst asking questions about a spotter is not necessarily an incorrect line of inquiry, overreliance on this factor lead the interviewer to confirm that the absence of spotter on site (i.e., the foreman working alone on the stairs, was the main contributory factor within this incident, which was incorrect).

Within incident investigation interviews, the timing of information can be critical as anchoring bias can lead investigators to focus

on a specific factor that is mentioned early in the process. Anchoring bias can hook onto the first or last piece of information received (Kahneman, 2011), or the unfamiliar, which is what has likely happened to the interviewer above.

4.5. It was preventable: Hindsight bias

Another common finding from the analysis was that most of the investigators viewed the circumstances of the incident as preventable (i.e., they believed that the incident could have been avoided if only a particular action was present or absent). Yet, this is a manifestation of hindsight bias, which often hinders organizational learning from incidents as it directs investigators to easy solutions rather than to fully explore the situation that led to the incident.

For example, one interviewer of the staircase incident stated *'I would have completely shut that area off and not allowed in engineered or put some sort of warning signs or braces or barricades to stop anybody from even utilizing the stairs. . ...I think that this is extremely preventable incident. Um, it should've never happened in the first place.'* This statement may well be 'true' – in that the incident may not have occurred if all these obstacles had been in place – yet in taking this hindsight perspective, other aspects of the incident remained unexplored, and the actual leading cause of the incident remained unexposed. Some of the participants ($n = 9$) demonstrated hindsight bias, which led them to reposition the incident in their own minds as avoidable, and in turn thus directed questions to the things they assumed would have prevented the incident. Drawing conclusions after collecting information is inevitable, however, predicting the outcome of an event before or during the interview tends to skew the line of questioning, thereby influencing the quality of the information collected.

4.6. Taking sides and sticking to them: Conservatism in belief revision

Typically, in an incident investigation, people have their stories to share, which might or might not differ from each other. Essentially, the role of an investigator is to remain objective to all those involved and to not favor one individual when making decisions. Yet analysis of the data revealed that most of the participants ($n = 23$) to some extent favored either the IP or the witness as they made judgments and asked questions about the cause of the incident.

For example, in the staircase incident, the witness (foreman) argues that they provided verbal warnings to keep anyone from using the stairs, however, the IP (superintendent) states that they received no such communication. When an investigator hears contradictory stories of the same situation, they should treat all such information carefully, explore alternatives and seek to triangulate information with other sources to avoid jumping to conclusions about who is telling the truth. Yet the data revealed that investigators do not always ask confirmatory questions of the other party or cross-check answers. Despite this being available and interviewers being asked specifically if they wanted to ask further questions of either interviewee, they often chose not to take this option and instead aligned their questions and conclusions to just one version of the truth they had heard.

When the witness had been issued first, the interviewers took the statement about a verbal warning as fact, one commenting: *'she did verbally warn people, for what good that is, right*?' In the second interview with the IP, their narrative stated no such warning had been given, but this was often not revisited by the investigators, and they did not cross-check this statement with the witness. In the counter situation, in which the IP said no warning was given in the first interview, and the witness stated there had been, the IP's narrative often took precedence; the statement of a warning was often ignored, and again no cross-check or further enquiry was made to seek clarification.

Despite such conflicting information embedded in the incident stories, investigators seemed reluctant to change their minds about a situation. This is suggestive of conservatism in belief revision, a bias that hinders a change in position or perspective, even in the face of contradictory or conflicting evidence. The tendency for people to cling onto such mistaken and perseverant beliefs even when presented with new evidence can lead to serious consequences (Anderson & Kellam, 1992). This occurs because of the fact that when the belief system is aligned with reality, belief perseverance coerces individuals to predict outcomes in advance, thereby clouding their judgment. This bias has the potential to encourage interviewers to valorize the information of the first interviewee over those that follow in terms of who is 'telling the truth,' but also to leave lines of fruitful questioning unfollowed when they emerge as such contradictions and conflicts are left unexplored.

4.7. Bigger than the sum of their parts: Biases working together

A final notable consideration that emerged from the data as a whole was that although each bias could be identified independently within the data to the extents as noted above, they did not always emerge in isolation and in several instances, biases worked in conjunction to exacerbate their individual effects. This notion is referred to as the *Combined Cognitive Biases Hypothesis* and was conceptualized by Hirsch, Clark, and Mathews (2006). According to this theory, Hirsch et al. (2006) argue that different cognitive biases interact and have a greater influence on each other and do not operate in isolation. For example, in the staircase incident, an interviewer who became anchored early within the interview process to the structural configuration of the stairs, then also became vulnerable to confirmation bias as they sought out information to reinforce that anchor, whilst also suffering from conservatism in belief revision and a reluctance to change their mind when new information was received that challenged their original thinking (i.e., verbal warning given by the foreman). This only serves to embed the original anchor even more deeply in the interviewer's mind, exacerbating its impact, which is enhanced through the influence of other biases as the interview progresses. Different combinations of biases could be identified across the data, and in combination they often served to increase the potential for misdirection, omission, and thus the limitation of learning from any incident.

5. Conclusions

The information collection phase, being the foundation of any investigation process is of the utmost importance, as all subsequent stages depend on the quality of the information obtained in that first step. Interviews, being subjective in nature, are unavoidably susceptible to be biased as that is simply human nature – all investigators will inevitably be biased, and it is therefore critical to understand which biases most commonly manifest in incident investigation interviews, how and when. Through simulated interviews, sited in a construction industry context, confirmation bias, FAE, past experience bias, anchoring bias, hindsight bias and conservatism in belief revision were identified as the most common biases that emerged. The manifestation of these biases was linked to the timing of information received, as well as more 'psychologically familiar' situations – such as the receiving of novel information, the emphasis of person over context, and the (again inevitable) past experiences of the investigators. Bias directs and shapes interviews through the lines of questioning taken by interviewers, which can lead to limited investigations, and the omission

of questions able to reveal more nuanced information about the incident. As accidents are unique, multi-causal and situated, so to limit investigations in this way from the very first step, and thus stymie organizational and industrial learning and resultant positive change, is something to be avoided.

This study offers a unique contribution to this field to date. From a theoretical perspective, these findings contribute to the small yet growing body of literature on biases in industrial incident investigations. From a practical standpoint, these findings can be used to inform strategies or underpin interventions to mitigate the effects of bias in the specific practice of incident investigation. For example, as suggested by MacLean (2022) these findings could support the development of specific education and training tools to help investigators remain mindful of biases both during interviews and when reaching conclusions to optimize learning from incidents and their reduction in practice.

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The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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