

WHAT IS RISK? CONSTRUCTION ACTIVITY NEAR HAZARDOUS INFRASTRUCTURE

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Construction management has a strong safety focus directed primarily at reducing risk to workers. There is a special class of construction work that has the potential for a different set of safety issues – work that could damage hazardous infrastructure with possibly catastrophic effects for workers and the public alike. The natural gas pipeline failure as a result of car park construction in a light industrial area at Ghislenghien, Belgium in 2004, which resulted in 24 deaths, is one such example. The primary focus of this research is a case study regarding project-related construction activity around high pressure natural gas pipelines in Australia. Drawing on data gathered from in-depth interviews, alternate definitions and meanings of risk are explored amongst stakeholders who are responsible in some way for work near or around high-pressure gas pipelines. The research uncovered perceptions of risk from project personnel in various parts of the supply chain, couched in terms of project delays, legal and insurance obligations, as well as reputation management. The research demonstrates that, whilst damage to buried assets is recognised as something to be avoided, awareness of the potential for major disaster is poor. Further, supply chain contractual structures based on 'pay per meter' and risk control strategies relying solely on enforcement and procedural compliance, create a safety environment that is ineffective and dangerous. Responsibility for risk is shifted down the supply chain and yet field personnel are exposed to incentives for timely project completion. Consequently, strikes or near misses may result as sub-contractors seek to avoid perceived 'unnecessary' time delays and any associated financial impact. The research shows that efforts to reduce the potential for pipeline strike need to be targeted at organisational and supply chain structural changes, rather than simply aimed at worker risk perception and enforcement of safety compliance strategies targeted at field personnel.

Keywords: risk, health and safety, contracting, motivation.

INTRODUCTION

Construction management has a strong safety focus, but this is directed primarily to reducing risk to workers from the physical hazards of their specific tasks. When work is undertaken close to hazardous infrastructure, the potential for catastrophe exists. This was dramatically illustrated in Ghislenghien, Belgium in 2004 when construction of a car park damaged a high pressure natural gas pipeline. When normal pipeline operations resumed some time later, the pipeline ruptured resulting in 24 deaths, mainly amongst emergency services crews (Mahgerefteh and Atti 2006).

In Australia, analysis of pipeline damage events has shown that 86% are caused by people outside the pipeline sector working near buried infrastructure (Tuft and Bonar 2009). Such events are effectively 'near misses' for Ghislenghien type events. For the

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gas pipeline sector, this provides a significant incentive to better understand the motivations of those who are responsible for such work.

This paper reports on some of the initial findings of research commissioned by the pipeline sector into attitudes towards risk of those involved in work near pipelines. It addresses a single case study of a large infrastructure project that involves significant construction activity near pipelines. The aim is to reveal specifically how relevant stakeholders comprehend risk and responsibility for prevention of pipeline damage or failure.

The case study project uses typical supply chain arrangements with project management retained in-house but responsibility for detailed design, installation work planning and activity managed by a complex chain of contractors and sub-contractors. All construction work is done on a pay per meter basis.

The analysis is based on an organisational view of accident causation and prevention as illustrated by James Reason's Swiss cheese model (1997) and the work of the high reliability researchers such as Weick and Sutcliffe (2001). In this way of thinking about safety, the performance of all components in the system is interlinked and the primary responsibility for safety rests with management, rather than workers in the field. We also draw on literature regarding error management (Reason 1990), proceduralisation (Bourrier and Bieder 2013) and the role of rules (Hale and Borys 2013a, b).

METHOD

This research uses a case study approach in order to develop a detailed and nuanced understanding of the perceptions of individuals through the supply chain of one construction project. As such, it makes no particular claim to generalizability instead relying on the value of case studies as concrete, context-specific knowledge that is critical for expert learning (Flyvbjerg 2006).

The research primarily draws on interviews with representatives from a case study organisation (CSO) involved in construction of a large-scale infrastructure project and their contractors (15 interviewees). Interviews with pipeline industry personnel (20 interviewees) also inform the results. These exploratory conversations aimed to ascertain the differing conceptualisations of risk including how such perceptions are framed and why. Further data is drawn from a content analysis of policy and procedural documents. Interviews were transcribed for analysis. Direct quotes were extracted regarding motivation, primary task and governance frameworks. These were then analysed in more detail to establish similarities and differences in attitudes to risk, safety, worker behaviour and organisation of work.

RESULTS AND DISCUSSION

In all cases, these descriptions are taken from the words of interviewees. Our focus is therefore on work as done (or at least as perceived to be done), rather than work as described in formally documented systems. We also emphasise the social aspects of work – who interviewees believe to be responsible, how they report on actions of others, what they believe to be important etc.

Attitudes to Risk

The first key issue revealed by the data is interviewees' understanding of the primary task of the CSO - rolling out a national infrastructure project on time and within budget. They do not (with a few minor exceptions) conduct fieldwork themselves, but

rather operate a complex chain of what they call Delivery Partners who manage contractors and sub-contractors across the country on their behalf. Nevertheless, the CSO project could potentially interrupt supply or damage a high pressure gas pipeline and attitudes to the risk that this poses are therefore relevant. Across all interview participants, the risks associated with strikes to underground services generally were conceptualised and described in terms of the possible consequences using words such as ‘potentially huge’, ‘catastrophic’ and ‘devastating’. But what are these consequences of concern?

In addition to safety, other identified risks included negative media coverage, and thus negative public perceptions of the reputation of any organisations that may be implicated in the event of a major strike or any interruption of supply eg:

“... it's our brand, it's our name, it's our reputation that is on the line because no one ever, if you ask anyone's that's going down the street, it's not ... the Delivery Partner ... So it is about us, it is our name and people will see our name and associate us with that damage before they associate the actual person who done the damage ... it's definitely a brand issue.” CSO 06

Other risks identified by the CSO representatives and contractors included damage to the pipeline asset and other infrastructure, subsequent remediation costs as well as economic consequences from interruption of supply due to a third party strike.

“Safety there's obviously a high risk or potential high consequence kind of impact. It'd be financial risk as well. I guess they're the two main ones aren't they? It's an environmental risk as well and it would be a risk to our reputation and our good name. It'd obviously be well publicised if something did happen.” Civil Contractor 03

“So, it's a significant problem ... the infrastructure that would be damaged, buildings, housing, road infrastructure, electrical infrastructure, water infrastructure, stormwater infrastructure, I mean, it's all, it's just a knock-on effect.” CSO 01

Other interviewees were more concerned about delays following an incident and the legal liability that could follow. As these CSO participants and a civil contractor engaged by a CSO Delivery Partner indicated:

“... there's delays in the build, there's ... It's the actual reporting time, interviews, and all that sort of stuff” CSO 10 and 11

“Yeah, I guess ... the first factor would be our legal liability as a [body with statutory responsibility] to engage with our contractors and Delivery Partners.” CSO 03

“Basically, our job with drilling is to get a new service from point A to point B. Obviously there is a lot of infrastructure in the ground already. 1) We don't want to damage it to cause down time; 2) the biggest thing is safety. We don't want the guys to get hurt.” Civil Contractor 02

Importantly, whilst stressing that the types of risk were not articulated ‘in any particular order’ and despite senior management claims that ‘safety is the first value in the company,’ worker safety or broader concerns around community safety were often some of the last aspects to be cited.

Perhaps the clearest indication that pipeline strike is not primarily a safety issue for the CSO is the fact that risk from all buried assets is treated equally. As one interviewee explained:

“... I don't think we really distinguish between them [types of buried assets], suffice to say that there's a work practice process going on that our contractors and workers need to manage.” CSO 03

Of course whilst the business risk is similar, the safety implications of striking a high-pressure gas line are completely different to that associated with damaging telecommunications cabling. For the pipeline industry, avoidance of pipeline strike is desirable because security of supply is their primary business goal and the public service linked to that is the highest priority. For the CSO, pipelines strikes have a different relationship to business objectives. On schedule and budget performance of their project is paramount and any asset strike, including pipelines, poses a risk to that.

Beliefs About Why Strikes Occur

Many CSO interviewees spoke about incidents of damage to buried assets in general terms and offered their opinions as to why they occur despite their efforts to eliminate this problem.

Generally speaking, there are two alternative ways in which errors by field personnel can be described (Hayes and Hopkins 2014: Chapter 4). The first is an explanatory paradigm that seeks to understand why an individual behaved in a particular way and so how this might be avoided in the future. These explanations are found in the organisational view of accidents described earlier.

Explanations of the behaviour of field personnel can also be made using an 'error management' approach to safety (Rasmussen 1982, Reason 1990) which focuses on the cognitive classification of errors as slips, lapses, mistakes or violations. Such classifications can also provide insights into the individual and organisational causes of error. Unfortunately the focus sometimes moves to a normative paradigm which attributes accidents to individual fault (Dekker 2007). In this paradigm, error would be eliminated if only workers behaved properly.

CSO people interviewed to date are largely office-based personnel, although some of them have roles involving site audit. A clear common theme in their explanations of why accidents occur is that field personnel are at fault. Their explanations are normative in several ways and so are focused on faults with the workers themselves, rather than providing any explanation as to why workers might have behaved in particular ways.

The first commonly proposed reason for errors in the field is lack of knowledge. Workers in the field make errors because they just don't know how to do the work in the right way. For example:

“I think people mostly are unaware of the hazards, they just don't know.” CSO 09

“So people see a marker and they go, “Oh well gas line must be under here so I'll be right.” Okay, so the different methodology being used by the different utilities is important for these guys to understand.” CSO 04

This is often an insidious way of shifting blame onto frontline personnel. Lack of knowledge can perhaps be an indication that improved communication and training is needed, but it is often framed instead as meaning that workers are ignorant or even stupid. Some of our interviewees were of this view. As another CSO person told us:

“It's about workflow management and laziness. Some of our Delivery Partners, their field people are overworked or just downright lazy ... You can't fix stupidity.” CSO 13

This individual is putting forward two normative explanations for worker errors - stupidity and laziness. Another normative explanation given by several interviewees was complacency or carelessness.

“Not enough due care and attention ... is there the danger that as people do tasks more frequently ... there’s a degree of complacency, ‘It hasn’t happened to me, it’s not going to happen to me,’ that sort of thing.” CSO 02

“You should not put a shovel in the ground before you do a [one call system]. The information’s there, it’s more interpretation I suppose, comes down to due diligence, due care.” CSO 06

In summary, the CSO reportedly has a chain of contractors who employ workers who are stupid (don’t know what they should do, despite having been told/trained), lazy (know what they should do but do something requiring less effort), careless (know what they should do but don’t pay sufficient attention) and complacent (know what they should do but ignore dangers). These explanations put aside consideration as to why people may have behaved in a particular way and as such are inconsistent with an organisational view of accidents as described in the introduction. Without that broader perspective, any efforts aimed at improving performance must focus only on enforcement of rules and punishment for deviation from the required behaviour.

Risk Shifting

There is an alternative explanation as to why workers do not always follow rules. In the case of the CSO, a minority of interviewees thought that there may be organisational reasons why workers behave ‘badly’, specifically, some workers may engage in these acts based on their belief that they are doing the right thing and in order to meet project deadlines or ‘get the job done.’ This type of routine violation is well known in the safety literature (see for example Iszatt-White 2007) and there is evidence of these types of pressures in the data:

“... I’ve seen our contracting team do the wrong thing in not getting their [one call system documentation] or getting a permit in place. It’s about timelines, trying to get the work done, pressure from further up in completing that job on time and under budget. That’s the whole thing, because the longer you have those crews out there or anything like that and they work into overtime, it may not have been budgeted for. So all those sorts of commercial issues come in for a contractor” IND-07

“Everything has a deadline, so at the end of the day, safety plus quality plus productivity should equal the end result. Sometimes we forget, we just look for the end result or for the target and the pressure to build can affect that. ... we’ve got, inside the company and outside the company, people driving ... the quicker you get a job done the more margin you make.” CSO 07

These comments highlight an important point that emerges from the data. CSO interviewees have indicated that the main reason for avoiding pipeline strikes is because of their time and cost impact on the project. However the reasons for avoiding the measures put in place to prevent strikes is also the time and hence cost involved. Rather than a question of safety, we now have simply two financial motivations that are fungible.

CSO interviewees were reluctant to see this link. One senior CSO manager stated that *“... getting paid by the metre might be a factor, but it’s not the root cause. I just think that there are a number of root causes and incentives or payment is only part of it”*

[CSO 01]. When probed, this participant went on to criticise the field contractors because they are “*poor at identifying where the assets are and exposing the assets*”. In other words their failure to follow process is the ‘root cause’ of accidental asset strikes. This illustrates the tendency for CSO personnel to ‘shift’ responsibility – and blame – for any accidental incursions away from any organisational or structural factors to the level of the individual contractor or frontline worker.

In summary, the CSO attempts to address third party activities around pipelines through specific systems and processes to govern work activities. Third party activities are subject to surveillance and monitoring using an ongoing audit process to ensure compliance with particular systems and processes as well as legislative frameworks. Underpinning these systems and processes are strongly held views that equate compliance with prevention of pipeline or asset strikes. As one CSO representative explained: “... *we just oversee it based on these guys following their own processes. And they have great ones and it's proven, like probably 98% of the time, had they adhered to that, their own process, it wouldn't have happened*” (CSO-10). This person seems to be allocating 98% of the responsibility for pipeline strikes to the workers and only 2% to problems with processes. In other words, a risk governance framework in the form of systems and processes is equated with safety.

Governance systems and processes

To manage the risk of pipeline strikes, the CSO implements particular systems and processes. Risk management, and thus public and worker safety, is conceptualised as compliance with specific governance frameworks that are articulated in legislation. The following comment emphasises that in the view of CSO interviewees, responsibility, and accountability, ultimately rests with the Delivery Partner (principal contractor) to follow and ensure compliance with rules that are fixed because they have their origin in regulation and liability:

“Yeah, well that sub-contractor would be responsible for it because it's their responsibility to get the [one call system] plans and locate the assets so they have to follow the rules. The principal contractor would wear obviously some of that responsibility if there were a death or anything like that and obviously up the chain. So that's why everyone has to have their due diligence up to the client, but the main person would be that sub-contractor.” CSO 12

Whilst clear identification of roles and responsibilities is important, as we can see, the data again reveals a tendency amongst CSO participants to allocate responsibility, and thus liability for errors to Delivery Partners or other frontline personnel. There is no sense that the primary goal of CSO interviewees is to protect the public from disaster.

This exclusively top down and highly rigid approach is reflected in the way that the CSO behaves. The CSO devolves responsibility for safe work systems and processes to their Delivery Partners, or principal contractors. However, these groups as well as any sub-contractors they may engage are required to align their policies with the CSO's overarching risk-based compliance framework, including appropriate training and supervision. Compliance with those processes is audited by the CSO. For example:

“My job is to manage a team of people whose tasks involve primarily audit and inspection for compliance to legal and other regulations of our Delivery Partners” CSO 03

A significant aspect of the CSO's array of systems and processes are 'critical risk controls (CRCs),' stipulated by top management that specify mandatory systems for working near underground assets. Of course top management attention to critical safety issues is to be encouraged as a lack of understanding of the impact of top management decisions on safety has been shown to be a major factor in several serious accidents (Hayes and Hopkins 2014). Having said that, Schein (2013) has described the need for what he calls 'humble inquiry' on the part of top management in order to understand the state of safety, promoting an attitude of listening, rather than telling. Telling is the dominant communication strategy from the CSO to its Delivery Partners who are contractually obligated to adopt and orient their own systems and processes around these CRCs. As these comments from CSO representatives and a Delivery Partner employee stated:

"They are contractually obligated to the critical risk controls. So they're given a copy at tender." CSO 01

"... we told [the Delivery Partners] that they had to align to [CSO critical risk controls] and get the systems to align to it. Then we did some audits on that to make sure that that included all the relevant things that we thought if you implement you reduce your risk of damaging the assets." CSO 12

At the CSO, safety is equated with, but ultimately secondary to, risk mitigation, which is attained through rule-based compliance that is monitored and audited using systems and processes including critical risk controls.

Compliance and proceduralisation of risk

Adherence to an overly compliance-based approach to safety, or the proceduralisation of risk, is problematic for safety. This is not to suggest that rules and procedures are not important. They play a key role in managing risk and are essential elements for any modern organisation to function effectively but a problem arises when procedures are seen as a universal panacea. Bourrier and Bieder (2013:3) provide a succinct description:

Historically, to put it bluntly, proceduralisation has been the response to flaws identified through accident investigation and analysis. It was also the only response that made sense in a world where beliefs on safety were (and still are in many places) based on a model which assumes that safety results from reliable equipment, good procedures and processes, well-behaved operators and well-designed organisations.

As we have seen earlier, the CSO takes the view that 'safety' is achieved by exactly these types of measures – good procedures and processes and well-behaved operators that adhere to procedures or rules. The world is, in fact, far more complex than this.

Rules, or procedures, can either act as an aid, supporting workers in a difficult task or as a standard to which compliance can be enforced (Fucks and Dien 2013, Hale and Borys 2013a, 2013b). There is evidence of this second approach in the CSO data. For example, CSO rules about prevention of pipeline strikes are described as 'rules that cannot be bent' and as 'hard and fast rules of what people must do' [CSO 01]. Nevertheless, evidence that this approach is not successful is also illustrated by that same participant who goes on to note, 'but we're still hitting things' [CSO 01].

A further issue with the proceduralisation of risk is that proceduralisation itself becomes a proxy for safety issues i.e. compliance with the process becomes the goal in its own right. Adherence to process, accompanied by a concern to manage liability,

drives a push towards a reliance on audits (Power 2007). This is evident across the CSO interviews:

“So firstly, we see that ... they’ve done a risk assessment and identified all the different activities and training required ... we look at the systems first, ... then we monitor them, that they’re compliant to their own systems ... “ CSO 04

“ ... we would audit that they have followed the processes ... they have their own processes that they have to follow ... we would turn up and do an interaction on a particular crew on a particular day, might be one week, might be one a day.” CSO 06

From this perspective, failure to comply or deviations from procedure become easier to understand. However, this also means that the social processes attached to the daily uncertainties and complexities, or the *“real conditions under which safety is produced”* are neglected (Bourrier and Bieder 2013: 3). The literature shows us that in reality, safety results from the complementary interaction of formal prescriptions as well as informal rules (Fucks and Dien 2013). A reliance on procedures can create a context in which individuals forget, neglect or avoid anything that is not formalised. Increasing formalisation of procedures, or bureaucratisation, was identified in early organisational sociology literature, which point out that bureaucracy can lead to over-compliance. In that type of situation compliance with rules becomes the aim rather than a means to a goal (Merton 1968). Such over-bureaucratisation in an organisation can result in the *“transformation of people into robots”* (Fucks and Dien 2013:32). This can also contribute to a decline in actions that perform and enhance safety, such as the ability to consider a variety of elements, an analytical and critical sense at work that includes taking the initiative and questioning procedures or practices that are seen as problematic, ineffective or too complex.

This is an important point because workers' willingness to reflect on, and then if necessary adapt, their work practices is challenged by procedures that contribute to perceptions that actions taken outside the rules are ‘too risky,’ particularly if people are convinced that those actions will lead to negative employee evaluations (Reason 1997). Added to that loss of autonomy and reflexivity, and despite being underpinned by an intention to enhance safety and worker responsibility, reliance on procedures and rules can contribute to a ‘blame culture’ where analysis of any organisational failures means that individuals are stigmatised as responsible for those failures (Dekker 2007). This type of human error paradigm is often used to reduce ‘failure’ to the individual level but neglects to consider broader organisational or social factors that might contribute to why individuals make ‘wrong’ decisions. As we have already seen, there is evidence in the CSO data that errors by field personnel are perceived as the ‘root cause’ of why accidents occur.

Safety research indicates the many ways in which a strict compliance approach such as that adopted by the CSO is unlikely to result in the best safety outcomes. This then raises the question as to why the organisation has chosen to use this method of managing what they see as a critical risk. It seems that, rather than directly addressing the difficult problem of managing the potential for a catastrophic pipeline rupture whilst meeting ambitious project schedules, the CSO pass on responsibility for the issue and, critically, for management of uncertainty, to their sub-contractors as the following extract of interview illustrates.

“... we expect our contractors to be diligent. But with the rates that are paid, via [CSO] or not so much [CSO], but ... the Delivery Partner, the rates that they pass onto their contractors, they take a lot of the margin out. So the Delivery Partners, it’s

metres in the ground to them, and while they're stopped and potholing and all of that, they're not getting paid for that. So it's a commercial impact." CSO 13

This comment indicates that as far as this interviewee understands it at least, contractors are required to follow procedures and yet the risk of variation in work that they are required to do as a result of those procedures is not paid for by the CSO or the Delivery Partners.

In summary, the CSO attempts to control safety outcomes by using a top down overly proceduralised governance structure. Indications are that it is not highly successful as reportedly strikes to underground assets continue to occur (although we have no specific statistical data on this). In considering why such an approach to safety has been taken, we have noted that the business model of the CSO appears to provide strong justification for adopting the strict compliance model that the CSO has put in place because it shifts financial risk away from the CSO itself.

IMPLICATIONS FOR THE CONSTRUCTION INDUSTRY

Our research to date indicates that within the CSO, there is a high awareness of the risk of damage to underground assets but this is seen primarily as a business risk to the organisation itself rather than a significant safety issue. The potentially catastrophic safety consequences of a high pressure gas transmission pipeline rupture are not widely understood. The San Bruno disaster in 2010 which caused eight public deaths and burned down this suburb of San Francisco illustrates the destructive power of a major leak from a high pressure pipeline (Hayes and Hopkins 2014). Construction activity could result in a pipeline accident on a scale not appreciated by the CSO and, we suspect, by many other construction organisations outside the pipeline sector.

In this case, the way in which project work is structured shifts management of low frequency but high consequence accidents to the bottom of the supply chain. We make no claim to generalise the findings and yet we note that this contractual structure is far from unique to this project. Privatised utility operators are constrained in their ability to address this directly (even if they are aware of the problem) as they have limited powers to mandate actions by other commercial organisations. There is clearly a role for government here but effective safety risk management also requires structural changes in order to align financial and business incentives with the desired safe behaviours throughout the supply chain.

This research is continuing with further interviews aimed to address two main groups - workers in the field and other organisations such as local councils that commission construction near hazardous linear infrastructure.

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