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Beyond ConCA: Rethinking causality and construction accidents

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ABSTRACT

The construction industry takes an orthodox approach to safety: Finding root causes, quantifying risk, and often blaming frontline workers. However, safety has reached a plateau and the limitations of this approach are starting to be acknowledged. A sociotechnical systems approach (as applied in the ConCA model) presents new opportunities to understand accident causation by linking immediate accident circumstances with the distal shaping and originating influences.

32 construction safety managers, consultants, and experts contributed their views regarding the hazards of construction (both human and physical) and the difficulties managing these. The findings provide an insight into the work of construction safety managers and their decision making which is influenced by industry-wide pressures and worker attributes over physical hazards.

Construction suffers from a wide range of pressures; a combination of both top-down, from the client, and bottom-up challenges from the workforce it attracts. The original ConCA model has been revised to reflect the findings. By applying systems thinking, the relationships between negative perceptions of workers' risk-taking and these challenges can be crystallised. The results support integrating safety into primary activities to increase engagement, learning legacies to transfer knowledge between projects, multi-disciplinary teams to raise risk awareness, empowerment to combat their feelings of dissatisfaction and disloyalty, and collaboration in risk management to incorporate workers' expertise and ensure they feel valued.

1. Introduction

Fatality rates in construction are three times higher than the average across all industries – 1.94 per 100,000 workers compared to 0.46 across all sectors in the UK (HSE, 2016) and 10.1 compared to 3.4 in the US (Bureau of Labor Statistics, 2015). The sector contributes substantially to the total number of occupational fatalities worldwide: 31% in the UK (HSE, 2014), 18.9% in the US (NIOSH, 2011) and 20.9% in the EU-28 (Eurostat, 2016). Over the last century these statistics have improved significantly, yet progress has plateaued in recent years (Bureau of Labor Statistics, 2015; HSE, 2014). Disillusionment with normative safety culture programmes (Guldenmund, 2010; Long, 2012; Sherratt and Dainty, 2017) and bureaucratic safety management systems (SMS) (Bieder and Bourrier, 2013; Dekker, 2014) is growing. Dekker and Pitzer (2016) claim these traditional forms of safety will never reduce accidents to zero because the methods themselves overcomplicate matters and draw focus onto trivial risks, leaving organisations vulnerable to catastrophic and highly improbable 'black swan' (Taleb, 2008) events.

Although construction's orthodox approach to safety may go some way to explaining this decline in safety improvement, progress is also hindered by the project-based nature of the industry which requires a dynamic and decentralised network of organisations (Lingard and Rowlinson, 2005). Building for a client means designs are unique, profit margins are low, and work is suited to a loosely coupled and dynamic network of specialist organisations contracted to specific aspects of the build. The temporal nature of work and contracts attracts uncommitted and low-skilled workers; subcontracting limits investment in training and safety management; financial constraints do not allow for contingencies or new ideas; learning is rarely transferred between projects; and the culture of litigation, blame and intolerance stifles progress (Harvey et al., 2016a). These difficulties of managing complexity, inconsistency and conflicts of interest in these temporary multiple organisations have long been recognised (Stringer, 1967).

This type of organisation presents many obstacles for management, learning, and innovation, and as such construction relies on a traditional stance of safety-by-compliance. Its philosophy is based on finding the 'root cause' of accidents, quantifying risk, and reducing it through technological and administrative interventions. In contrast, contemporary safety paradigms encourage a holistic view of jobs, work,

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and systems (Hale and Hovden, 1998; Wilson, 2014) and a humanistic view – focussing on ensuring safe operations, rather than preventing unsafe ones – and seeing people as a valuable source of responsiveness and resilience, rather than a liability to be constrained (Hollangel, 2014). For safety in construction to continue to improve, developing this type of approach could benefit the sector; however, others have questioned whether these new concepts are applicable (Harvey et al., 2016b) or necessary (Lingard, 2013).

1.1. Sociotechnical systems and systems thinking

Sociotechnical Systems (STS) theory developed in the 1950s and originally focussed on the impact of technology at work, but has also been applied to risk, health, safety, and accidents (Waterson et al., 2015). This era introduced a shift away from traditional perspectives on human error towards a more naturalistic and contextualised approach "*to provide a 'holistic' assessment of work–system interfaces and to capture the interaction between these*" (Waterson et al., 2015). STS sees humans as assets and technology as a tool, and emphasises quality of life, respect for individual differences, and respect for stakeholders (Eason, 2008; Read et al., 2015).

The role of social and cultural factors in accidents has been recognised for over 30 years (Pidgeon and O'Leary, 2000; Turner and Pidgeon, 1997), as well as political, economic, legislative and regulatory influences. Fundamental to an STS approach to risk management is the belief that accidents "*are not only caused by direct physical events, nor by human errors alone. They have their roots in organisational settings and in the sociotechnical system companies are active in*" (Swuste, 2008). Therefore, when considering the role of humans in accidents, a systems focus is vital – taking account of context, interactions, complexity, emergence and alternative perspectives (Wilson, 2014).

1.2. Systems thinking in construction

There have been calls for construction to move away from a 'root cause' mentality towards accidents since the turn of the millennium (Gibb et al., 2001). Several studies looking into the factors affecting performance on construction sites emphasise managing safety at every level of the system (Sawacha et al., 1999); In particular, the Construction Accident Causation (ConCA) model promotes a holistic view of incidents (Haslam et al., 2005). The model shows the relationships between the immediate circumstances causing an accident, and the factors which shape and originate it – following in the footsteps of Reason's 'Swiss Cheese' metaphor (Reason, 2000) (Fig. 1). It demonstrates the requirement for a collaborative effort to own and manage risk from the client team, concept designers, project management, preconstruction planners and the industry as a whole, and to ensure risk management robust, integrated and participatory (Gibb et al., 2006).

An integrated approach has been shown to support project success (Franz et al., 2017), organisational learning (Behm and Schneller, 2013), the relationship between designers and constructors, (Atkinson and Westall, 2010), teamwork between trades (Baiden and Price, 2011) and safety leadership, by developing trust and communication throughout the system (Donovan et al., 2016). Systems thinking has been applied to demonstrate the emergence of events, such as why safety outcomes are often inconsistent with inspection results (Saurin, 2016) or supposed leading indicators (Lingard et al., 2017). However, a need for further research into systems thinking in construction has been recognised (Love et al., 2016); While in other sectors systems models have progressed and developed, ConCA remains the best fit for construction.

The existing literature on systems dynamics modelling in construction often takes a '*hard*' (Scholz and Tietje, 2002, p. 120) or objective approach to modelling the complexity of construction organisations and performance, based on data mining of accident reports (Chi and Han, 2013), existing literature (Shin et al., 2014), or simulations (Goh and Askar Ali, 2016). Conversely, literature on risk management and risk-taking focuses on the range of proximal and distal factors which predispose workers to these behaviours (Choudhry and Fang, 2008; Oswald et al., 2014) but rarely explore the relationships between these and where they originate from (Asilian-Mahabadi et al., 2014).

1.3. The present study and organisation of the paper

The aim of this study was to review the credibility of the ConCA model with a panel of expert interviewees. Their perception of the system, the pressures they face, and the factors which shape their decision-making and leadership style were discussed and mapped onto the original framework. This included the intrinsic hazards of the building process, the workforce, and the wider system. These data were used to crystallise relationships between these factors and substantiate the systemic nature of accident causation.

The findings are presented as 2 sections. First looking bottom-up at the nature of work and the workforce, then looking top-down at the organisational and industrial challenges. The discussion brings these together drawing out 5 key themes, or common perceptions of workers, and exploring their systemic origins. Finally, a developed and updated version of the ConCA model is proposed which gives a fuller picture of accident causation.

2. Method

2.1. Study design

Occupational Safety and Health (OSH), ergonomics, built environment, and STS are all research fields which have been said to take an overly pragmatic approach to research (Dekker et al., 2012; du Toit and Mouton, 2012; Shannon et al., 1999; Waterson et al., 2015). A qualitative approach is advocated to gain a deeper understanding of the social phenomena involved – in this case decision making and risk-taking. In particular, interviewing was chosen as it gathers meaning-laden and contextualist data to explore and make sense of these constructs.

A draft protocol was developed based on investigators notes from a focus group with 14 participants who discussed the key issues facing safety and health in construction projects. This ensured the scope of the questions would cover a sufficient breadth of human and technical factors at all levels of the system, in accordance with STS theory. The questions were chosen to gain an in-depth understanding the role of those managing risk in construction with each question focussing on a different facet – hazards, challenges, workers' attitudes, and factors contributing to unsafe acts. This was piloted with 1 participant to confirm the questions and probes were thought-provoking and the responses relevant and valuable. The final semi-structured interview protocol was designed comprising of 5 questions (Appendix 1).

Limiting the questions to a loose schedule helped to achieve a '*rich*' (dense and meaningful), saturated dataset focussed on these areas of interest (Guest et al., 2006), which in turn maximises the potential to find meaning (Onwuegbuzie and Leech, 2005). However, a semi-structured design was chosen as it allows a balance between gathering rich and focussed data and keeping the feel open and conversational; this builds rapport between the participant and investigator, encouraging them to share stories and examples from their own experience (Rabionet, 2011). A semi-structured design also supports probing or following-up responses to understand their meaning (Given, 2008) which is important given the exploratory research question.

2.2. Participants

Participants were recruited through the researchers' contacts and snowballing the invitation to participants' colleagues. Judgement sampling was applied (based on occupation and experience) to create a