Buildings as complex systems: the impact of organisational culture on building safety

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High-risk buildings can be considered as complex systems, which draws attention to the organisational and social underpinnings of their safety. This research draws on complex systems theory and high reliability organisations (HRO) literature to develop insights into the cultural aspects of safety management and regulation of high-risk buildings. Ten semi-structured interviews were undertaken to explore the opinions and experiences of built environment professionals in England about the ongoing regulatory changes regarding high-risk buildings following the tragic fire at Grenfell Tower. The findings expose some aspects of the organisational culture that underpin the safety-related behaviour in high-risk building life cycle in England, which are incompatible with those that underpin HRO. The findings also show how the studied regulatory changes are subsumed by this organisational culture and fail to deliver their intention. Hence, the paper establishes organisational culture of the building life cycle as a key consideration for safety management and regulation of high-risk buildings. The conclusion calls for future regulatory, practical and research efforts to develop a better appreciation of the organisational culture, and to aim for measures to cultivate a culture that enables collective mindfulness.

Keywords: building regulations; building safety; complex systems; high reliability organisations; organisational culture.

Introduction

Building safety is a topic of utmost importance considering the potential catastrophic outcomes of safety failures. Building regulations are the main means through which building safety is assured, but despite the widespread use of building regulations globally, serious safety failures continue to occur in buildings (e.g., Structural Safety 2019, Kodur *et al.* 2020, Fire Safe Europe 2021); thus, resulting in attempts for regulatory reforms worldwide (The World Bank 2013). A common principle underpinning most of these attempts is the adoption of a ‘risk-based approach’ (Black 2010), which suggests regulating building safety based on a classification of safety risk-

level. Such an approach typically considers factors such as the size, design features, construction methods, and final use/operations of the building (The World Bank 2013). Thus, it has been recognized that, when it comes to assuring safety, high-risk buildings need to be considered as complex systems, "where the actions of many different people can compromise the integrity of that system" (Hackitt 2018, p. 6).

A conception of high-risk buildings as complex systems implies that the safety of these buildings must be understood and managed holistically. However, currently, the academic literature, professional expertise and regulations on building safety are fragmented, mirroring the fragmented organisation of building life cycle (Latham 1994, Pitt and Hinks 2001, Alashwal et al. 2011). This paper explores how the safety of high-risk buildings could be approached holistically, as complex systems, and the role building regulations could play in enabling this.

To this end, in this paper, insights from research on complex systems and high reliability organisations (HRO) (Weick et al. 1999, Weick and Sutcliffe 2007), in particular, the idea of collective mindfulness rooted in organisational culture (Weick 1987), are applied to an empirical case. This case concerns the ongoing regulatory reform in England following the tragic fire at Grenfell Tower, a high-rise residential block in London, UK. In the aftermath of the tragedy, the UK government commissioned a report, known as the Hackitt Review (2018), to identify the lessons to be learnt from the incident with respect to systemic failures in the building regulatory regime. The Hackitt Review (2018) suggested that, in terms of safety, high-risk buildings should be treated as complex systems, and it recommended several changes to the regulatory system for high-risk buildings in England, while also emphasising that these need to be accompanied by a culture change. Following the publication of the Hackitt Review (2018), the UK Government, which had already implemented some

regulatory changes, decided to implement all the regulatory recommendations of the Hackitt Review (2018) within proposed legislation (MHCLG 2020b), with the aim of establishing a holistic life cycle approach for managing the safety of high-risk buildings as complex systems.

In this setting of ongoing regulatory reform, ten semi-structured interviews were conducted with actors who engage with fire-safety related issues in construction project delivery and operations in England. By exploring the interviewees' opinions about, and their response to, the regulatory changes, the interviews revealed aspects of the organisational culture in high-risk buildings' life cycle in England. These aspects are in contrast with those that underpin collective mindfulness in HROs. Furthermore, the regulatory changes are subsumed by this organisational culture, which prevents the regulatory changes from creating the desired changes in practice. The conclusion calls for future regulatory, practical and research efforts to put organisational culture at the heart of safety management and regulation in high-risk buildings' life cycle; and to cultivate an organisational culture that enables collective mindfulness.

The paper is structured as follows. The next section discusses the need for, and the safety implications of, conceiving of high-risk buildings' life cycle as a complex organisation. This is followed by a discussion of the literature on high reliability organisations (HRO), which explains how complex organisations can reliably prevent catastrophic safety failures by establishing an organisational culture that enables collective mindfulness. The methodology section presents the research design and provides background information about the empirical setting within which the interviews were conducted. Subsequently, the findings are presented as three themes demonstrating the interviewees' perceptions of, and response to, the regulatory changes; thus, revealing some aspects of the organisational culture of high-risk buildings' life

cycle in England. These cultural aspects and their effects on the regulatory reform are discussed in relation to the cultural underpinnings of collective mindfulness to provide insights for the management and regulation of safety in high-risk buildings.

Conceiving of high-risk buildings as complex systems

The safety of a building is determined by interdependent decisions and actions taken by a variety of stakeholders during the interrelated phases of design, construction and operations/occupation; however, there has been a lack of research studying building safety holistically, from a life cycle perspective (Yau *et al.* 2008). Most academic and regulatory literature concerning building safety mainly focusses on individual types of safety hazards (e.g., fire safety, structural safety) and phases (e.g., fire safety of design, emergency response in case of a fire) (Maluk *et al.* 2017; MHCLG 2010); and therefore, lacks a holistic view which acknowledges the strong interrelationships between various subsystems and overall building performance (Meacham 2016).

Applying complex systems theory to buildings offers a more holistic perspective, emphasising that safety in a complex system is more than the sum of its parts (Dekker *et al.* 2011). As a result, the few publications that consider high-risk buildings as complex systems aptly emphasise that social interactions, which characterise the design, delivery/installations, and occupation/operations (i.e., the life cycle), must be recognised as a key part of the complexity (Schalcher 2010, Meacham 2016). The Hackitt Review (2018) follows the same argument, pointing out that the complexity of high-risk buildings is related to the fact that the actions of numerous people involved in the building's life cycle can compromise the integrity of the building.

The conception of high-risk buildings as complex systems, where complex technology and social relationships co-exist, implies that there is no longer a definitive

relationship between the behaviour of individual constituents (i.e., specific building technologies or stakeholders) and the safety outcomes of the system (i.e., the building). Rather, technological and social issues must be understood as the interacting parts of an organisational whole, which together determine the performance of the system (Perrow 1984, Reason 1997, Allocco 2010). Hence, in the context of high-risk buildings, it is the organisation of the building life cycle (with all its social and technological constituents) that needs to be understood as a complex system.

Organisations which exhibit the behaviour of complex systems (complex organisations henceforth) have been researched extensively in management and safety research. A complex organisation consists of various social and technological entities that interact in ways that produce non-linear, path-dependent, and at least to some extent unpredictable outcomes (Maylor *et al.* 2008; Aven and Ylönen 2018). As each entity in a complex organisation is limited in its situational awareness of the entire system, the behaviour of such a system is not amenable to traditional systems analysis, which relies on the regularity of interactions, separability of elements, and the presence of clear cause-and-effect relationships (Maylor *et al.* 2008; Dekker *et al.* 2011).

For this reason, complex organisations have widely been associated with safety failures that cannot be attributed to specific human- or technology-related errors (Perrow 1984). Rather, in complex organisations, safety failures occur due to an unfolding series of situations through which social and technological issues are interweaved involving, for example, technology failure, human errors, lack of communication within and between organisations, inappropriate regulation, etc. (Reason 1997, Allocco 2010). Thus, situations can arise where nobody has a full understanding of, or the full authority or the means of intervention on, the developing safety hazards (Perrow 1984). Therefore, understanding safety in complex organisations

requires a recognition of the often-conflicting safety considerations of multiple stakeholders involved (Dekker *et al.* 2011).

In safety science, this recognition has led to a shift away from safety management through bureaucracy (Dekker 2014), which focuses on KPIs, quantified risk (Aven and Ylönen 2018), regulations and root cause analysis of accidents, towards a focus on the social conditions and the organisations' strategies and abilities to cope with complexity (Haavik *et al.* 2019). The need for a focus on social and organisational issues is also implied in the context of high-risk buildings by Hackitt (2018), who claimed that "we need to adopt a very different approach to the regulatory framework covering the design, construction and maintenance of high-risk residential buildings which recognises that they are complex systems where the actions of many different people can compromise the integrity of that system" (p. 6). High reliability organisations (HRO) literature is one of the main schools of thought that adopt such a focus.

High reliability organisations and collective mindfulness

Literature on high reliability organisations (HRO) is one of the main schools of thought focussing on the social and organisational underpinnings of system safety and accident prevention in complex organisations (Lekka 2011). Based on observations of extremely safety-critical settings (e.g., nuclear plants, air traffic control), HRO researchers argue that it is possible to achieve a consistent record of safety over long time periods through organisational measures that effectively prevent and contain catastrophic errors (Roberts 1990, LaPorte and Consolini 1998, Lekka 2011). Previously, ideas from HRO have been used in construction research to improve occupational health and safety (Enya *et al.* 2018; Harvey *et al.* 2019; Sherratt and Ivory 2019), as well as construction management (olde Scholtenhuis and Dorée 2014), during project delivery; however,

these have not considered building safety.

In HRO literature, the five processes of 'mindful organising', which enable 'collective mindfulness' (Weick *et al.* 1999; Weick and Sutcliffe 2007), have been widely accepted as necessary for achieving high reliability for an organisation (Cantu *et al.* 2021). These five processes are 1) preoccupation with the avoidance of failure, 2) reluctance to simplify interpretations, 3) sensitivity to operations, 4) commitment to resilience, and 5) under-specification of organisational structures (Weick *et al.* 1999).

'Pre-occupation with failure' refers to the need for noticing, taking seriously, and learning from process or system lapses, which should be treated as the symptoms of safety issues. 'Reluctance to simplify interpretations' refers to an organisation-wide awareness that processes are interconnected, and so, anything 'out of the ordinary' needs to be further examined, and intervened in if necessary, as soon as it is discovered, before it builds up into a bigger problem. 'Sensitivity to operations' highlights the importance of maintaining a situational awareness during operations because even routine operations involve variations from one time to another, and such variations might trigger a hidden system interaction that can quickly cascade into a larger problem if not recognized and intervened early. 'Commitment to resilience' refers to the organisational ability of detecting, containing, and bouncing back from, unpredictable disruptions before they disable operations or develop into major safety hazards. Finally, 'under-specification of structures' highlights the necessity of prioritising subject expertise over authority and power, when dealing with developing conditions that can create safety hazards.

Organisational culture of collective mindfulness

Weick *et al.* (1999) emphasise that 'collective mindfulness' is less about decision making and more about inquiry and interpretation grounded in capabilities for action,

which suggests that achieving high reliability through 'collective mindfulness' is a matter of organisational culture (Weick 1987, Pidgeon and O'Leary 2000, Nævestad 2009, Schulman 2020). According to Pidgeon and O'Leary (2000), organisational culture is intimately related to how people make meaning, and so, it encompasses the symbols and systems of meaning through which a given group understands the world. Thus, organisational culture is a set of assumptions and their associated practices, and serves to construct a particular understanding of risk, danger and safety in organisations (Pidgeon and O'Leary 2000).

Weick (1987) highlights two important roles of organisational culture for dealing with safety in complex organisations: 1) culture as a means for sense-making under complexity; and 2) culture as a means for coordination at a distance under complexity. First, because culture underpins meaning making and interpretation, it determines how ill-structured situations are understood within complex organisations, which provides the premises for subsequent decisions. This means that the shared beliefs and expectations in a complex organisation determine how the organisation simplifies its environment to make sense of what the hazards are and what precautions are appropriate (Weick and Sutcliffe 2007; Nævestad 2009). When there is discrepancy between the organisation's 'taken for granted' beliefs and assumptions for dealing with hazards, and a worsening but ill-structured situation, warning signs that could be otherwise noticed and acted upon are ignored, thus, leading to potentially catastrophic safety failures (Turner 1978, Nævestad 2009).

Second, culture is crucial for coordinating action at a distance without imposing tight bureaucratic centralisation through standard operating procedures, which are unable to effectively deal with non-standard (i.e., unpredictable, emerging, unprecedented) behaviour of complex organisations (Derek 2014). According to Weick

(1987) both centralisation and decentralisation are crucial for high reliability organisations to deal safely with the complex behaviour, and organisational culture is the major enabler for harnessing both the benefits of centralisation and decentralisation at the same time. In Weick's (1987) words:

> "… [Organisational culture] creates a homogeneous set of assumptions and decision premises which, when they are invoked on a local and decentralized basis, preserve coordination and centralization. Most important, when centralization occurs via decision premises and assumptions [i.e., via organisational culture], compliance occurs without surveillance. This is in sharp contrast to centralization by rules and regulations or centralization by standardization and hierarchy, both of which require high surveillance" (p. 124).

On a similar note, Schulman (2020) emphasises the importance of achieving coherence between the formal organisational structure and organisational culture to reliably assure safety, and explains that for each formal structural element, such as roles, rules, communication links as well as accountability and authority, there are likely to be shadow cultural elements that can reinforce/support or undermine/contradict those formal arrangements. Hence, decisions about the formal organisational structure require a deep appreciation of both local (e.g., construction firm) and wider (e.g., construction industry) organisational culture (Schulman 2020).

Based on these arguments, Schulman (2020) articulates some of the cultural aspects of HRO that stand out for enabling collective mindfulness for reliable safety. The first of these aspects is a sense of responsibility for all types of safety hazards which makes people think and care about safety beyond their immediate departments/daily works. Such an attitude must be supported and protected as part of the organisational culture, so it can spread to the entire organisation and prevent competing organisational values, such as efficiency, cost reduction or speed in

completion of tasks, from being prioritised over safety. Another cultural aspect of HRO is scepticism about what might go wrong, which is crucial for detecting uncertainty and potential errors in measures, models and assumptions. Finally, according to Schulman (2020), HRO have an attitude of relying on "precursor" strategies that identify conditions or states that, while not failures or accidents in themselves, can lead to failures. Precursor strategies acknowledge that the behaviour of complex systems is emergent. Thus, when circumstances are perceived to move outside the routine, operations are ceased until the new circumstances are better understood or they return to the routine conditions of operation.

This literature review suggests that when high-risk buildings are seen as complex systems, collective mindfulness is required to reliably prevent catastrophic safety failures. The presented literature suggests that organisational culture, which guides meanings and enables coordination at a distance in complex organisations, is the key element for the enactment of collective mindfulness. Hence, the empirical inquiry explores the organisational culture in high-risk buildings' life cycle from the lens of this literature to develop insights on how safety of high-risk buildings could be approached and regulated effectively.

Methodology

Previous literature observed that the life cycle of high-risk buildings presents complex and interrelated technological and social issues that concern the safety of those buildings. These observations cannot be properly explained or addressed by the existing fragmented literature on building safety, which mirrors the fragmented organisation of building life cycle (Latham 1994, Pitt and Hinks 2001, Alashwal *et al.* 2011). For this reason, this research applies complex systems theory and the HRO's concept of collective mindfulness, which is rooted in organizational culture, to provide a new way

of understanding and addressing this puzzle. By applying this theoretical framework to an empirical case, the findings and discussions highlight how complex building safety issues are perceived and handled, and why regulations alone are not sufficient for addressing them.

The design of the empirical inquiry is informed by an interpretive view of organisational culture. This sees culture as a social phenomenon driving human behaviour underpinned by norms, attitudes, beliefs/assumptions and perceptions (Smircich 1983). Organisational culture can then be conceived as the pattern of assumptions developed by a group as it adapts to its environment and responds to problems (Schein 1990). Culture is continuously recreated as the members of the organisation behave and communicate in ways which seem to them to be natural and obvious for accomplishing their work. In this way, they construct particular understandings of risk, danger and safety (Pidgeon and O'Leary 2000).

England is selected as the empirical setting due to the ongoing reform to the building safety regulatory regime, where the aim is to establish a holistic life cycle approach for managing the safety of high-risk residential buildings as complex systems, following the Grenfell fire (MHCLG 2020a). Inquiring into this setting of change through semi-structured interviews allowed the research to capture some of the deeply rooted attitudes and perceptions present in the organisation of the building life cycle, thus enabling insights into the culture that drives the safety-related behaviour (Glendon and Stanton 2000). Semi-structured interviews were used because of their exploratory strength in terms of capturing various perceptions and attitudes of the interviewees on the studied regulatory changes whilst also allowing other related lines of enquiry to emerge during the interviews (Blandford *et al.* 2016).

Ten semi-structured interviews were conducted with different actors who engage with fire safety related issues in construction project delivery and operations in England. The interviews took place after the regulatory changes implemented immediately after the Grenfell Fire as well as after the publication of the Hackitt Review (2018) and the consequent draft new building safety bill. The interviewees were selected through purposive sampling using the criterion that they were representative of the variety of actors involved with building delivery and operations at different points of building life cycle. They were all considered to have the necessary expertise to supply useful and perceptive comments on some, or all, of the questions (Rowley 2012). Table 1 sets out the list of interviewees with each respondent being given a descriptive name to preserve their anonymity.

[Table 1 near here]

The interview questions focused on revealing the ways in which interviewees perceive/apply the planned/implemented fire safety regulatory changes. The interviewees were asked to disclose not only their part in the decision-making process and any changes to the process as recommended by the independent investigation of the Grenfell fire (Hackitt 2018), but also the changes to their data sources / documents, communication with others and courses of action. The interviews took between 45-60 minutes to complete and reflexive notes recording the researcher's initial thoughts were logged at the completion of each interview. Transcripts of the interviews were produced and checked against the recordings to ensure that they represented a verbatim record of the interview.

The data was analysed using Braun and Clarke's (2006) six steps process of reflexive thematic analysis. The steps are 1) familiarisation with the data, 2) generating initial codes, 3) searching for themes, 4) reviewing themes, 5) defining and naming

themes, 6) producing the narrative. Though the steps are sequential, qualitative analysis is an inherently recursive data interrogation process, so the overarching themes were identified by moving back and forth between the steps. The analysis was broadly divided into two main stages of i) 'exploration' (of the empirical puzzle) (Steps 1 – 4), and ii) 'explanation' (of a solution for the empirical puzzle) (Steps 5 and 6). The first stage of exploration (Steps 1-4) was not wedded to any specific theoretical or epistemological position. It adopted a data-driven approach (Braun and Clarke 2006) to capture the issues that the interviewees raised, and how they deal with them, in all their complexity and richness, using the interviewees' own words (i.e., exploring the puzzle). Overall, 92 preliminary codes were created with 738 extracts of data which were put into five candidate themes to establish a provisional relationship between the codes, themes, and sub-themes which related to the implications of the planned and recently implemented changes in fire safety regulation (Step 3). The codes included both changes in fire safety documentation (e.g., the creation of the new fire and emergency file) and changes in the regulatory oversight process such as the creation of the Building Safety Regulator and the new regime of duty holders. In the next step of the analysis (Step 4), these five candidate themes and associated codes were reviewed so that they were meaningful and clear and distinct from each other (Patton 2002), reducing the number of themes to three as shown in Figure 1 (Step 4).

[Figure 1 near here]

Step 5 was about defining and naming each of the previously identified themes. This involved describing what is interesting about the theme (in terms of the research questions) and why, as well as identifying the story that the theme is telling (Braun and Clarke 2006). Therefore, it is at this point that the analysis started to look for an 'explanation' of the findings based on the theoretical perspective presented in the

literature review. Thus, the previously identified themes of 'the golden thread', 'building regulations' and 'HRRB cladding' (see Figure 1) were reconsidered in terms of organisational culture, and defined and narrated as 'perceptions around safety information', 'fitness for purpose' and 'perceptions of risk' respectively. In the following, first the empirical setting is described briefly to provide the background information for the analysis, which is followed by the presentation of findings.

The empirical setting: post-Grenfell regulatory reform in England

Historically, the regulation of fire safety has been informed and shaped by tragic disasters that have consequentially led to significant regulatory reform (Spinardi and Law 2019). One such tragic incident took place in London, UK in 2017. A fire broke out at Grenfell Towers, a 25-storey high-rise residential block of flats, which tragically caused 72 deaths and a further 72 non-fatal injuries. This tragic event created international awareness of the need to reconsider the management of fire safety in construction project life cycles. The UK government commissioned a report, known as the Hackitt Review (2018), to identify the failures in the regulatory regime that led to the tragic incident at Grenfell and to provide robust recommendations for reform.

The review had a focus on the application of building regulations and safety to high-risk residential buildings (HRRBs) and the need to provide assurance to residents that the buildings they live in are safe and will remain safe. Hackitt (2018) stated that the current regulatory system for ensuring safety in high-risk and complex buildings was not fit for purpose and that a radical overhaul was required of the culture of the construction industry and the effectiveness of the regulators.

The reasons for this systemic failure of the regulatory system were multiple. The guidance provided was complex and impenetrable for the user, and roles and responsibilities were unclear. There was no differentiation in the competency

requirements for those who worked on relatively simple, straightforward buildings and for those who worked on high-risk complex buildings. Compliance was weak and enforcement and sanctions were virtually non-existent, while the system of product testing for fire safety did not provide meaningful quality assurance. Hackitt (2018) has stressed that a new regulatory framework needs to be created "which will drive a real culture change" (p.6) within an industry that has been characterized by ignorance, indifference, and failure to learn from other sectors. The end goal is that safety is to be prioritised and addressed holistically by all actors involved in the development, construction, maintenance, and occupation of HRRBs.

Although some regulatory amendments were made soon after the Grenfell fire, such as bans on external cladding materials and restrictions on the use of desktop studies for the fire test BS8414, the details of the regulatory reform followed the independent investigation (Hackitt 2018) and an industry-wide consultation. Eventually, the UK Government accepted all the 53 recommendations of the Hackitt (2018) review in their implementation plan (MHCLG 2018a). This was followed by the draft Building Safety Bill (MHCLG 2020a), which was published in June 2020 to take forward the proposed reforms to the building regulatory system. The new regime adopts a very different approach which recognises that HRRBs are complex systems where the uncoordinated actions of the different actors can compromise the integrity of the system. Therefore, the core of the proposed legislation is the introduction of formal roles and responsibilities for new duty holders to ensure accountability and allocate risk appropriately (Phillips and Martin 2021).

The draft bill also provides formal structural rules for the consideration and approval of safety information at key gateway points during the development process and prior to occupation by the new role of Building Safety Regulator. It is proposed that

this ‘golden thread of building information’ will provide the key that links the design intent with the safe occupation of the building, and that Building Information Modelling (BIM) will be used as the suitable digital platform for the knowledge transfer across the phases of the building life.

Findings

In this section we present the findings of the analysis based on the three themes that were defined as ‘perceptions around safety information, ‘fitness for purpose’ and ‘perceptions of risk’. This reveals some of the perceptions/attitudes and associated practices that drive the safety-related behaviour in the organisation of the high-risk buildings’ life cycle within the studied empirical setting.

Theme one: perceptions around safety information

Under the proposed regulatory framework, duty-holders will be responsible for creating and maintaining a digital golden thread of building information related to fire and structural safety for the entire building life cycle. A duty-holder is defined as a key role (whether fulfilled by an individual or organisation) that is assigned specific responsibilities under the regulations at a particular phase of the building life cycle. The golden thread of information aims to ensure that the original design intent and any subsequent changes to the building are captured, preserved and used to support safety improvements. The new regulations will include guidance and standards setting out what digital requirements the golden thread of information would have to meet, including specifications regarding the sharing and access of information. This aims to contribute to information being more easily kept up to date, maintained, accessed, and used, to ensure delivery of safer buildings (MHCLG 2020b).

However, the interviews revealed that those involved in project delivery are confused about the new duty holder descriptions, and the corresponding responsibilities regarding safety information, because they view them in comparison with The Construction Design and Management (CDM) Regulations 2015 that are currently in force. Thus, the contractor did not think that their role would significantly change:

> "As a Principal Contractor under CDM Regs we supply a complete package of information so what is different? …we always make sure that the works have the necessary approvals before we start."
> "We pass all this information to the client via the CDM Regs, so shouldn't a golden thread for a building already be in place?... I can't really see us needing to buy any new technology to deal with the change."

The project architect believed that greater clarity needed to be provided around the responsibilities of the new roles under the proposed system of duty holders:

> "It may not be that easy to transpose CDM Regulations concepts onto a new ongoing building responsibility …I am not sure that I actually know what that means."
> "[At Grenfell] the individual parts of the cladding system might have been compliant with fire regulations but as a whole the system failed so who would be to blame under the new system? This is a grey area when it comes to identification of blame and litigation."

The litigation solicitor had similar concerns as to how the new duty holder framework would mesh with the CDM Regulations and how it would be interpreted and enforced:

> "The 'safety case' will include both 'construction' and 'housing management' elements. The proposed approach based on the CDM Regulations does not fit well with the housing management perspective, so further thought will be needed with respect to this."

In a similar vein, the findings suggest that the way in which project delivery actors understand and perceive the new golden thread requirement is also based on the existing practices shaped by the Regulation 38 of the current Building Regulations, which provides guidance on the handover of fire safety information to the responsible person before the occupation of the building. In the context of fire safety, Regulation 38 is often discussed and maybe agreed on during the design process, but then not complied with in practice as the design team may not understand how important it is to provide the correct 'as built' fire safety information to the owner (i.e., responsible person). Based on previous experiences under Regulation 38, the managing director of the company of chartered surveyors was sceptical about the ability to produce accurate as-built drawings and other information in a digital format for the golden thread:

> "Clients rarely provide us with as built construction drawings but when they do, they are never correct!"
> "Digital records? There are not many clients that can open a CAD drawing, they also request PDF documents."

The approved inspector opined that building control could be the key to making sure that Regulation 38 is complied with; thus, facilitating the golden thread:

> "At the moment everybody seems to pay lip service to Regulation 38 and there is no accountability for how the information is passed over…Regulation 38 must be tightened up and building control officers may have to take a more prominent role in the process to ensure that the information is passed onto the responsible person for the subject premises."
> "How can the Golden thread work if Regulation 38 is not enforced?"

However, the contractor was unfamiliar with Regulation 38, and was sceptical that accurate as-built drawings could be supplied as part of the handover documentation to create an accurate golden thread of safety information:

> "I don't know what Regulation 38 is, but part of our handover process is to pass the initial drawings, as built drawings and fire alarm testing certificates to the client."
> "Is it feasible to have accurate as-built's? It is a dream, it would be nice, but it will definitely take a mentality change…"

Actors involved in building operations are directly concerned with the occupier's safety and currently the 'responsible person' designated under Regulation 38 has the responsibility of ensuring the production and communication of adequate Fire Risk Assessments (FRA). Arguably, the new requirement for a golden thread of information will be the basis to produce FRAs more adequately with all the necessary information available accurately in a digital format. However, the interviews revealed that different actors who might be tasked with producing FRAs in the industry are taking different fire safety regulations as their basis and also pay little attention to the communication of FRAs with residents. This raises questions about the difference that a digital golden thread of information could make for improved FRAs and emergency action. For example, the residents' fire consultant stated that:

> "The powers that-be aren't providing a clear message to the residents of high-rise buildings, better guidelines need to be provided to people about when they should stay put and when that should be changed to simultaneous evacuation."
> "Professionals and the Fire Rescue Services are, maybe, carrying out Fire Risk Assessments on the wrong basis, in the original code of practice issued in the sixties [BSI Code of Practice 3] it is understood that residents would want to leave the building if there was a fire and stated that protected fire routes should be provided as an alternative …as fire risk assessors we should be advising clients to install fire alarms and waking watch systems if needs be."

The expert witness echoed the resident's fire consultant's views:

> "I send a completed FRA report to a client attached to a covering email, does that ever get passed onto the residents? If the report makes recommendations to clear blocked communal stairs does the work get undertaken? It may not do…"

> "10-15 years ago we established a stupid culture where everybody thought they could attend a half day training session and become a fire risk assessor."

However, the fire engineer, who followed a different guide, the National Fire Chiefs Council's (NFCC) guide (2018), provided a different interpretation of upon what guidance FRAs must build:

> "The evacuation of residents in the event of a fire is complex and if a simultaneous evacuation policy is carried out the residents may inadvertently obstruct the fire rescue services, or they may hurt themselves, be crushed, during the evacuation… In my view, staying put is the safest way forward for the residents."

There is no indication that the implementation of a digital golden thread of information of fire safety would solve this challenge of meaningful communication through the prescription of new roles and responsibilities, handover procedures and digital formatting requirements.

Theme two: fitness for purpose

In the mid-1980's the English building regulations changed from a prescription-based system to a performance-based one which lists broad standards and outcomes that new buildings must achieve. Performance-based regulations describe the required performance outcomes of the regulated entity, as opposed to prescriptive regulations which prescribe the technical and procedural requirements that must be followed (Barua *et al.* 2016). This was done in England to encourage the implementation of innovative design solutions, though it can also create uncertainty with respect to compliance.

There are several methods for an external wall cladding system to achieve building regulation compliance. One method allows materials that do not conform to the limited combustibility criteria to be used in an external cladding system provided that compliant performance can be demonstrated by carrying out the full-scale British

Standard 8414 (BS 8414) test in a specialist laboratory. If it complies with the requirements set out in BR 135 (BRE Global 2020), then it is deemed to comply with Approved Document B. However, the full-scale BS8414 tests are considered to be cost-prohibitive, which resulted in the use of the desktop study method of compliance where building control officers would accept proposed cladding systems that vary from those tested to BS8414, if they had been assessed as compliant with the criteria set out in BR135 by a 'suitably qualified person'.

The Hackitt Review (2018) was extremely critical of the use of desktop studies and recommended that they be significantly restricted and be carried out only by competent people, which was ratified by the government (MHCLG 2018b). However, the restrictions have been received in different ways by various actors within the industry which has led to differing views being offered as to how the industry should proceed with respect to the restrictions. The extreme option has been to only specify non-combustible materials that will comply with the building regulations and not require any further laboratory testing. The senior architectural project manager, for example, warned that sustainable design innovation may be stifled as a consequence of these changes:

> "There is a new emphasis on system testing and rather than carry out the test some architects are refusing to specify combustible materials anywhere on any building, it is stifling innovation in building design …how can zero carbon be achieved if designers won't or can't use sustainable materials such as engineered timber or cross laminated? The UK could fall behind the rest of the world in terms of sustainable design."

This view was confirmed by the Approved Inspector who advised that the use of non - combustible materials may cause unintended consequences in the future:

> "Already we are seeing design innovation being stifled as developers only want to use non-combustible materials, for example we are seeing the use of stainless-steel cavity trays which though they are non-combustible they may cause problems with movement to the surrounding brickwork in a few years' time?".

The residents' fire consultant agreed that desktop studies should be restricted but took a different view on the validity of the BS8414 test and questioned whether it replicated real-world on-site conditions:

> "The BS8414 test is undertaken in an idealised environment, it is not a realistic test. The test panels are normally in perfect condition which isn't how they would be installed on site".
> "Ultimately the residents are the one[s] living in the building, they have to be reassured about the cladding and know that they are safe…whatever the test results say the thing that matters is how it is installed onsite, the residents need evidence that cavity barriers are installed correctly".

The fire engineer held a robust view of the BS8414 test, believing it to be fit for purpose but thought it a mistake to restrict the use of desktop studies as they provided a pragmatic way of assessing the fire performance of combustible materials.

> "BS 8414 is one of the best fire tests in the world, none of them are perfect but I cannot recall one major fire that has occurred at a building where the materials passed the BS8414 fire performance test"
> "I think the government will have to rethink desktop studies…it is impractical to apply a BS 8414 test to every external cladding system, there is only one test centre in the UK so how could they cope?!".

The responses illustrated that no universal view is held about the restrictions of desktop studies for BS8414 combustibility test, with each actor not being able to look beyond their own field of expertise and interpreting the change in regulations to suit their own practices. Hence, regulatory compliance, rather than safety excellence, seems

to be the main consideration in terms of how different actors perceive the safety regulations.

Theme three: perceptions of risk

In the wake of the Grenfell fire the UK government issued a ban on the use of combustible materials to the exterior of new buildings over 18 metres in height. It also published a series of fire safety advice notes detailing what owners of high-risk residential buildings (HRRBs) should do to ensure the building is safe for residents as required by the previously published Regulatory Reform (Fire Safety) Order 2005 (MHCLG 2020b). Until these conditions are met, the flats within these buildings have been valued by lenders at £nil, which has made thousands of high-rise flats unsaleable, causing frustration for both landlords and leaseholders. This has occurred because, in many cases, the building owners did not hold, or could not access, the required technical details about the materials used in the construction of their buildings; hence, they could not provide the necessary absolute assurances that there is no combustible material contained within external wall system (Phillips 2021).

To address this problem, a new safety certification process has been devised by the Royal Institution of Chartered Surveyors, known as External Wall Systems 1 (EWS1) to provide comfort to owners and mortgage lenders by delegating the assessment of fire safety risk to a competent chartered construction professional. The role of the EWS1 assessor is to assess the fire safety risk of a building's external wall system and provide a certificate stating whether the building would require remedial works based on the materials and systems installed. This process was created to help residents feel safe and the mortgage funders resume lending for HRRBs (Phillips and Martin 2021).

However, the interviews revealed that even the advent of this certification process has not achieved the desired result. The Client-side Senior Manager reported that there are still significant issues with the assessment process.

> "The information provided by the Fire Engineers was easy to understand but due to issues around professional indemnity we found that they would not make direct recommendations with respect to the materials that could be used in recladding works… The underwriters did not understand the fire mitigation issues."

This was confirmed by the Project Director of the Chartered Surveying Practice, who stated that the stance of professional indemnity insurers has changed the way they need to inspect HRRB's and how they compile on-site records:

> "Unless we know exactly the type of external cladding that has been used or we can undertake intrusive investigations then we are unable to sign off an EWS1 form…not all clients hold the necessary records nor fund the cost of an intrusive inspection which can cost between £25,000-£75,000 depending on the size of the subject building"

Thus, the sale of high-rise flats remains extremely difficult. The nascent EWS1 process stalled as professional indemnity insurers focus on regulatory risk, i.e., the risk that the implementation of new regulations will cause them monetary losses, and this has meant that insurers will not provide full insurance cover to professionals for fear that it may shift liability for a building's future safety onto the chartered professional. Consequently, the insurers' stance has also meant that, in some cases, professional surveyors and engineers have started to consider legal and reputational risk over fire safety risk and are refusing to sign off EWS1 forms even when there is only a very minimal amount of combustible material to be found on a HRRB. The Project Director described why this issue has occurred.

> "If we inspect a HRRB and find a small amount of timber cladding on the external elevations then we will state that the property is a fire safety risk…how can we take any other course of action if our insurers won't provide their standard cover?"

The problem was exacerbated in January 2020 when the Government's expert panel removed the 18m height threshold for a HRRB by advising that owners of all multi-occupied residential premises with cladding or without cladding and of any height must consider the fire safety risks presented by external wall systems and fire doors. The effect of this was to increase the number of EWS1 inspections requested by mortgage lenders and, as the Project Director explained, this meant that the EWS inspection was being undertaken on properties that would not usually be considered to be a fire safety risk.

> "We are being asked to undertake EWS1 inspections on low rise blocks of flats constructed of cavity brickwork which are extremely low risk in terms of spread of flame but how can we advise that they are not a fire safety risk if we can't confirm the exact material that has been used for insulating the cavity?"

Overall, the EWS1 process has demonstrated that safety-related behaviour is strongly influenced by different perceptions of risk, which include risks other than safety risks, and which might be triggered unintentionally due to regulatory changes.

Discussion

The findings expose three important aspects of the organisational culture that drives the safety-related behaviour in high-risk buildings' life cycle in England. The first part of this discussion elaborates these aspects and discusses them through the lens of organisational culture presented earlier. This enables insights about some key areas of concern on the road to achieving an organisational culture of collective mindfulness and a holistic way addressing safety in high-risk buildings' life cycle as complex systems.

The second part discusses the role building regulations could play as part of such a holistic approach.

Organisational culture in high-risk buildings' life cycle

The three themes identified in the findings represent three important aspects of organisational culture that underpin safety-related behaviour. Theme 1 (perceptions around safety information) highlights that various actors involved in the building life cycle are mainly concerned with their formal information-related responsibilities, rather than the usefulness or purpose of that information for meaningful communication with others to assure safety. Arguably, this has paved the way to superficial practices, for example, paying lip service to Regulation 38, the disbelief in the accuracy of as-built drawings, and the failure to communicate with residents about fire risk assessments. In turn, these superficial practices result in a lack of consideration of 'safety' as a system-wide phenomenon.

Similarly, Theme 2 (fitness for purpose) highlights that safety regulations are mainly interpreted from a regulatory compliance perspective rather than with a focus on safety. Thus, only the issues the regulations raise for one's own specialist practices are taken into account. The different perceptions of the fitness for purpose of regulations/rules determine individual perceptions of what matters most about them, and so, the 'acceptable' ways of achieving compliance. This resonates with Hu *et al.*'s (2020) concept of 'surface compliance' which refers to behaviours that focus on 'demonstrating' compliance, as opposed to 'deep compliance' where practitioners invest discretional effort to support overall safety in the organisation. The type of compliance may reflect the different intentions and strategies that underpin safety behaviour, and their associated safety outcomes (Hu *et al.* 2020). Hence, arguably, this cultural aspect underpins the behaviour of 'gaming the system' which is highlighted by

Hackitt (2018) as one of the important problems in managing safety of high-risk buildings.

Finally, Theme 3 (perceptions of risk) highlights that perceptions of risk do not exclusively focus on safety risks. Reputational and professional/legal risk considerations strongly affect safety-related behaviour, even when such behaviour leads to significant disruption in practice as in the case of EWS1 process. This resonates with the widely accepted belief that actors in the construction industry typically have adversarial relationships that lead to blaming each other, whereby they seek to minimise their level of exposure to poor performance instead of working together to improve the system performance (Baiden *et al.* 2006).

Overall, these three aspects of the organisational culture in high-risk buildings' life cycle are in strong contrast with the cultural underpinnings and processes of collective mindfulness advocated by HRO literature (Weick 1987, Weick *et al.* 1999, Weick and Sutcliffe 2007, Schulman 2020). The focus on formal communication requirements, surface compliance and non-safety risks suggests that there are no reliable premises for making sense of, and decisions about, the developing building safety hazards (Weick 1987). Rather, the premises for interpretation and decision-making shift away from safety due to a major consideration of risks other than safety risks (Theme 3) and become flawed due to the lack of meaningful communication (Theme 1) and/or a commitment to safety excellence (Theme 2). 'Inward-looking' and 'self-concerned' constructions of risk, danger and safety (Pidgeon and O'Leary 2000) discourage the prioritisation of safety over other organisational goals such as efficiency, speed, cost etc., and inhibit an attitude of scepticism towards safety (Schulman 2020). In this setting, it becomes impossible to develop precursor strategies to catch and contain safety hazards early (Schulman 2020).

Hence, the current organisational culture is not supportive of the five processes that enact collective mindfulness (Weick *et al.* 1999; Weick & Sutcliffe 2007). Instead of 'pre-occupation with failure', there is pre-occupation with reputational and professional/legal risks; instead of 'reluctance to simplify interpretations', surface compliance means an acceptance of simplifications; and instead of 'sensitivity to operations', there is the desire of getting things done without questioning every step along the way. Similarly, 'commitment to resilience' requires a collective effort for anticipation and a collective response to developing hazards, which are hindered by the exclusive focus on formal information requirements. Finally, 'under-specification of structures' to prioritise subject expertise cannot deal with developing complex safety issues due to the concerns about reputational and professional/legal risks as well as the focus on formal information requirements, which create a lack of understanding of the bigger picture.

To address the safety of high-risk buildings holistically, as complex systems, a change is required in the attitudes and perceptions towards meaningful communication, deep compliance and absolute prioritisation of safety risks, so that they become more supportive of collective mindfulness. Thus, by revealing the disparity between the identified attitudes and perceptions and the HRO literature, this research establishes a basis for future debate on the way forward for the holistic management of safety in high-risk buildings as complex systems.

Building regulations and managing safety as complex systems

The studied regulatory changes have the ambition of enabling a holistic, life cycle approach to the management of high-risk residential buildings as complex systems in England. However, the findings suggest that they fall short of enabling the desired change in practice due to the persistence of the cultural aspects discussed in the

previous section. Nevertheless, the analysed empirical case does provide some important insights into the role that the building regulations could play in establishing the management of safety holistically, as complex systems, for high-risk buildings.

Theme 1 (perceptions of safety information) exposes that the interviewees believe a digital golden thread of safety information to be comparable with their existing formal information roles, responsibilities and handover practices, instead of seeing it as a novel and improved process for better communication. This means that this new concept is assimilated under the existing formal and distant way of communicating, thus challenging the idea that having a digital thread of safety information would in itself ensure the delivery of safe buildings (MHCLG 2020b). This resonates with Schulman's (2020) argument that organisational culture can undermine the organisational structure unless the structure adequately considers the culture. Hence, the current academic and practical focus on digital traceability of building information to improve building safety (e.g., Watson *et al.* 2019, Li *et al.* 2019, NBS 2020) cannot achieve a change in practice unless the human aspects of communication are properly understood and addressed.

Moreover, the focus on surface compliance (Theme 2) raises questions about the applicability and added value of two popular approaches for regulation and control of high-risk buildings: performance-based regulations and automated digital regulatory checks. Although performance-based regulations can be preferable to support flexibility and innovation for high-risk building projects which present unique technical challenges, under a dominating 'surface compliance' culture, outcomes-based regulations might also undermine safety, and even drive opportunistic behaviour (Hackitt 2018). For this reason, it can be argued that it is not only the competence levels that must be addressed to gain the benefits of performance-based regulatory approaches

(Spinardi and Law 2019), but also the organisational culture must shift from ‘surface compliance’ towards ‘deep compliance’. Another approach that has attracted increasing attention over the last few years is automated digital regulatory checks using building information models (D-COM 2020). However, similarly, it can be argued that while the automation of regulatory checks through digital technologies can bring a more uniform use of regulations by eliminating the individual interpretations of the regulations, it will not shift the cultural aspect of ‘surface compliance’ to ‘deep compliance’. Hence, automated digital regulatory checks must be used cautiously in managing the safety of high-risk buildings, when a culture of surface compliance exists.

Finally, the various perceptions of risk (Theme 3) that affect safety-related behaviour must be understood and considered as part of any regulatory effort. Meacham and van Straalen’s (2018) work, which perceives a building regulatory system as a complex socio-technical system, provides some important insights into where these different perceptions of risk might stem from. The authors’ framework points out the importance of the wider institutional settings, such as the form of law, credibility of regulatory bodies etc. in a specific country, for the performance of the regulatory system; thus, highlighting the relationship between the institutional context and the organizational culture in high-risk buildings’ life cycle.

Conclusions

The life cycle of high-risk buildings consists of complex interactions involving numerous technology and social actors that determine the safety of the building. This implies that the life cycle of high-risk buildings needs to be understood as a complex organisation, which draws attention to the organisational and social underpinnings of their safety. Hence, this research used the HRO concept of collective mindfulness, which is rooted in organisational culture, as a lens to examine the organisational culture

of high-risk buildings' life cycle in England. By inquiring into the perceptions and attitudes of various built environment professionals regarding the ongoing regulatory reform for high-risk buildings, the research has revealed three cultural aspects which work against collective mindfulness and also hamper the regulatory efforts for improving safety. Thus, organisational culture of the building life cycle is established as an essential consideration for safety management and regulation of high-risk buildings. The empirical inquiry is limited to a specific country and the data collected is limited to ten semi-structured interviews. However, the insights developed about the relationship between the organisational culture of high-risk buildings' life cycle, and safety management and regulation, are applicable to other empirical settings.

The three demonstrated cultural aspects, which are i) formal and distant communication, ii) surface compliance, and iii) consideration of non-safety risks, provide a starting point for considering building safety from an organisational culture point of view. On the one hand, they provide a basis for practitioners, researchers and regulators to recognise the cultural underpinnings of the safety issues in practice, and so, help them to bring organisational culture to the fore of the practical discussions and the wider debate on building safety. On the other hand, they also demonstrate how seemingly different sets of perceptions, and their associated practices complement and reinforce each other to enact particular views of safety, danger and risk across the building life cycle, which serve multiple interests simultaneously. Thus, they demonstrate how difficult it is to shift the organisational culture of building life cycle only through top-down, structural interventions which prescribe change that are limited to a subset of perceptions or practices (e.g., changing regulatory approaches or rules, implementing digital integration for information management or for compliance checks etc.).

The three identified cultural aspects also provide a starting point to articulate how an organisational culture of collective mindfulness could be achieved in the life cycle of high-risk buildings by outlining communication, compliance and risk as key areas of concern. Efforts for shifting the perceptions and attitudes in these areas need to consider the two key roles of organisational culture of collective mindfulness as i) providing decision premises for dynamic sensemaking, and ii) enabling coordination at a distance (Weick 1987), to deal with unpredictable and irregular safety issues that may appear in many disguises. This means that while top-down, structural interventions are needed in these areas, such interventions should not stand alone, and must themselves be developed out of an understanding of the necessary changes to organisational culture. In other words, they should enable a context within which the right social-relational foundations of collective mindfulness can grow, including the necessary vision, discourse and infrastructure. For example, the changes to the rules governing information management should primarily aim to enable a better understanding of how actions of one actor affect the other actors (i.e., heedful interrelating) (Weick & Roberts 1993) rather than improving digital record keeping. Similarly, changes to the building regulations and legal responsibilities must enable context-specific conversations between the relevant actors about different interpretation/application of the regulations, and different types of present risks and their acceptable distribution respectively. Such conversations could then reveal safety hazards that would otherwise go unnoticed or uncovered, thus, providing the necessary dynamic sense-making premises and shared sensitivities to enable coordination at a distance.

Finally, such top-bottom interventions need to be complemented by continuous practice-level social and organisational actions, for example, encouraging, and committing time and resources for, such relevant conversations to happen and influence

decisions and actions. It is evident that the fragmentation between the actors, the long timelines, and project-based organisation of buildings' life cycle make such practice-level social and organisational initiatives very challenging. However, professional and organisational leadership can make a major contribution to overcome this challenge by, for example, including collective mindfulness in professional competency frameworks, creating trainings and awareness campaigns about collective mindfulness, co-developing and disseminating collective mindfulness code of conduct and best practices.

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Table 1. List of interviewees

Descriptive Name	Organisation	Years in the Construction Industry
Client-Side Senior Manager	Client/Housing Association	30
Expert Witness	Chartered Surveyors	20
Constructor	Contractor	20
Building Control	Approved Inspector	5
Litigation Solicitor	Solicitor	25
Managing Director	Chartered Surveyors	40
Fire Engineer	Multi-Disciplinary Practice	15
Senior Project Manager	Architect	30
Project Director	Chartered Surveyors	25
Residents HRRB Fire Consultant	Self Employed Consultancy	35

Figure 1. Concept map at the end of the exploratory stage of the analysis (i.e., Step 4)