WELCOMING HIGH RELIABILITY ORGANISING IN CONSTRUCTION MANAGEMENT

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To achieve project objectives, construction project managers have to manoeuvre through complex coordination structures. They have to simultaneously deal with limited budgets, tight schedules, demanding stakeholders and a fragmented supply-chain. Despite their extensive coordination efforts, project managers are frequently confronted with unexpected delays that force them to improvise and re-plan. As a consequence, budgets and schedules tend to overrun and project organisations appear out-of-control rather than stable and reliable. To enrich our understanding of these phenomena, we propose using the theoretical lens of High Reliability Organising (HRO). HRO stems from research into high hazard industries, and is relatively new to construction management. It provides five generic guiding principles that help practitioners anticipate and contain unwanted events. Given that the use of HRO beyond high hazard contexts is not universally accepted within the scientific community, we ask whether it is justified to apply the HRO lens to the organisation and coordination of 'mainstream' construction projects. We elaborate on this issue by addressing its main theoretical concepts, its origin and its application beyond the fields of risk and safety. We further explain why reductionist interpretations of HRO concepts unnecessarily limit HRO's research domain. We propose a pragmatic reinterpretation of HRO that provides access to the field of construction management. Finally, we present preliminary results of our study into delays and overruns in inner-city subsurface utility reconstruction projects. Our theoretical and empirical arguments provide a stepping-stone for future HRO research projects in the construction management field.

Keywords: organisation, productivity, project management, reliability, mindfulness.

INTRODUCTION

Scoping and delivering projects is the core business of the construction industry. Reliably achieving agreed project targets is crucial for the success of clients, construction firms and other stakeholders in the industry. Among these projects, subsurface utility construction projects are very much in the minds and view of the community: they are both exposed and notorious for overrunning schedules and budgets. These projects amount to complicated coordination puzzles that are often constrained by tight budgets and deadlines. Numerous public and private clients, contractors and authorities are involved and have to plan, monitor and align their interrelated activities. However, despite good intentions and a significant time spent on early stage coordination, it seems in practice that project plans are often

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overloaded. Especially in inner-city areas, subsurface utility reconstruction projects generate noise and dust and impede traffic flows, access to locations and the functionality of spaces. Pressures to reduce the burden and hindrance to businesses and people living and working close to such projects are high, limiting the opportunity to include slack in the scheduling. As a result, any unwanted events derail construction schemes and force project managers to re-plan and improvise in an already tightly coupled schedule of activities. Consequentially, budgets and schedules have to be extended, stakeholders become frustrated and the public perceive the industry and its project predictions as unreliable. In studying the phenomena of coordination in these utility projects, we have spent a significant amount of time in the field. We explored how practitioners try to achieve project goals while coping with unwanted events and tight project plans. We also explored whether new ICT instruments contribute to improved alignment and inter-organisational coordination of interrelated construction activities. To structure and analyse our empirical data, we look through the lens of High Reliability Organising (HRO). Pragmatically, this lens seems to be of value as its concepts and principles focus on increasing performance reliability through anticipation and containment of unwanted events.

Unfortunately, when we present our research findings to scientific peers, the discussion often stagnates as we are confronted with debates about the legitimacy of applying the HRO lens. Rather than focusing on the projects and their issues, debates drift into disputes about whether applying the HRO lens is justifiable in the construction management domain. As these debates frequently distract from the presentation of our work, we have decided to challenge this critique and respond to the debate in this paper.

In this positioning paper, we aim to move on from this debate about the legitimacy of using the HRO lens and refocus on the coordination of utility projects. This paper is structured as follows: the first section describes the origin and concepts of HRO. Next, we explain how a reductionist interpretation of the HRO terms and contexts hampers the acknowledgment of the HRO lens's pragmatic value. We then illustrate how HRO principles apply to mainstream organisations. Further, we use the HRO lens to explore coordination of utility projects. The paper concludes by restating our view that a pragmatic reinterpretation of HRO provides a lens through which one can study reliability issues associated with construction projects.

HIGH RELIABILITY ORGANISING: ORIGIN AND CONCEPTS

High Reliability Organising research focuses on how the presence, or lack, of structures, mechanisms and routines within high hazard organisations leads to failures and catastrophes. HRO scholars have developed insights into how practitioners seek to enhance reliable performance, and avoid non-goal actions and non-goal results, by looking at how practitioners cope with potential errors and undesirable events. We first address the theoretical fields upon which HRO builds, and we then define two important HRO concepts: mindfulness and heedful interrelated action. This set of concepts and principles is referred to in this paper as the 'HRO lens'.

The foundations for the development of HRO is Perrow’s (1984) Normal Accidents Theory (NAT). NAT was derived through a retrospective analysis of the meltdown disaster at the US Three Mile Island nuclear power plant. Perrow's concept was that organisations could be categorised along two attribute axes: complexities and couplings. He concluded that organisations that have tight couplings and interactive complexities are vulnerable to accidents. Inspired by Perrow’s findings, a Berkeley-

based research group (including LaPorte, Rochlin, Schulman and Roberts) became interested in how organisations in high hazard environments perform so exceptionally well – that is virtually error-free. By observing how organisations cope with failures, Roberts (1990) was one of the first scholars to define the characteristics of a Highly Reliable Organisation. Successive studies on, for example, the Challenger Explosion (Roberts and Rousseau 1989), the Mann Gulch forest fire (Weick 1993) and naval aircraft carriers (Weick and Roberts 1993) advanced insights into the reliable performance of similar high hazard organisations and further developed the High Reliability Organising theory.

One commonly used concept drawn from High Reliability Organising is 'mindfulness' (Weick, Sutcliffe et al. 1999; Weick and Sutcliffe 2007). In essence, mindfulness comprises a set of principles that describe how organisations can enhance reliability of their performance. The five principles are divided into two categories: anticipation and containment (see Figure 1). Anticipation focuses on identifying and preventing potential unwanted situations, while containment is about reacting to, and recovering from such situations. Both categories will be further elaborated below.

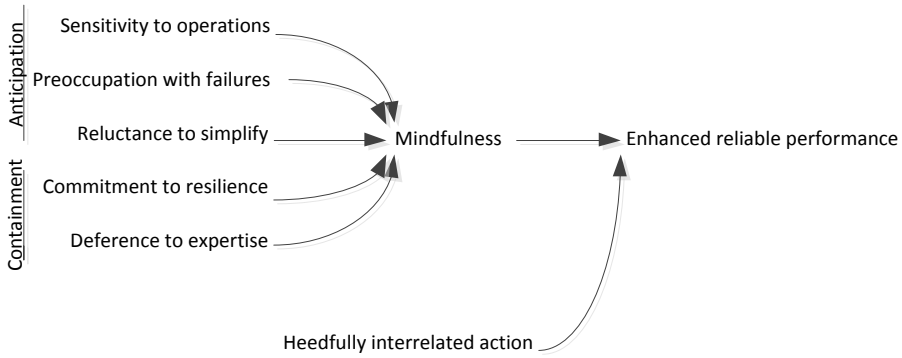

Figure 1 - concepts of mindfulness and heedfully interrelated action that lead to enhanced reliable performance (adapted from Weick et al. 1999)

The first anticipatory principle is 'sensitivity to operations'. Practitioners that follow this principle continually try to make sense of interrelated operational tasks and know how these tasks might be influenced and change over time. The second anticipatory principle is 'preoccupation with failures'. Through this, organisations continuously try to identify potential causes of failures and delays. They try to record and learn from previous faults to better cope should similar events occur in the future. The third aspect is that organisations that anticipate unwanted events have a 'reluctance to simplify' interpretations: they challenge standard assumptions and deliberately try to interpret observations in as much detail as possible. These three anticipatory principles help organisations identify potential failures and create strategies for dealing with them.

Principles related to mindfulness further focus on containing unexpected and unwanted situations. Such events can derail operations, and containment aims to reduce their negative impact. The fourth mindfulness principle, 'commitment to resilience', allows organisations to recover from unexpected situations. Organisations following this principle buffer resources, and create and update failure-recovery plans. In case of an unwanted event, they further change decision-making structures from hierarchical and formal into more flexible informal horizontal structures. The fifth mindfulness principle refers to a 'reliance on expertise' for solving problems.

Organisations that follow this principle favour expert opinions over, for example, commercial pressures.

Another concept central to High Reliability Organisation theory is heedful interrelated action. When interacting in a heedful way, practitioners execute their own tasks but understand how this individual task is influenced by, and contributes to, related actions by others within a system (Weick and Roberts 1993). This increased attention to interdependencies contributes to a more reliable performance.

Although HRO ideas stem from research in high hazard industries, we argue that its concepts can help in understanding reliability in mainstream organisations. As this line is far from universally accepted, the next section describes how the classical HRO research setting complicates the use of the HRO lens other industries.

THE HRO LABEL CONFUSES

This section explains how reductionist interpretations of the terms High Reliability and Organising are obstructive when presenting findings on reliable coordination of subsurface utility reconstruction projects. We offer a critique of the reductionist perspective on HRO, and propose looking through the HRO lens from a pragmatic viewpoint.

People introduced to the principles of HRO often assert that only organisations that can be characterised as 'highly reliable' can use the HRO lens to boost performance[2]. This stance frequently turns our research presentations into a reductionist debate on whether a construction project can be a ‘High Reliability Organisation’ or not. Bourrier (2011) described classical High Reliability Organisations as performing well while being bounded by a strict no-failure requirement. Reductionists would therefore argue that only error-free organisations can be 'highly reliable'; and the HRO label is strictly reserved for error-free organisations. If this is the case, should an 'HRO' organisation lose its HRO label when an error occurs? Authors with a less rigid view accept that highly reliable organisations can make mistakes and operate in a “nearly error-free fashion” (LaPorte and Consolini 1991). This nuanced interpretation blurs the distinction between highly reliable and not so highly reliable organisations, and enlarges the population of 'HROs'. This then allows a broader range of organisations to adopt the HRO lens.

The term 'organisation' also confuses. Often, the initial interpretation of 'organisation' reflects Morgan’s machine metaphor (Morgan 1997 pp.11-31). This then directs the focus towards studying structural and procedural aspects, whereas the HRO lens seems to be more about behaviour and processes than structure. Although HRO scholars have tried to avoid this misunderstanding by using 'organising' rather than 'organisation', this has not ended the debate surrounding the structural characteristics of an HRO.

Finally, does the shifting boundary between HROs and non-HROs diffuse the debate? We think only slightly, and that it makes little practical sense to determine whether organisations are 'real HROs'. The categorisation and classification debate generates only limited insight into the way the concepts that constitute the HRO lens can be

[2] This is analogous to the idea that the perspectives and concepts of quality control can only be applied to organisations that are already acknowledged for their high quality products.

used. It would seem more productive to abandon the reductionist perspective and concentrate on how the HRO lens can help any organisation enhance its performance.

HRO RESEARCH IS UNNESSESARILY CONFINED TO HIGH HAZARD INDUSTRIES AND SAFETY ISSUES

It is often argued that HRO labels and concepts should be confined to high hazard industries. High hazard industries are strongly linked to safety, and accept high societal and organisational costs, deal with extensive regulation and procedural requirements and are often protected from market forces (Schulman 2011). This situation suggests that having unsafe and risky environments force organisations to follow HRO concepts, which subsequently lead to reliable performance. HRO is thus presumed to be a natural contingent response to a high hazard environment. In less hazardous environments, organisations should not need to afford the investments required to make them reliable. In this line of reasoning, the terms reliable and safe are lumped together and substitute for one another without explanation. This seems to be due to the 'fact' that HROs in high hazard environments are 'reliably safe'. This linguistic contamination of terms obscures the reasoning and the debate. The fact that classical HROs have such a strong focus on safety neither logically implies that reliability should be confined to safety, nor that HROs should be confined to the high hazard domain. The simple fact that hazardous environments encourage certain organisations to use HRO principles does not prohibit organisations in less hazardous environments utilising the HRO lens, maybe to some lesser extent, to become more reliable. We therefore take a pragmatic stance and argue that the term reliability is not confined to safety, and may also refer to other goals set by an organisation.

By replacing the reductionist view with a pragmatic perspective on HRO, research can benefit from productive discussions about processes and principles that enhance the reliability of organisations (see Table 1 for a comparison of the perspectives). Next section provides examples of how other scientific fields borrowed the HRO lens.

Table 1: comparing the reductionist and pragmatic perspective on HRO

	Reductionist view	Pragmatic view
Unit of analysis	Structure and context of typical HROs	Processes and principles that enhance reliable performance
Meaning of reliability	Reliability as an absolute goal	Reliability as a process
Function of HRO lens	Distinguishing HROs from non-HROs	Understanding reliability issues and processes that enhance reliably
Main assumptions	Org's are either highly reliable or not	Org's can seek to enhance reliability
	HRO concepts do not apply to non-classical HROs	HRO lens applies to common organisational goals

HRO CONCEPTS AND PRINCIPLES OBSERVED IN MAINSTREAM ORGANISATIONS

Insights from High Reliability Organising are relevant for mainstream organisations because they "provide a window on a distinctive set of processes that foster effectiveness under trying conditions" (Weick, Sutcliffe et al. 1999). Roberts and Bea (2001) suggest the same by stating that “neither the sausage maker, nor the chemical-plant manager is immune from errors that can have far-reaching consequences.” These

perspectives do not bother defining and identifying HROs, instead they focus on the underlying reliability-enhancing processes and characteristics (Lekka 2011). This alternative approach to HRO becomes more visible as we see its concepts cross their original boundaries and slowly find their application in mainstream businesses. This section provides several examples of studies that have observed mindfulness and heedful interrelationships taking place outside the domain of high hazard industries.

At the first European ProHRO conference in The Hague (2011), various scholars presented research on reliable processes within regular organisations such as educational institutes, the police, detention centres, theatre and manufacturing. Further, the literature reports on the application of the HRO lens in aviation, oil production and the railway sector (Roberts 2009) and in hospitals (Vogus and Sutcliffe 2007). Closer to construction, one also sees scholars exploring how practitioners can apply principles of mindfulness to support the effective adoption of information technology (Swanson and Ramiller 2004). Further, De Bruijne and Van Eeten (2007) analysed how restructuring the utility sector impacted on the performance reliability of large technical infrastructure. Finally, Mitropoulos and Cupido (2009) looked into the work practices of high and low performing residential framing crews. They found that a guiding principle of 'going a little slower to avoid mistakes' helped crews to finish their work quicker, while also resulting in fewer errors and accidents. All these studies present elements that resemble behaviour that is, explicitly or implicitly, related to the HRO concepts. The next section brings the discussion closer to the construction industry.

MINDFUL PRACTICES IN UTILITY CONSTRUCTION PROJECTS

Here we return to the context outlined in the introduction, our domain of research: the coordination of inner-city subsurface utility reconstruction projects. Our aim is to provide an example of how researchers could use concepts from the HRO lens. We discuss our research efforts and address the typical coordination in utility projects. Finally, some observations made during the study are described and related to the HRO lens, in particular to the concept of mindfulness.

During our study of reliability issues in utility projects, we studied three such reconstruction projects taking place in a mid-sized Dutch city (150,000 inhabitants). In these projects, the municipality, several service providers and (sub)contractors planned and executed a number of tasks related to the reconstruction of cables, pipes, sewers, intersections, squares and road sections in both residential and commercial areas. The overall duration of the projects varied between six and twelve months. In this period, we spent a significant amount of time with practitioners observing planning and execution activities. We attended over thirty multi-stakeholder meetings, joined construction site visits, and had informal dialogues with experienced practitioners. We also interviewed nearly ten practitioners to retrospectively analyse a project that overran its schedule by more than fifty per cent.

Inner-city utility projects are known for their unreliable performance. During these projects, both municipalities and private utility companies, who both own distinct parts of the overall subsurface infrastructure, plan and execute construction work in a shared public space. While the municipality will procure work according to EU regulations, other utility owners commonly each employ their preferred contractors in framework agreements. This diffused ownership and contractor mobilisation, coupled with a limited and shared physical space, complicates the coordination of construction

work. We estimate that, as a consequence of this complexity, delays force the managers of the majority of such projects to abandon initial plans, improvise and re-plan, resulting in projects overshooting both budgets and deadlines. Perhaps surprisingly, most clients and contractors seem able to enumerate the main causes of these delays and overruns. Although this knowledge should help them in anticipating future delays, it seems that practitioners repeatedly overlook or neglect many potential issues. If this is the current situation, how could the HRO lens add to the understanding and managing of this coordination practice? Below, the principles of mindfulness are placed in the context of the just described project practices.

We observed limited 'sensitivity to operational issues' in several construction meetings. During these meetings, many discussions were blocked because of a client's limited knowledge of interrelated operational activities. One reason for this is that subcontracting policies distanced clients from actual construction processes. Further, fragmented ownership of the utility network and ambiguous lines of command impeded clients' awareness of interrelated operational processes. Since no client was formally in command of overall project coordination, they all approached their projects as isolated processes, neglecting the management of interfaces with related construction activities.

With regard to the 'preoccupation with failure' principle, we found that most site supervisors and contractors had a fairly comprehensive view of which unwanted onsite events could occur. Our dialogues with practitioners, for example, showed that they were able to provide detailed examples of events that had held up construction. These were, for example, blind-cutting, detecting potentially hazardous objects and poor weather conditions. Despite their knowledge of such failures, we did not observe work planners taking this into account when developing construction plans.

Further, municipal utility renewal programmes set strict deadlines for the execution of projects, putting pressure on planning and scheduling activities. As a consequence, a lack of time prevented work planners in one of our cases from thoroughly studying existing site conditions. As existing site maps were already of poor quality, the work planners greatly oversimplified conditions and project plans. Additionally, we were told by experienced project managers that they assume ideal and unhampered construction progress almost every time when they make project schedules. Their logic seems to be that: "you never know when hold ups will actually occur". In the end, such simplified plans and schedules do not contain contingencies and are, not surprisingly, waylaid by unexpected problems during the project's execution.

We expected practitioners to follow the 'commitment to resilience' principle when they had structures in place that enabled them to quickly react to unwanted delays in the construction work. This was limitedly possible in practice. For one, we found that project managers hardly had back-up strategies in place. Besides, re-planning and improvisation was inefficient as many work changes needed to be formally approved through time-consuming procurement procedures.

Clients and contractors seem to strongly follow the principle of 'deference to expertise'. The site managers were often unable to explain the formal organisation structure and the positions of the 'partners' on site. They knew, however, who to contact in the event of an issue arising. During unplanned, unexpected situations, contractors therefore try to circumvent formal procedures and directly contact the appropriate manager or supervisor. As an outcome, practitioners informally agree to quickly reschedule small project components or temporarily suspend construction.

Beyond describing the reliability complexities and issues that need to be addressed in utility project coordination practice, our aim is also to better understand how new technologies can enhance reliability in utility project coordination. We elaborate on this idea briefly by hypothesising about how a 4D-CAD scheduling tool could enhance reliability of practice.

Our research shows that 3D- and 4D- CAD construction process visualisations help in confronting the lack of information, avoiding the urge to oversimplify and to ignore potential delays. Practitioners become particularly sensitised to operational interdependencies when designs are integrated on the 3D level, and are pushed towards schedule integration when 4D-CAD approaches are used. 3D design and 4D-clash-detection help practitioners to enhance their awareness of potential errors and failures. Through scenario-based scheduling, the tool also allows practitioners to acquire in-depth knowledge of alternative project schemes, making projects more resilient to unwanted situations.

Pragmatically, the HRO lens provides a valuable structure for making sense of the coordination challenge and the behaviour of the practitioners involved. The lens further supports future policymakers in their efforts to make plans that enhance the reliability of utility projects, and allows researchers to study causalities between new technologies and reliability on these projects.

CONCLUSIONS

Debates about the legitimacy of applying the HRO lens frequently distract from the diffusion of insights into the complicated dynamics of coordinating subsurface utility construction projects. Rather than discussing the projects and their issues, our presentations turn into reductionist 'either-or' discussions as to whether construction projects are High Reliability Organisations. We argue that this categorical way of defining HROs is irrelevant as it prevents researchers reaching a deeper understanding of utility project coordination. This paper aims to move on from the recurring dispute over the application of HRO theory and concepts in the construction domain. The debate as to whether the utilisation of the HRO perspective is permissible and justified as a lens in Construction Management (CM) research obstructs the wider application of the HRO perspective in the construction domain and in the CM field. Based on our research into the coordination in subsurface utility reconstruction works, and the value we experience in this HRO perspective, we have argued that the CM-application of HRO is permissible. Although some argue that the HRO lens is not applicable to the construction industry, we would point out that this study is not the first to adopt a theoretical lens from another field. Researchers frequently exchange theoretical lenses to understand phenomena in novel ways. For example, other cross-fertilisation has occurred through the adoption of theories from economics, supply-chain management and computer engineering. Despite the fact that these fields were very different to construction, CM researchers successfully adopted theories such as Transaction Costs, LEAN and Systems Engineering. This argument supports the exploration of how the HRO lens can be applied to construction management research.

To try and understand the position taken by those scholars who feel that the HRO perspective cannot be applied in the construction domain, and is therefore irrelevant, we tested the arguments that deem HRO to be impermissible in a construction context. Firstly, we found that the terms High Reliability and Organising seem to confuse the debate. These terms steer the debate towards a reductionist classification issue. Secondly, restricting the HRO ideas to the high hazard environment where it was first

applied is difficult to defend. Many of the key HRO scholars have themselves rejected that stance, and researched HRO in other industries and domains. Further, some valuable research has already been published on HRO in the construction domain. The connection often made between the HRO perspective and safety also seems to be related to linguistic blurring of the terms reliable and safe. HRO is primarily focussed on reducing errors. Since the classical HROs needed to be “reliably safe”, the terms 'reliable' and 'safe' became virtually synonymous. The initially selected domain had safety as its main performance parameter. We argue that organisations in other domains can still opt for error-free performance and reliability in terms of other parameters without compromising HRO principles.

To illustrate the descriptive power of the HRO lens, this paper has also described how its principles apply to mainstream organisations such as hospitals, service providers and framing crews. Additionally, the study shows how the HRO lens can be used to describe the intricacies of coordinating a utility construction project.

In moving the scientific debate in the direction of the HRO lens (involving mindfulness and heedful interrelated actions), we create a breeding ground for the more widespread use of the HRO lens in construction management research. We seek to advance HRO developments by arguing for a more pragmatic interpretation of the HRO lens. The HRO lens has merits for scholars as well as practitioners in construction management.

To move ahead, we urge CM scholars to suppress any reductionist classification impulses, to free the HRO lens from its restriction to a classical (high hazard) HRO environment, to focus on reliability rather than safety and to experiment with the principles of mindful organising and heedful interrelationships to study reliable processes in construction projects.

FUTURE RESEARCH EFFORTS

This study's empirical findings are of a preliminary character. We have not attempted to draw definitive conclusions in presenting the HRO principles, and future research needs to examine construction’s HRO lens in more detail. More specifically, it might be that some concepts and principles better fit the construction industry context than others. Research should therefore put further effort into contextualising (i.e. refining, adapting or extending) the HRO lens for the construction domain. This requires researchers to learn more about both well and poorly performing construction projects.

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