Rework and its Unintended Consequence in Projects: The Emergence of Uncomfortable Knowledge

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Making Sense of Rework and its Unintended Consequence in Projects: The Emergence of Uncomfortable Knowledge

Abstract: To make sense of the rework phenomena that plagues construction projects a longitudinal exploration and mixed-method approach was undertaken to understand its causal setting and why it remained an on-going issue for organizations contracted to deliver an asset. The research reveals that rework was an zemblanity (i.e., being an unpleasant un-surprise) that resulted in: (1) project managers ignoring established organisation-wide procedures and, at their discretion, amend them to suit their own goals while denouncing the importance of recording and learning from non-conformances; (2) a deficiency of organisational controls and routines to contain and reduce rework; and (3) an absence of an organisation-project dyad that supported and promoted an environment of psychological safety. A new theoretical conceptualization of error causation that is intricately linked to rework and safety incidents is presented. The research provides managers with 'uncomfortable knowledge', which is needed to provide insights into the determinants of rework that form part of their everyday practice.

Keywords: Construction, errors, quality, rework, safety, zemblanity

Introduction

'Getting it right first time' (GIRFT) eliminates defects and the need for rework. Naturally, this underwrites an organization's ability to improve their productivity, performance, and competitiveness. While this goal is often underpinned by a quality management strategy and framework or its variants, GIRFT remains a significant challenge in project-based and labor-intensive industries such as construction. People are fallible and therefore prone to making errors. Committing an error may result in a rework non-conformance (NCR), which requires a process or activity that was incorrectly completed the first time to be corrected to the specified state (Love, 2002).

Having to undertake rework is a chronic and costly problem within the construction industry worldwide (Burati *et al.*, 1992; Barber *et al.*, 2002; Josephson *et al.*, 2002; Hwang *et al.*, 2014; Taggart *et al.*, 2014; Forcada *et al.*, 2017; Love *et al.*, 2018a). Despite decades of research and the proliferation of project management tools and techniques such as *agile*, *lean*, and *system dynamics* to combat rework through deeper understandings and structured interventions, projects are still experiencing cost and schedule overruns as a result of errors (Cooper 1993; Williams *et al*., 1995; Parvan *et al*., 2015; Sterman *et al*., 2015). Indeed, there has been a tendency for construction organizations to consider it to be a normal function of operations, despite its negative impact on project performance and profitability (Moore, 2012).

Studies examining rework costs in construction have tended to be based upon a limited number of cases studies (i.e., typically ranging from one to six) which makes extrapolating generalizable conclusions somewhat difficult. Furthermore, many have relied upon questionnaire surveys with sample sizes less than 200, which have required respondents to provide estimates of the occurrence of rework in projects that they have been involved with (Love *et al*., 2016a). In addition, rework costs incurred in construction projects remain relatively unknown, as many organizations do not specifically measure them (Love *et al*., 2016a; Love *et al*., 2018a) for the purpose of either robust accounting or, management learning. If, however, organizations were able to formally determine rework instances, impact and causation, these organizations could find themselves experiencing [which Giustiniano *et al*. (2016) refers to as] *organizational zemblanity*. In this instance, the active and passive behavior of staff and subcontractors contribute to a series of poor decisions and inappropriate actions that adversely influence project performance. That is, rather than a chorus of unexpected events that culminate in rework, those that occur are known about - a form of zemblanity; that is, an unpleasant un-surprise (Boyd, 1998). Against this contextual backdrop, the research presented in this paper seeks to address the following research question: If construction organizations know that rework is an issue in their projects, then why do they not put in place mechanisms to contain and reduce its occurrence?

This paper commences by reviewing the extant literature to provide a theoretical framing of rework causation in construction to understand its underlying characteristics. Then, it draws upon findings obtained from the experiences and views of practitioners as well as examining documentation from real-life projects to make sense of the mechanisms that lead to rework. A manifestation of zemblanity is unearthed and as a consequence, the paper suggests that there is a need for construction organizations to reconsider how they can actively address and attend to errors to improve the performance of their projects. In particular, the retrospective interpretation of rework events and unintended consequences provides the basis for improving future actions and putting in place containment and reduction strategies. While there is an absence of a robust theory surrounding rework causation (Love *et al*., 2016a), the research presented in this paper makes a significant contribution toward aiding its development not only in construction, but also in projects that are utilised within environments where critical safety systems are in place such as oil and gas and nuclear sectors. The research provides managers with uncomfortable knowledge and inconvenient truths that can confront projects in everyday practice. Bringing such knowledge to the fore provides a basis for construction organizations to exercise critical reflection about what they are doing within their projects, to understand why they are doing it, and determine the consequences of their activities.

Toward a Theoretical Framing of Rework

To address the proposed research question, it is necessary to understand what is meant by rework and how it manifests in projects. Definitions of rework abound the normative literature (Love *et al*., 2018a). For example, Robinson-Fayek *et al*. (2003) referred to rework as the "total cost of re-doing work in the field regardless of the initiating cause" (p.14). A *caveat*, however, is that Robinson-Fayek *et al*. (2003) excluded change orders that can result in re-doing work and errors due to off-site manufacture from their definition. Similarly, Love (2002) defined rework as the "unnecessary effort of re-doing a process or activity that was incorrectly implemented the first time "(p.9). This definition also includes design and construction errors, omissions and changes that may arise.

With the increasing use of non-traditional and specifically relational procurement methods to deliver projects where design and construction are conducted concurrently or by a single entity undertaking these functions (as well others) such as the provision of financing an asset, the definition offered by Love (2002) is still relevant. Within construction, rework can take place either during the production of an asset or after it has been handed over to a client during the defect's liability period and beyond into the occupation stage. The research presented in this paper focuses on the former.

The Emergence of Error and the Linkage to Rework

Rework is typically a product of human error, which can arise due to actions (e.g., slips and lapses), judgment and decision-making (e.g., cognitive biases or heuristics) or violations (Reason, 1990; Reason, 2008). Errors, however, are an effect or symptom of an organization and the project environment within which people work. They are not a random act but are systematically connected to aspects of people's tools, task, and their work environment. There is, however, no universally accepted definition of an error but there is a consensus that it involves a form of deviation from an intention (Reason, 2008). Cognitive science has formed the basis for examining human errors (Hollnagel, 2004). It views the human as an information processor that attempts to direct actions and make decisions using limited resources (Stewart and Grout, 2001: p.446). In this instance, errors arise when people are overworked or apply stored and standard routines and rules to inappropriate situations. Bearing this in mind, there are two distinct steps that are required to solve a problem or perform a task: (1) forming an appropriate intention or plan; and (2) acting out that intention. A failure in either step ca, therefore,e result in an error.

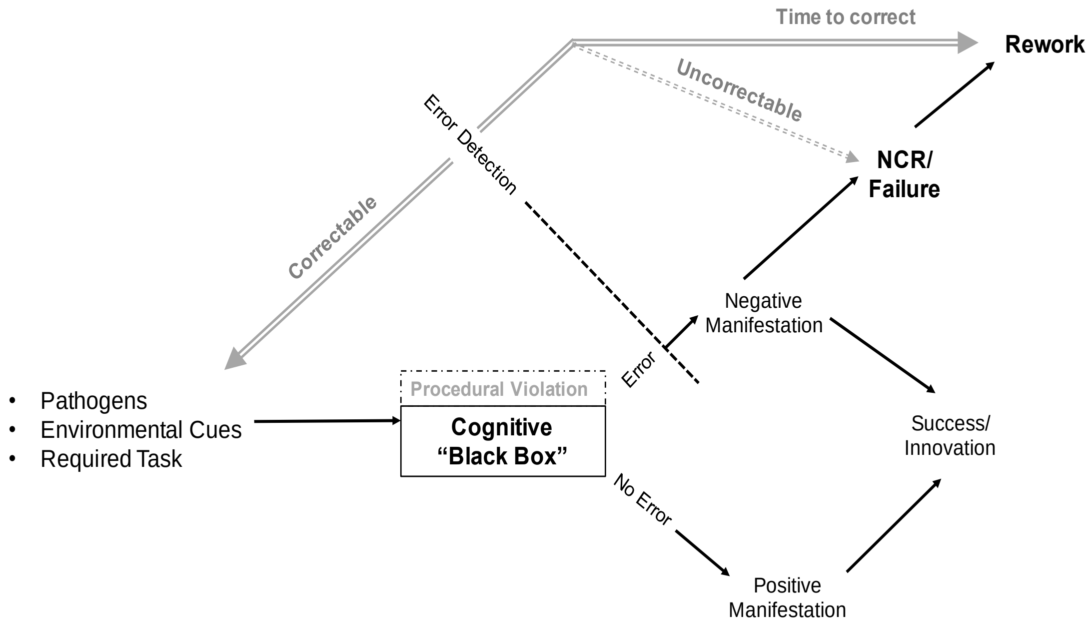
Such unintended deviations from plans, goals or adequate feedback processing, as well as incorrect actions from a lack of knowledge, have been referred to as *action errors* (Frese and Zapf, 1994). Another form of error is an omission, or otherwise known as a procedural violation, which involves a conscious intention to break-a-rule or not conforms to a standard or procedure (Reason, 1990). In these cases, people tend to break rules to make work more efficient or the decisions they make become a trade-off between the information presented to them and the often-limited time to attend to a task (Love *et al*., 2016a). Noteworthy, errors in judgment and decision-making (cognitive biases and heuristics) can also emerge, though are difficult to contextualize. Accordingly, Mousavi and Gigerener (2011) have stated that “human judgments are usually considered erroneous when measured against logical and statistical norms of rationality” (p.97), as the context within which a decision is being made is not considered and given meaning/recognition. The research presented in this paper is confined to examining errors of action and omission, as they imply non-attainment of a goal and non-conformity and therefore peoples' experiences are drawn upon to derive meaning and understanding of these non-conformities.

The importance of understanding why errors transpire and what remedial actions can be taken to avoid them, or recover from their occurrence has been the subject of considerable research (Frese and Keith, 2015). Human error that takes the form of mistakes (rule-or-knowledge based), slips and lapses of attention, and acts of omission and commission (Reason, 1990) can cause rework. A conceptualization of the causal linkages of error and rework is presented in Figure 1. Here pathogens juxtaposed with environmental cues serve as inputs to the cognitive black box (Stewart and Grout, 2001).

Pathogens are the strategic and economic decisions that can influence the way in which a construction organization processes information. They, therefore, impact the way they manage risk and subsequently create an environment for errors to happen (Love *et al*., 2009). Such decisions are a result of attendant risks, which are referred to as *latent pathogens*. Before they become apparent, individuals and organizations often remain unaware of the impact that particular decisions, practice, and procedures can have on a project's performance and productivity (Busby and Hughes, 2004).

Pathogens lie dormant within a system for a considerable period of time and become part of everyday work practices. Within the black box the appropriate rule or routine is selected to undertake a daily task, or "the direct conscious effect is applied" (Stewart and Grout, 2001: p.48). When, however, the task is performed under conditions where pathogens are present and an active failure arises (e.g., slips, lapses, mistake, and procedural violations) errors will invariably arise, which can either result in a failure or NCR, which may subsequently require rework.

An individual's cognitive ability can be impaired by constraints and demands that have been imposed by the environment within which a project is delivered as well as the nature of tasks and associated conditions that they have been exposed to during the construction process. For example, boredom can arise when a person is either prevented from doing what they want to do or forced to do what they do not want to do (Fenichel, 1951). These two types of boredom may be referred to as thwarted or forced engagement of attention. Another significant type of boredom that is not characterized by constraint, but by a condition, is the apparent freedom in which the individual is unable to maintain attention on, or interest in, any object or task. Thus, in the case of attention slips, and action failures these frequently are attributed to situational boredom (Robertson *et al*., 1997). In addition, boredom proneness leads to carelessness and is positively correlated with a tendency to result in high rates of cognitive and behavioral errors that occur through a lack of motivation and effort (Wallace *et al*., 2002). This has been observed in practice, for subcontract trades where there is a high degree of task repetition, such as the placing and fixing of reinforcement (Sing *et al*., 2014).



Adapted from Stewart and Grout (2001:p.449)

Figure 1. A conceptualization of errors linking to rework

Active failures are difficult to foresee and are unable to be eliminated by reacting to the event that has occurred. Failures of this nature that occur are usually caused by an individual at the coalface of operations and can immediately have negative results. Conversely, latent conditions can be identified and remedied before an adverse event occurs (Reason, 2008). For example, latent conditions that have been identified as triggering peoples' actions to commit errors during the design process are the (Love *et al*., 2009): (1) failure to undertake design reviews; and (2) distribution of incomplete contract documentation to contractors. The submission of low design fees as a result of a competitive tendering process by consultants to secure a contract often results in tasks being omitted and limited time being provided to produce documentation. This is further exacerbated by time constraints often imposed by clients without considering their impact on design-related activities and thus places pressure on individuals within consultancy organizations involved in a project to omit tasks to achieve a planned goal. A similar scenario is regularly played out during the construction process (Eden *et al*., 2005). This has been especially the case when limited resources have been provided to supervise construction activities and when subcontractors are presented with over-optimistic schedules to complete their works (Love *et al*., 2016b).

The output is an action or decision that can manifest as either a positive or negative outcome within a project. If no error occurs, then a task is successfully completed. If an error is detected, an NCR may be issued, which may result in a product or process failure that is unable to be corrected. Alternatively, the NCR may require corrective action. Errors, however, do not necessarily have negative consequences. An individual and organization's development are dependent upon doing something new, making errors, and then trying to improve. According to Festinger (1983) errors are integral to the development of an organization's culture, as dealing repeatedly with past errors and mistakes can lead to new problems being resolved and therefore contribute to its progression and maturity. Furthermore, innovation is an unattainable goal without experiencing and making errors; the processes of discovery are inherently contradictory and chaotic, and naturally subject to being error-prone (Bledow *et al*., 2009).

Construction, in contrast to other industries such as health and manufacturing, has tended to treat errors as being problematic and a source of failure rather than a road to eventual success and source of innovation. Unfortunately, the construction industry has often only tended to learn from failures arising from disastrous events, which have resulted in serious injuries and/or death, and those where serious structural or environmental events have occurred (Love *et al*., 2013).

Research Method

Sense-making describes the process whereby people observe and interpret novel, ambiguous, confusing events, and coordinate a response to clarify their meaning (Kudesia, 2017). In this instance, the equivocality associated with the emergence of rework is examined so as provide a plausible account of order and to make sense of its occurrence (Maitlis and Christianson, 2014). Sense-making goes beyond "interpretation and the active authoring of events and frameworks for understanding, as people have a role in constructing the situations that they attempt to comprehend" (Maitlis and Christianson, 2014: p.58). Therefore, it enables understanding of people's environment to be attained through verbal and embodied behaviors that have occurred often underpinned by norms, custom, and practice. Through this process, people become aware of their behavior and enact mechanisms to initiate changes in their environment in ways that necessitate new understanding and changed action. When equivocal events cause breakdowns in meaning, a new form of sense needs to be re-accomplished. Accordingly, Snook (2000) suggests that the adoption of a sense-making perspective enables a richer understanding of how events come to be, portraying even negative events as "good people struggling to make sense rather than "bad ones making poor decisions" (pp.206-207).

An 'organizing' rather than 'organization' perspective to sense-making is adopted for the purposes of this research (Lant and Shapira, 2000). Here 'organizing' is viewed as a process whereby the views and interlocking behaviors of individuals involved in rework events are sourced (Kudesia, 2017). Within the sense-making literature 'organization' refers to the presence of conflicting rationalities that exist between different groups within a single organization. As a project comprises multiple organizations this perspective of sense-making was chosen. Moreover, within an 'organization' perspective an illusion of stability exists, which negates the process of re-accomplishment (i.e. ability to respond and initiate change) when an unexpected event occurs (Weick, 1979; Gioia, 2006). As construction operates in a dynamic environment that is constantly subjected to disruptive events occurring, it is reasonable to assume that it is important to learn from errors made and initiate redress.

Sense-making is retrospective in nature, as disruptions prompt individuals to turn their attention to information from the past to interpret how the event came about. Essentially, it comprises a three-part mantra: (1) What happened; (2) What went wrong; and (3) How can we do it better next time (Kudesia, 2017). The narrative, however, associated with retrospective sense-making has predominately focused on unexpected events, particularly those that have resulted in legal inquiries being undertaken (Weick, 2010; Goh *et al*., 2012; Guistiniano *et al*., 2016). In the case of rework, it is also often treated as being an unexpected event, although individuals often knowingly commit errors and subsequently conceal them (Ford and Sterman, 2003). Individuals then do not inform their managers of the expected bad news until they come to light and genuinely act surprised at their occurrence. In reality, this is where zemblanity prevails. To make sense and understand zemblanity in the context of rework, the meaning is derived from an "evolving product of conversations" (Currie and Brown, 2003: p.565).

Data Collection and Analysis

To acquire an understanding of the rework phenomena that consistently plagues Australian construction projects, a longitudinal and mixed-method approach to data collection was adopted, which commenced in February 2014 and was completed in May 2017. To address the proposed research question, the study comprised of three sequential stages that cascaded upon and informed each other (Figure 2):

1. *Understand the nature of rework*: In this stage, the research sought to make-sense and garner an understanding of what, why, how and when rework occurred and to examine the mechanisms that were in place to contain its occurrence. As noted below, the research undertaken in this stage revealed that there was a tentative relationship between rework and safety events. It was therefore assumed that if rework can be reduced then safety performance would improve.
2. *Determine the relationship between quality and safety*: Following from stage 1, the relationship between quality and safety was examined and quantified. Bringing to the fore the significant effect rework was having on safety outcomes would highlight the need to address rework rather than ignoring its presence. In addition, construction organizations' have typically eschewed measuring rework costs and therefore demonstrating its impact on their 'bottom-line' raises an awareness to contain and reduce its occurrence; and

3. Determine the precursors to rework: The primary aim therefore of this final stage was to validate the findings from stage 2 practitioners' views and experiences of rework events that led to safety incidents. Also suggestions for containing and reducing were also solicited.

All data that was collected throughout the research process was inputted into *NVivo* Version 11 to organize, analyze and obtain insights from the semi and unstructured interviews and documentation that were undertaken. A flexible coding process was followed, initially using common terms that were derived from the literature (axial) and from the case study, with additional words being added as the research progressed (emergent) (Saldaña, 2013). The initial codes captured broad themes such as defects, violations, quality auditing, and monitoring capabilities as well as subcontractor compliance capabilities that occurred during the construction process. The descriptive first-cycle of coding enabled data portions of the data contained within the transcripts to be summarised (Miles *et al*., 2014). The second-cycle coding provides the basis for inferences from documentation to be determined and patterns regarding rework events to be established (Miles *et al*., 2014).

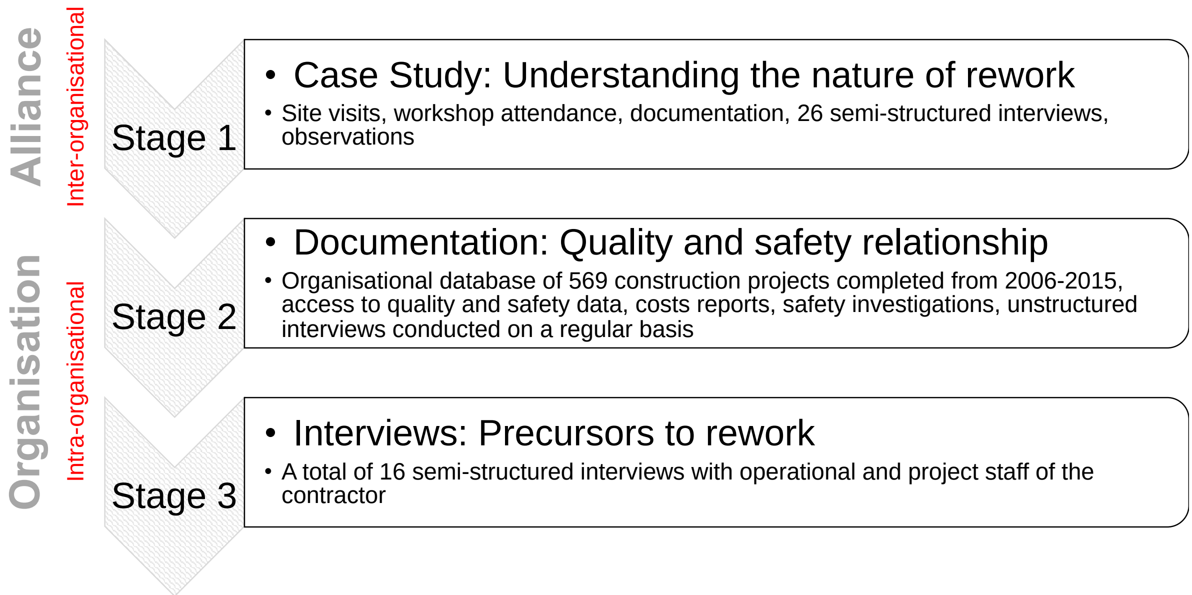


Figure 2. Stages of the research process

In summary, the qualitative data were analyzed using NVivo to provide an understanding of the nature of rework, its precursors and impact (stages 1 to 3). More specifically, the data obtained from the construction organization's documentation in stage 2 provided the ability to quantitatively examine the relationship between quality and safety. A detailed analysis of the relationship that emerged is beyond the scope of this paper and can be found in Love *et al*. (2018b). In this paper examples identified from interviews and the documentation are provided to examine the nature of rework and safety to provide a context to their relationship.

Case Study: Stage 1

A cross-sectional case study was initially undertaken to understand 'why' and 'how' rework occurred and its unintended consequences. The case study was a program alliance that delivered 129 water infrastructure projects over a five-year period at a value of AU$375 million. The alliance comprised a contractor, consultant, and client. Under the management of the contractor, subcontractors were contracted to construct works. A total of 26 semi-structured interviews were undertaken during the fourth year of the alliance's duration with project team members and subcontractors (Table 1). Visits to several sites were also undertaken to conduct the interviews with subcontractors. All interviews were digitally recorded and ranged in length from 25 to 141 minutes, which were subsequently transcribed and distributed to interviewees to check and confirm their accuracy. Interviews commenced by asking interviewees about the extent rework that they had experienced and obtaining an understanding of 'why' and 'how' it occurred and its consequences. Then, questions focused on the strategies and processes that had been implemented to contain and reduce rework. In the final part of the interview, participants were asked to describe the mechanisms that were in place to engendering learning and innovation.

Unlimited access was provided to the project's database that contained a 'lessons learned' register, accident and incident statistics, NCRs, site meeting minutes and contractor forum reports. Several workshops were organized by the alliance and facilitated by an independent consultant to openly discuss with subcontractors why rework was occurring in the projects that were being constructed. The researchers were invited to attend, observe and listen to the discourse that transpired at a lessons-learned workshop that examined rework events that had occurred in projects, which lasted approximately 90 minutes (Figure 3).

From the interviews that were undertaken and from the discussions at the workshop it has been observed that that rework was being performed there was a greater propensity for safety incidents to occur. A site manager for the contractor re-affirmed these views as they had observed that projects they had been involved in had experienced an average of 30% delay due to rework events and safety incidents. To all participants involved in the workshop this was considered to be a known, unknown; it was an *un-surprise* to them.

Table 1. List of interviewees and workshop from the alliance project

Interviewee	No. of interviewees	Duration (Minutes)
Alliance Manager (Alliance Leadership Team)	1	42
Project Director (Alliance Leadership Team)	1	52
Chairman (Alliance Leadership Team)	1	20
Design Manager	2	66
Delivery Manager	1	24
Design Team Leader	1	78
Commercial Manager	2	79
Systems Engineer	1	24
Risk, Quality and Support Team Leader	2	37
SQE Manager	2	31
Construction Manager	1	25
Project Manager	5	141
Project Engineer	1	25
Site Managers	2	29
Site Supervisor	1	25
Project Manager	1	60
Foreman	1	44
Contractor Workshop (35 participants from the	-	90

alliance team, consultants and subcontractors_

Documentation: Stage 2

Issues surrounding the relationship of rework and safety incidents that emerged from the case study led the researchers to examine in further detail this issue with a contracting organization. The researchers were provided access to all NCR and safety data for 569 projects the organization had constructed from 2006 to 2015. In addition, access was provided to safety investigation reports, project reviews and monthly financial and performance reviews for projects. Fortnightly informal discussions with the governance and compliance managers who were located at the construction organizations corporate headquarters over a period of a year were undertaken to acquire an understanding and to be able to interpret the quality and safety documentation provided for the projects that had been constructed over a nine-year period.

Data were analyzed to determine if there was a statistical relationship between rework and safety, and to identify specific project types where these instances may arise, so they could be examined in further detail. In addition, specific rework events that contributed to safety incidents were examined with meaning being gained from the conversations that transpired with the governance and compliance managers. The researchers questioned and interrogated the plausibility of the interpretations of events that were derived from various documentation sources that were made available. A process of triangulation was enacted, which enabled data saturation (Glaser and Strauss, 1967) and content validity to be attained.

Interviews: Stage 3

As a result of unearthing a significant statistical relationship from the documentation provided in stage 2, semi-structured interviews were undertaken to identify the precursors of errors that led to both rework and safety incidents. A total of 16 interviews were undertaken with operational staff in Safety, Quality and Environment (SQE) at head office and those on-site from the same organization. Each interview ranged from 40 to 75 minutes and was digitally recorded and transcribed *verbatim* and distributed to interviewees to check and confirm their accuracy. Specific role types and projects that interviewees referred to during the interview have been suppressed in this paper for reasons of commercial confidentiality.

Research Findings

The data that was collected throughout the duration of the research was rich in content. The findings are presented sequentially in accordance with the stages undertaken to build a robust foundation to conceptualize the reality of rework causation. In doing so, a process of zemblanity was revealed to be present at the individual, project (i.e., alliance) and organizational (i.e., construction organization) levels when procedures and systems to ensure quality was cast aside to achieve a specific outcome, irrespective of the attendant risks. A similar approach was undertaken by Giustiniano *et al*. (2016) who used the concept of zemblanity to examine the Costa Concordia shipping disaster in Italy, "when in systems designed to impede risk, key actors nonetheless construct their own misfortune" (p.7).

Uncovering the Dark Side: An Un-surprise in Practice

The documentation provided by the alliance case study was the best that could be produced under the circumstances. It had been subjected to review and evaluation by all participating organizations (e.g. contractor, client, and consultants) that agreed to engage in an open and transparent relationship under the auspices of a no-blame environment.

The initial organizational controls that were adopted by the alliance project were derived from the contractor's organization, which formed an integral part of its corporate governance (Figure 3). The structures, processes, and controls that had been developed by the construction organization were supposed to provide the alliance with a standardized means to deliver the construction works. However, their implementation within the alliance led to a sequence of decisions that resulted in a series of *vicious circles*, which manifested as rework and safety incidents occurring during the construction of projects.

Two and half years into the alliance's five-year program of construction works, the frequent occurrence of rework led to projects, on average, experiencing three-week delays with the total cost for additional management and supervision being in excess of AU$1 million. The consultants, contractor, and subcontractors were aware of the problem, but continued to confirm and apply the processes and procedures that had been used to design and manage the delivery of projects. If the *status quo* had prevailed, then it was estimated that the rework would directly cost the alliance in excess of AU$3 million over the life of the program.

The alliance leadership and management team were steadfast that this could not continue and sought to address the problem head-on. They initially organized a series of workshops to examine why rework was occurring, which was attended by the alliance team and their subcontractors. During the workshop, a construction supervisor stated that they had observed and documented that safety incidents had also increased. The supervisor suggested from their immediate observations from several projects that the likelihood of safety incidents occurring while undertaking rework was four times greater when compared to performing normal work activities.

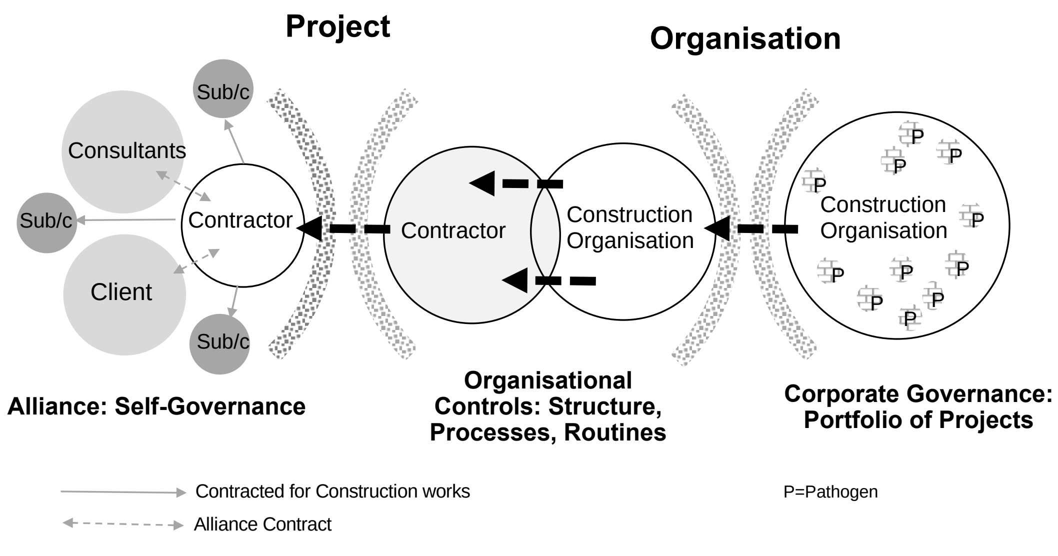


Figure 3. From corporate to self-governance: De-legitimisation of organizational controls

This observation was subsequently confirmed by analyzing the actual injuries and high potential incidents, of the NCR and safety incident, registers compiled from 79 of the 129 projects that had been completed at the time interviews had been undertaken.

Figure 4 provides evidence of the number of safety incidents that occurred while undertaking rework. On discovery of these figures presented in Figure 4, alarm-bells resonated within the client's organization as they had a duty of care to ensure they provided a safe working environment for all people engaged with their projects. Conversations with the contractor and subcontractors, however, echoed what was already apparent to them; rework was contributing to safety incidents. But, management within their organizations was not sympathetic as reflection and questioning of rework causation was perceived to be an irrelevant action. Providing a forum to legitimately engage in reflective practice and the coalescing and exchange of experiences provided a mechanism for collective thinking to be engendered. In addition, substantive rationalities could be weighed and assessed enabling participants to make sense of the issues at hand and therefore jointly determine suitable courses of action to remedy in the future the situations that had previously confronted them on-site.

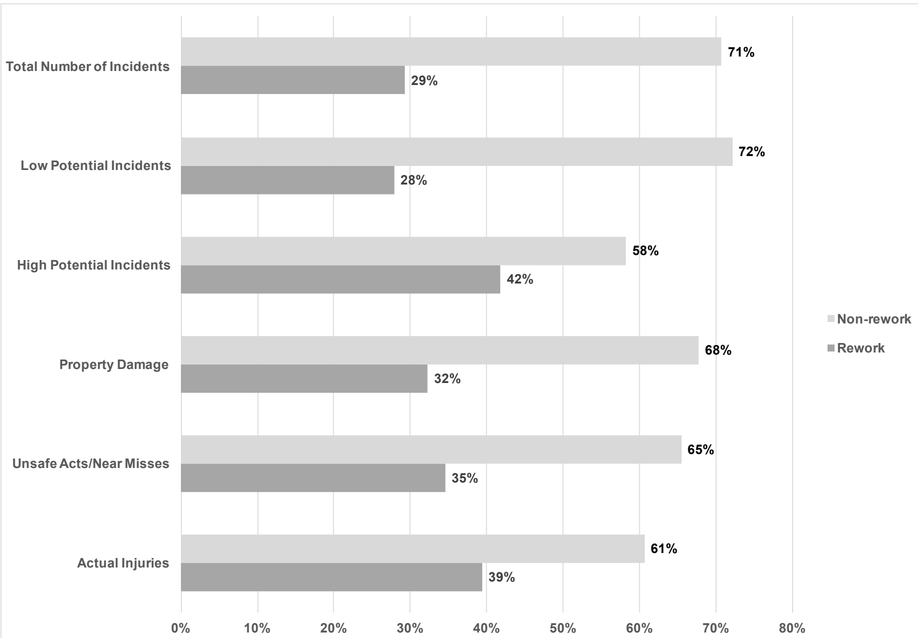


Figure 4. Safety incidents during rework events within the alliance project

The contractor organizational controls had been adopted by the alliance thwarted the management of projects and subcontractors' ability to effectively perform activities. The established processes and procedures (e.g., quality assurance (QA), safety, and environmental) were cumbersome and over-reliant on paper-based manuals that did not actually reflect the nature of the work to be undertaken. Accordingly, the alliance was having to amend them every time a new project commenced because of varying design requirements, environmental conditions, contractor experience, and procurement issues.

While intra-and-inter organizational mechanisms were in place to enact safety, to comply with legislation, they were lacking in their aim to contain and reduce rework. It had not dawned on the contractor and subcontractors, until the problem had been explicitly articulated, to question the existence of rework, as it was a norm and had become an embedded function of practice (i.e. simply the way of doing things). An example of temporal zemblanity emerged in this instance, being facilitated by unreflective obedience that permeated everyday practice (Guistiniano *et al*., 2016).

Facing an on-going demand to convey water throughout the region due to a long-standing drought, there was an urgent need to construct a series of pipelines. Rather than obtain approvals from land-owners prior to determining the route and design of the pipelines, a decision was made to acquire the pipes prior to their construction to expedite the delivery of water. It was anticipated that some land-owners would object to the proposed pipeline routes, and therefore a cost contingency was incorporated for any proposed changes that could potentially occur.

Unsurprisingly, the lack of timely engagement with stakeholders resulted in repeated scope changes, as sections of pipelines were required to be re-directed. This resulted in backfilling trenches that had been previously excavated, additional clearing and grading, re-aligning and bending of pipes. The rework that was required placed unnecessary additional pressure and stress on subcontractors and reduced their ability to meet the projects' originally contracted schedule.

Project delays that ensued meant that the client organization's ability to provide water to local farmers, the community and businesses throughout the region was held-up. This had the potential to tarnish their service quality and lead to customers being dissatisfied. Such delays were not welcomed by the subcontractor staff as they had to spend additional time in remote areas and be subjected to harsh environmental conditions and extended the time they were away from their families. Naturally, this adversely impacted morale and exacerbated the need to complete projects as quickly as possible, which evidently increased the propensity for people to take short-cuts and cause more rework.

Despite the alliance being a relational-based procurement method, the in-house engineering consultants' engagement with construction supervisors and subcontractors was minimal, which stymied their ability to ensure the constructability of their designs. Within the alliance, design and construction activities were separated and limited reviews were undertaken prior to tendering the works. This resulted in errors and omissions being contained in the documentation that was produced and provided to subcontractors. Errors and omissions were often not identified until work commenced on-site, requiring requests for information (RFI) to be raised and often resulted in extreme confusion as to what was supposed to be constructed. Due to contractual cost and time constraints, subcontractors regularly anticipated, improvised and relied upon their experience to redress the documentation errors rather clarifying and confirming with construction supervisors.

While the subcontractors who were interviewed perceived that they were at the time being proactive in undertaking such actions, they were in retrospect demonstrating ignorance of their contractual obligations. This was a common occurrence, and not unexpected by the alliance as most subcontractors had never before been contracted to undertake major works and abide by the processes and safety procedures of a 'Tier 1' construction organization. Notably, 'Tier 1' construction organizations are generally the largest or the most technically-capable in their supply chain. They have the skills and resources to supply the critical components and they have established processes for managing suppliers in the tiers below them.

Deceptive Behaviour: In Search of a 'Quick Buck'

An example illustrating this problem came to the fore during the construction of a recycled water pipeline where the subcontractor procured 100 valves from a supplier who had them manufactured in

China. The contract for valves was valued at AU$240,000, but cheaper alternatives had been procured particularly as they were able to be acquired a month earlier than those specified. The specification within the contract made it explicit that valves needed to be sourced from a specified Australian supplier. Therefore, the subcontractor had engaged in deceptive behavior that was motivated by a desire to improve their margin and ensure timely arrival. Knowingly following a predetermined script of their own creation, the subcontractor had placed themselves in a position of financial vulnerability. In this way, they were putting in place the likelihood for the process of zemblanity to come into being. The subcontractor knew what they were doing was not in accordance with the contractual requirements.

However, upon testing the sourced valves from overseas, 25 of them were found to be defective; the brass nut locking mechanism failed as soon as turning pressure was applied. Five valves had been installed in the road traffic roundabouts (i.e., a circular intersection where traffic flows counter clockwise around a center island) that been completed. The defective valves were required to replaced and a new order was raised with the original Australian supplier stipulated in their contract. The constructed roundabouts had to be partly demolished and additional road traffic management put in place, at an estimated rework cost of AU$200,000 in addition to re-ordering 100 new valves. While the valves were being replaced a couple of laborers required first aid (e.g., for sprains, strain, and cuts) and several near misses were reported. For example, an excavator slewed over a road narrowly missing an oncoming car. This occurred as the person responsible for traffic management had been using their mobile telephone while directing traffic and inadvertently allowed a car to pass while machinery was operating.

Failing to Plan, Planning to Fail

In another example, inadequate planning and sequencing of works and utilization of equipment provided the basis for a series of unfortunate actions stemming in a cascade of errors, which resulted in a considerable amount of rework that not only jeopardized safety performance but ended in a contractual dispute. The project was a storage facility that was needed to supply a regional town with water. The original contract value was AU$13 million and during the site's preparation, the subcontractor deployed over 20 large pieces of plant each costing approximately AU$3,000 per day (e.g., backhoe loaders, tippers, bobcats, and graders), for clearing, excavating and grading the site. During the first six weeks, the subcontractor began clearing the site, excavating and stockpiling soil, which was also needed to form the embankments for the storage basin. In doing so, the subcontractor inadvertently mixed the topsoil with the clay that was excavated. Then, they constructed the water storage pit on-top of the good clay, which was also needed for the embankment.

Despite the contractor's supervisor providing advice about how the construction process should be undertaken, the subcontractor's project manager was on record stating "Don't tell us what to do, this is what we do for a living". However, in the execution of their discretion, they demonstrated an element of doubt in what they were doing. This over-confidence existed as the subcontractor had a pedigree in earthmoving while having no experience in constructing water storage facilities. The alliance was cognisant of the subcontractor's prior experience but had every confidence that they could perform and complete the project in accordance with the pre-determined deliverables due to their previous track record. The project manager refused to listen and communicate directly with the construction supervisor, despite every effort being made to engage in constructive dialogue. The refusal to acknowledge and accept the guidance being provided resulted in the subcontractor having to recreate stockpiles for the topsoil, clay, and silt more than three times larger than the original, which contributed to their costs increasing and to a delay to the programme. The self-assured hubris of the project manager and their unwillingness to acknowledge the advice provided by the supervisor led the commercial director referring to Socrates who stated, "the only true wisdom is in knowing, you know nothing".

As a result of poor progress, the subcontractor's project manager was relieved of his duties, as a loss of AU$600,000 had been incurred over a six-week period. A new project manager was installed, but to the surprise of the construction supervisor continued to follow the same logic of double-handling material as they perceived it would be a more cost-effective option, despite repeated requests to re-examine their adopted construction methodology. It appeared to several alliance team members that an 'escalation to commitment' (Shaw, 1976) had occurred, which lead to a series of unfortunate actions. Moreover, the subcontractor began to violate environment and safety procedures when it was perceived that they were trying re-coup lost time and money. The cavalier behaviour of the newly appointed project manager had parallels with the concept of the *smart idiot* identified in Giustiniano *et al*. (2016) where someone is so confident of their limited expertise that they generate dangerous situations. With such behavior being played out, the contractor anticipated that an adverse event would occur, and as a result, several NCRs were issued to the subcontractor as well as warnings regarding their non-adherence to procedures.

The material used to create the embankment would not compact as topsoil and clay had been mixed together; a process of lamination had occurred. As a result, the subcontractor was required to scrape three meters off the three embankments that had been completed and re-do them. During this process, there was a fuel spillage and water was contaminated. Then, while attending to this problem, a laborer was struck by an excavator, though luckily only required first aid. The project was going from bad to worse, and an independent consultant was brought in to act as a mediator between the contractor and subcontractor to mitigate further environmental, quality and safety issues. Ultimately, this turned out to be a successful strategy that ensured the project was completed, but it was estimated that rework cost the subcontractor approximately AU$7 million. With the benefit of hindsight, both the alliance and subcontractor agreed that the interfaces between their organizations could have been managed more effectively, but the organizational controls put in place were inadequate and needed to be revised and improved.

De-legitimization of Organisational Controls

Recognizing the amount of rework that was occurring and its adverse impact on safety performance, the alliance initiated a change strategy that saw its entire processes and procedures re-engineered, which meant that those that were initially adopted were de-legitimized. Subcontractors' voices were heard, and the alliance recognized that there was a need to change to reduce rework and improve safety performance. Over a six-month period, with input from all alliance members and their subcontractors' new processes and procedures were developed and a collective learning environment was enacted.

Unearthing the Relationship between Rework and Safety Performance

While the alliance case study described above comprised of water infrastructure projects, the 569 examined in this second stage were derived from the building, infrastructure, rail, and the mining sectors. The main contractor, however, formed part of the alliance and their previous participation in stage 1 of the research provided the basis for a further line of inquiry to focus on the relationship between rework and safety data. A total of 19,314 cases of NCRs were recorded with 47% (n=9,098) being reported as rework by the organization from projects that had been constructed. In line with extant literature, the costs of rework arising from NCRs were determined from the NCR reports provided for individual projects. A detail examination of these reworks costs has been presented elsewhere in Love *et al*. (2018c). In sum, the costs of rework from NCRs were able to be determined for only 218 of the 569 projects. The analysis revealed that: (1) mean rework costs were 0.18% of contract value; (2) structural steel and concrete subcontracted works had the highest levels of NCRs; and (3) differences were found in the cost of NCRs between procurement methods and contract size.

Of the 569 projects that were examined, 456 reported injuries, and a total of 17,783 NCRs were recorded. Injuries were further categorized into four main types as part of the construction organization's safety management reporting system: (1) lost-time injury, (2) first-aid injury, (3) alternate work injury, and (4) medical treatment injury. Pearson correlation analysis between the frequency of injuries and rework was significant (r^2 =0.70, p =.000) (Teo and Love, 2017). The quality and safety documentation provided was mined with the assistance of NVivo to make sense of the nature of events that had been captured by the construction organization's reporting systems. However, it is worth noting that the quality and safety information that had been recorded by site personnel and reported from projects was often scant in detail. An issue that contributed to the contractor's employees under-providing limited information about NCRs was that senior management consequently considered them to be associated with a poorly performing team and project and therefore had the potential to adversely influence their reputation in the marketplace.

In becoming familiar with the rework events that had occurred and been documented and to overcome the paucity of detail, the researchers were also provided access to safety investigation reports, witness statements, monthly project, assurance, and performance reviews. Examples of rework that resulted in a safety incident are presented in Table 2. Here the violations identified are skill-based, as they form part of a person's repertoire of capabilities or habitual actions and thus translate into typically taking short-cuts to make work more efficient when subjected to time and cost constraints.

Table 2. Examples of safety incidents arising during a rework event

Error Type	Classification	Event Description
Violation *Skill-based*	Unsafe Act	Workers were tasked to investigate a **defective pipe** that was leaking. One of the workers, who was wearing height safety equipment, proceeded to access a roof *via* an extension ladder. They ascended to an awning, which was 5.1m above ground level, using an extension ladder. They then secured a base plate (anchor), which was then attached to their safety harness and climbed onto the awning. Subsequently, they retrieved the ladder and placed it on the awning so as to access the roof, a further 5m in height. The worker did not utilize the ladder bracket/roof safety access system that was in place to access the roof, as it was located at a height of 9.5m which was deemed to be **unsafe.**
Violation *Skill-based*	Unsafe Act	An employee of the contractor conducted an **unplanned task** to obtain a level within the base of a manhole for a surveyor who had turned up a day earlier than originally planned. The employee had propped a ladder against the manhole and climbed to the top. When on top of the manhole the employee attached a lanyard from their harness to the handrail on a shield, which is an '**unsafe' act** when working from a height. A ladder was then inserted into the manhole and the level determined by climbing down the top two rungs.
Violation *Skill-based*	Unsafe Act	A **formwork fold was missed** during its original installation of a deck. This resulted in a concrete mowing strip placed was not acceptable. A worker had to measure the formwork fold from the underside of the deck. They proceeded to install planks for an access and work platform and measured the fold. But, the worker forgot to install the handrails, though had put in place end rails. The worker was stated that they had been in a hurry to complete the task and had **forgotten to install the handrail** that would have protected him from a fall.
Violation *Skilled-based*	First-Aid Injury	**Fabrication errors** were identified on a fender frame, which required the lugs to be re-welded. As the boilermaker was repairing cracks using a die grinder, its 'tip' jammed and rotated the blade anti-clockwise. This resulted in the boilermakers right thumb being smacked against the fender frame. The boilermaker is fully qualified, and competency was assessed **but used a die grinder as a 5-inch grinder in an area where it was not appropriate to do so**. Neither the pre-start card nor task risk assessment, however, identified the use of a die grinder and the hazards of the tool malfunctioning.
Lapse	Unsafe Act	**A pile needed to be re-drilled** from a barge. A Bauer drill on a 280T crane was used. There was a restricted and limited work area. There were long lengths of hydraulic hoses attached from drill head to a power pack. Spoil skip bins were also stored on the deck. A task risk assessment had been undertaken and signed off. A rigger was attempting to guide the hydraulic hoses up past a spoil bin. The hoses swayed back towards them**, trapping the riggers left hand between the hoses and the underside edge of the spoil bin**. The lift was stopped straight away, hook lowered and hand without any injury.
Slip	First-Aid Injury	Concrete honeycombing was identified during the construction of a Coffer Dam's wall. Rather than **rectifying the defect** when it was identified, the project manager decided to complete the wall's construction and at a later date rectify the honeycombing, so as not to delay the project's completion date. While carrying out patching work on the dam wall, a worker fell approximately 34m down the Left-Hand Abutment to the overflow whilst attached to a rope fall arrest system. It was found that the fall arrest system was not secured to an anchor point and subsequently gave way while the employee was descending the rock face. **After the employee presented to the site office for first aid, an ambulance was called and taken to a hospital.**

Serious safety incidents as a result of rework were identified in 28 projects. In these instances, serious refers to causing or having a high potential to result in an event or series of events that result in significant adverse effects on the safety or health of a person. For example, in the case of a road project, a worker attempted without supervision and approval, to crimp/bend a 20 mm Polyvinyl Chloride tendon pipe, which dislodged the base of the concrete segment, causing pressurized grout to discharge and strike the worker's face. In doing so, the grout dislodged the worker's safety glasses and entered their left eye. In this case, no direct access was provided to the worker who had been injured, but it appeared from the incident reports that they had acted like a reckless optimist, a behavior identified in Giustiniano *et al*. (2016), as they had been overly confident in their ability to perform the task at hand, while ignoring the required safety procedures.

The Precursor to Rework: Absence of Psychological Safety

Implicitly, the findings from the case study (stage 1) and documentation (stage 2) intimated that the drivers of rework and safety incidents both tended to relate to illusions of *control* (i.e. overestimating the extent to which an outcome can be governed), *invulnerability* (i.e. underestimating the likelihood that breaking a rule will result in adverse consequences) and *superiority* (i.e., being highly skilled and therefore can do the required task differently than expected) (Reason, 2008). With safety incidents occurring predominately during a rework event, then the assumption that if rework is reduced, safety performance will improve, naturally follows. Bearing this in mind, interviews within the construction organization in stage 3 were undertaken to acquire an understanding of the key precursors to rework occurring in projects that interviewees had been involved with delivering (Figure 2). A precursor, in this instance, is a reasonably detectable event, condition, or action that serves as a warning that may result in rework.

Interviewees were asked to recollect a rework event that they had been involved with and explain how and why they perceived it occurred. Drawing upon the findings, the precursors to rework are presented here. Notably, there was an overarching consensus amongst interviewees that rework resulting from violations and mistakes committed by workers at the coalface of operations were the main contributors to unsafe acts. There was a perception that there was a propensity for workers to often opportunistically consider the benefits of committing a non-compliance over and above the consequences. This explicitly came to the fore during the interviews as limited resourcing to supervise construction works juxtaposed with time constraints were identified as conditions that resulted in violations and mistakes being made. Rather than focusing on the condition resulting in the action, it had been observed that project managers blamed the individual worker, and thus reprimanded them accordingly. While workers may commit violations and errors during construction, it is the way in which the project is managed by the contracting organization that ultimately makes it possible for them to occur.

An Overlooked, but Known Relationship

A quality manager suggested that rather than their organization put in place mechanisms to reprimand workers for committing non-compliant actions, more emphasis was needed to focus on espousing the benefits of compliance. The incongruity here was that while management demonstrated an outright commitment to safety by placing it at the heart of its operations and culture, quality was pushed to the sidelines within the organization. This has been identified as an issue when management adopts mini-Machiavellian leadership where they tend to want to keep secrets (Argyris, 1976) or in this case to withhold information from industry clients and stock market so as not to portray an image of inferior performance. The lack of commitment and support from senior management for quality transcended into the portfolio of their projects. The raising of NCRs was deemed to be a nemesis by management, the corollary being that there was often a reluctance by the project's site management team to report and document them as well as provide a detailed description of their causes and specific financial consequence. In these instances, such actions resulted in blind obedience to authority (i.e. Autoritätsdusel) and hindered learning from taking place (Sommer, 2001). As Einstein so eloquently stated the "stupor of authority is the greatest enemy of the truth" (Sommer, 2001:p.93).

It was repeatedly acknowledged that quality was pivotal for engendering and managing change and improvements to the organization's processes and project. While the corporate rhetoric made explicit the embodiment of quality in everyday work practices, only a limited number of examples of projects where their project managers/directors aspired to achieve excellence and openly engage in learning from previous rework experiences were able to be identified. In the examples provided, project managers/directors, ironically worked alongside their team members to ensure they GIRFT. In doing so, they shed their hierarchical status and nurtured a learning milieu by enacting a continuous improvement strategy, which resulted in an environment of psychological safety being established. The absence of such an environment in projects and a focus on simply meeting cost and schedule deliverables provided a breeding ground for opportunistic behavior to emerge, which subsequently hindered the ability to GIRFT.

Edmondson (1999) describes psychological safety as the collective belief of *how* team members and leaders respond when another member puts themselves *on the line* by asking a question, reporting an error, or raising an awkward issue. As people were generally discouraged from reporting and documenting NCRs by their project managers, learning between the organization-project dyad was stymied. Unsurprisingly, the pervasive effects of status and power, particularly that being placed on that personnel accountable to a project manager, mixed with an individual's inherent sense of self-preservation heightened the interpersonal risks of exposing NCRs.

The reluctance to report NCRs provided the backdrop for legitimizing the non-conveyance of near misses. Even though legislation required all safety incidents to be reported, there remained a disposition to only report those where physical harm to a person or damage occurred. While it was acknowledged that near-misses provided valuable information about hazards and were essential elements for calculating risks, it was deemed impossible to obtain an accurate count of their occurrence due to the unwillingness of people to report them. Despite the high level of formalization and an absolute priority to safety within the industry, the construction organization's paucity of intra- and inter-organizational mechanisms to ensure that work was subjected to GIRFT resulted in a series of bad decisions being made that gave rise to a spiral of zemblanity occurring.

Emergence of Bahramdipity

On completion of each stage of the research, the findings were reported to the construction organization's management. It came as no surprise to them that rework was contributing to safety incidents, but the extent to which it did raised a few eyebrows and caused alarm. However, at the same time, these observations created a mindfulness of the problem. Management's dogmatic and steadfast approach to ensure their safety performance compared with or was better than industry standard meant that quality had been overshadowed.

In this instance, a Boydian dialectic explicitly existed, as there was a degree of interaction between serendipity and zemblanity at play. Yet, being so focused on safety at the expense of *quality*, the construction organization was unable to understand the *gestalt*. Drawing on Berlin's *hedgehog-fox typology*, the approach the construction organization adopted was akin to that of the hedgehog where their world is seen through a lens of a single defining perspective, in this instance safety, rather than that of the fox who draws on a wide variety of simultaneous experiences and views (e.g., quality, safety, and environment) (Jahanbegloo, 2000). Despite management within the construction organization being alarmed, the research findings were suppressed, as the organization was not prepared to initiate the required change management initiative to re-calibrate its strategy and structure. Such an action is akin to *bahramdipity* which is defined as the "suppression of a discovery, sometimes a serendipitous one, by a more powerful individual (Bahram) who does cruelly punish, not merely disdain, a person (or persons) of lesser power and little renown who demonstrates sagacity, perspicacity and truthfulness to the Bahram" (Sommer, 1999: p.81)

Discussion

The findings presented to illustrate the deep-rooted issues that reside and are inherently embedded within work practices in construction. Paradoxically, people remained unsurprised by rework emerging in their projects and accepted it as an innate function of practice, despite its adverse impact on safety and cost. The overarching elements contributing to zemblanity emerging from not GIRFT were threefold: (1) project managers tended to ignore established organization-wide procedures and at their discretion amended them to suit their goals, while denouncing the importance of recording and learning from NCRs; (2) a deficiency of organisational controls and routines to contain and reduce rework; and (3) an absence of an organisation-project dyad that supported and promoted an environment of psychological safety and collective learning in projects.

The management of projects by a construction organization involves the rationalization of choices (Clegg and Courpasson, 2004) and good decision making. The strength of a construction organization's corporate control system influences the way projects are managed. Therefore, the ability to eliminate arbitrary decisions and actions taken by project managers is dependent on ensuring that an environment of psychological safety exists. This is to ensure that goals and desired outcomes are aligned between the corporate strategy and the project. Without a unified managerial approach to GIRFT and the provenance of divergent values and beliefs about quality in a construction organization, varying sub-cultures may be established in projects. Differing modalities of control in projects can place an organization in a maelstrom, especially when a series of significant cost/schedule overruns, engineering/environmental failures or death occurs. Often it is only after the occurrence of a major adverse event that a change in mindset and practice are introduced by an organization. The fundamental reason is that they fear their competitive position and reputation will be jeopardized as well as their long-term viability within their marketplace. For many construction organizations, the inability to deny that not GIRFT is an inconvenient truth will remain, unless some form of regulatory framework comes into place to measure the quality performance of projects. Construction organizations need to engender a culture of psychological safety throughout their organization so that the management of error becomes a norm.

A breakdown in the use of quality systems can result in a disconnect with safety (Das *et al*., 2008). As demonstrated from the findings presented, management played a pivotal role in contributing to this scenario materializing throughout the organization; a process of zemblanity was unintentionally designed and subsequently embedded into practice. As a result of such managerial actions, whether undertaken unwittingly due to legislative pressures or purposefully as part of a cost rationalization initiative, attributing the source of errors to employees unable to GIRFT provides a disservice to icons of the quality movement such as Deming (Das *et al*., 2008). There is a need for management to move to a position to openly recognize that rework is a problem, and thus projects are not and never will be totally safe. In doing so, there is an acknowledgment that an environment for GIRFT and safety must be created through practice in all levels of the organization and portfolio of projects.

Theoretical Implications

Apart from a limited number of studies (Das *et al*., 2008; Wanberg *et al*. 2013; Love *et al*., 2015), there has been an absence of systematic research in the operations and project management literature that has examined the relationship between quality and safety. The research presented in this paper seeks to contribute to filling this void, as it has identified that having to undertake rework due to errors also significantly contributes to safety incidents which in turn causes delays and thus more pressure to take short cuts and make errors – a dynamic behavior pattern. Evidence provided indicates that if rework is reduced, then safety performance can be significantly improved, and this will then logically augment organizational productivity during the construction process and profitability. The initial conceptualization of errors and rework presented in Figure 1 is now revised to incorporate safety.

The theoretical framing of rework causation that emerged from the research is presented in Figure 5. Errors are inevitable in construction, but the way in which an organization responds to their occurrence influences their ability to mitigate their adverse consequences and to learn from their mistakes. In the context of construction, an emphasis has been typically based on error prevention (i.e. blame oriented-environment and blocking erroneous action), and while obviously important, strict adherence can produce a negative mindset toward errors, as was evident from the findings. The corollary, in this instance, is that there is a reluctance of people to review and analyze their past actions and share experiences relating to errors. Thus, rigid error prevention reduces or even eliminates the beneficial potential for learning.

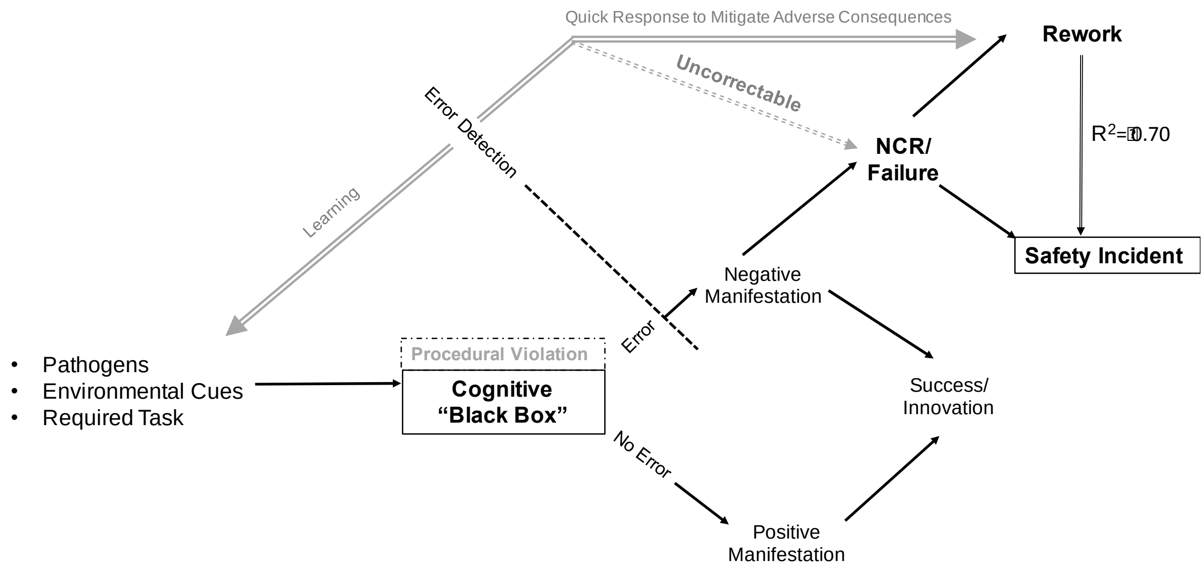


Figure 5. Linkages between error and rework: Emergence of safety incidents

Industry practitioners are aware rework is a problem in construction projects, but it has been and continues to be, surprisingly, ignored by many contractors. Put simply, construction organizations' performance and competitiveness will remain adversely impacted until this problem is 'openly' addressed throughout all levels of their business and changes made. On acknowledgment of the problem, error management can be used to extend error prevention that forms an innate part of practice in construction (Frese and Zapf, 1994; van Dyck *et al*., 2005; Keith and Frese, 2015).

Error management commences after an error has occurred and has the goal of: (1) avoiding or reducing negative error consequences; (2) reducing the occurrence of the same error in the future; and (3) optimising the positive consequences of errors, such as learning and sometimes even innovation (Frese and Keith, 2015). While errors and violations are deviations from goals, plans or standards, errors are always unintended, whereas violations are conscious decisions not to adhere to agreed policies or rules. But, when a violation is made resulting in an NCR, the process implemented to address the subsequent rework, for example, can trigger a series of further errors that can result in safety incidents. Errors and violations, therefore, interact with one another and should not be dealt with independently when they materialize.

Managerial Implications for Project Management

The extent that zemblanity embeds "a set of mechanisms for making sense of social processes" has implications for practice in project-based organizations (Davis, 2015; p.341). In the case of the findings presented, construction organizations and their project managers are presented with uncomfortable knowledge: it may be denied, dismissed, diverted or displaced (Rayner, 2012). Uncomfortable knowledge can be used as a gauge of an organization's and their projects health. The more uncomfortable knowledge an organization maintains, the closer it is to becoming an *Ancien Régime* (Funtowic and Ravet, 1994). In the case of rework, the creation of knowledge is only possible through the systematic social construction of ignorance (Ravet, 1987), which in this instance has been encased in zemblanity. In consideration of the findings presented, construction organizations have not had access to an appropriate frame of reference in their projects, which is needed to become fully cognizant of the problems associated with not GIRFT within them. Frames are value-based, but without them it is impossible to comprehend the extent and impact that events, such as rework, have on organizations and the performance of their projects (Lakoff, 2010).

Within project-based organizations (particularly those operating in environments where critical safety systems are in place), error-making symptoms can be countered with prudent leadership that is able to provide equal credence to quality and safety throughout all levels of their organization and project portfolio. Fostering an environment of psychological safety is paramount to confronting errors and violations within projects. Reporting NCRs should not be seen as being a symptom of a poor performing project and site management team. Quite the contrary, as Edmondson (1999) observed that the better performing teams admit to errors and discuss their occurrence - a 'climate of openness'. Without such a climate in place, zemblanity can become embedded within the structure and processes of an organization and vicious circles of bad decision-making are enacted. To break this cycle, management should not only provide their employees with a voice to identify and share their experiences about error, but to also give them the tools and encourage them to generate solutions to the problem at hand. In doing so, they will make their employees and subcontractors accountable for their actions and learning.

Conclusions

The paper has sought to deal with the following research question: If a construction organization knows that rework is an issue in their projects, then why do they not put in place mechanisms to contain and reduce its occurrence? To address this question, there was a need to understand the causal nature of rework, and its consequences. It was revealed that construction organizations have limited understanding and knowledge of how rework manifests and its adverse consequences, particularly on safety outcomes. While rework remains an on-going concern for construction organizations it has unfortunately become accepted as a being a norm or a zemblanity.

The research revealed that in some instances, NCRs resulting in the need for rework may become ‘hidden events' in projects. That is, widely experienced, but hidden and unreported by project managers to their senior management. Here rework remains hidden as senior management are often reluctant to hear ‘bad news', placing it within the realm of being implausible and denying its existence. If rework, is formally reported then senior management may well consider that their projects are being poorly managed. The degree of underreporting of NCRs that prevails in construction, may be difficult to believe, but unfortunately is a reality of everyday practice for many organizations We have observed that denial itself acts a deterrent to taking seriously reports of NCRs. Thus, for senior managers it may be a case of "it can't be, therefore it isn't" (Westrum, 1982: p.383).

Being able to GIRFT is central to acquiring productivity and performance improvement in construction. Rework that is often needed to ensure a product or process conforms to its required standards is neither an unfortunate event nor just a case of poor leadership. In the case of the research conducted in Australia, it was observed that it emanated from a progression of inappropriate decisions that materialized from a lack of organizational controls and routines that were unable to moderate the effects of people's behavior and actions. The contextual insight suggests that a situation where an organization created an avoidable situation that resulted in rework and safety incidents was therefore created. Elevated levels of formalization and an absolute priority for safety, with a lack of inter-and-intra systems to capture and learn from NCRs that required rework, resulted in an acceptance of zemblanity. This acceptance created a designed sequence of poor decisions that reinforced the presence and acceptance of rework, which also adversely influenced safety performance. Zemblanity was embedded in work practices coming to the fore by:

- project managers ignoring established organization-wide procedures and at their discretion amending them to suit their goals, while denouncing the importance of recording and learning from NCRs;
- a deficiency of organizational controls and routines to contain and reduce rework; and
- an absence of an organization-project dyad that supported and promoted an environment of psychological safety and collective learning in projects.

These inherent issues have become ingrained within organizational and project-related practices being reinforced with a focus on error prevention. In addition, the uncomfortable knowledge that is presented provides a representation of a reality that prevails.

With a focus on error prevention, NCRs were deemed to be fundamentally a sign of a poor performing project team. But, previous research has dispelled this assumption. Thus, there is a need for construction organizations to re-calibrate their orientation toward embracing error management, if they going to reduce rework and improve their safety performance. In doing so, they will be required to put in place mechanisms to report, share, communicate, help with, and to quickly handle errors that arise in projects. Rationalizing and supporting the need for the adoption of error management, a new theoretical conceptualization of error is presented, which identifies its linkages with rework and safety. The new knowledge arising from this research provides an impetus for construction organizations to re-evaluate the zemblanity associated with rework to a position where serendipity as a result of knowing of errors becomes an integral function of practice. While the research was conducted in an Australian context, it is suggested that the findings presented would align with the experiences of construction organizations in other parts of the world. Naturally, cultural nuances would need to be considered, but as many organizations adopt and adhere to international quality and safety standards, the experiences presented provide a basis for comparison and act as a stimulus to redress rework as it is a problem worldwide in construction.

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