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## Creating a mindfulness to learn from errors: Enablers of rework containment and reduction in construction



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### ABSTRACT

Empirical research has revealed that the salient issues that influence the conditions for errors to manifest in construction are attributable to: (1) authoritarian leaders blocking communicative action; and (2) an absence of an organizational culture that supports and promotes learning from errors. The errors that emerge from leadership and cultural issues in construction have been overlooked in the literature. We, therefore, develop a rework containment and reduction (CORE) framework that can be used to create an environment that supports and promotes learning from errors. Our CORE framework comprises four strategic enablers: (1) authentic leadership; (2) error management; (3) psychological safety; and (4) psychological contract. The framework can provide construction organizations with the opportunity to learn and modify work practices to redress their rework problem. Additionally, it affords a platform for organizations to create capacity and willingness to exercise critical reflection about what they are doing, to understand why they are doing it, and to determine the consequences of their actions.

### 1. Introduction

“This is we, it's us, all together, how can we, as a collective, address this problem?”

John Morrison, Frontline Coach

At a technical symposium in Melbourne, Australia, in November 2018 Mr. John Morrison<sup>1</sup> made a call for industry practitioners to address the problem of rework collectively, as it is negatively impacting the performance, productivity and safety of construction projects (Forcada et al., 2017a; Love et al., 2018a). In this paper, we define rework as “the total direct cost of re-doing work in the field regardless of the initiating cause,” which expressly excludes the change orders (variations) and errors caused by off-site manufacture (Robinson-Fayek et al., 2004 p.1078). Notably, the reported costs of rework have been reported to range from less than 1%–20% of a project's contract value (e.g., Barber et al., 2000; Love and Li, 2000; Forcada et al., 2017b; Teo and Love, 2017).

While rework remains an on-going concern for construction organizations, it has unfortunately become accepted as being a norm or a *zemblanity* (i.e., an unpleasant, unsurprise) (Love et al., 2019). In some instances, non-conformances (NCR) that require rework become ‘hidden events’ in projects. That is, widely experienced, but hidden and

unreported by project managers to their senior management (Love et al., 2018b). 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. Unfortunately, however, this underreporting is a reality of everyday practice in many organizations as the presence of NCRs are often denied in projects (Love et al., 2018b). For senior managers, it may be a case of “it can't be; therefore, it isn't” (Westrum, 1982: p.383).

Advocates of Lean Construction, for example, may well disagree that there is an absence of effective strategies to combat rework. An array of lean concepts (e.g., Last Planner®) can be applied to address waste in construction. However, there is limited empirical evidence that such concepts can reduce and contain rework. We do not discount the benefits that may materialize from enacting lean concepts within construction at an operational level, quite the contrary. Indeed, in theory, lean has a place to play in reducing rework. In practice, however, there has been a tendency to apply lean concepts in a prescriptive and piecemeal manner without supplanting the processes where new modes of work can be enacted. Moreover, a ‘zero defect’ mentality often resides within

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construction organizations that adopt lean concepts as they strive to prevent errors at their source. As a result, the ability to innovate and learn can be stifled (Love and Smith, 2016).

Without an organizational culture that supports and promotes learning from errors, people are unable to perform their work effectively and therefore successfully utilize tools, techniques, and technologies to contain and reduce rework (Love et al., 2018a). Irrespective of the various tools, techniques and technologies that have been widely advocated to tackle rework (e.g., Rogge et al., 2001; Love and Irani, 2003; COAA, 2006; Han et al., 2013; BuildingPoint, 2016) the issues that contribute to its occurrence are associated with leadership, organizational culture and behavioral issues (Love et al., 2018a, b, c).

Such errors arise due to actions (e.g., slips and lapses), judgment and decision-making (e.g., cognitive biases or heuristics) or violations (Reason, 2000; Love et al., 2018c). Errors, however, are an effect or symptom of an organization and the project environment within which people work. They are not random acts but are systematically connected to aspects of people's tools, tasks, and work environment (Dekker, 2006). It is often the strategic decisions taken by managers or decision-makers that can provide the latent conditions for errors to materialize at the coalface of construction. While people make mistakes, organizations make it possible for them to be serious. Accordingly, Reason (2000) eloquently stated: "we cannot change (the) human condition, but we can change the conditions under which people work" (p.768).

If construction organizations are to contain and reduce rework, then errors but need to be viewed as an opportunity to learn and modify their work practices, where necessary (Love et al., 2018a). Unfortunately, however, many construction organizations have limited knowledge about the precursors of rework and its costs (Love and Smith, 2019). This situation has arisen as many organizations have eschewed putting in place mechanisms to establish 'why' and 'how' a rework event unfolded and measured its costs. We have put forward that this situation arises, in part, as a result of construction organizations unwittingly engaging in the practice of 'functional stupidity' (Alvesson and Spicer, 2012; Love et al., 2018).

To address 'functional stupidity,' we have previously submitted that construction organizations embrace an error management culture. In doing so, they can equip themselves with a growth mindset so that learning from experience becomes the catalyst for containing and reducing rework (Love and Smith, 2016; Love et al., 2018b). Drawing on our previous empirical research (e.g., Love et al., 2018a, c, d, e) and the extant literature, we develop a rework 'COntainment and REDuction' (CORE) framework that can be used to create an environment that supports and promotes learning from errors.

Rather than musing on prescriptive operational strategies, our proposed CORE framework strategically focuses on a collective of behavioral, cultural, leadership, and psychological aspects of work. By taking such a strategic focus, construction organizations will be better positioned to execute their business plans through their projects. We then discuss the implications of our proposed framework for practice.

## 2. Rework: a review

Despite the burgeoning interest in determining the causes, costs and consequences of rework, which has stemmed several decades (e.g., Farrington, 1987; Barber et al., 2000; Josephson et al., 2002; Han et al., 2012; Hwang et al., 2014; Forcada et al., 2017b), we have been unable to develop robust strategies to contain and reduce its presence in construction projects.

Two approaches that have been used to determine the causes and costs of rework are the *project* and *construction* perspectives (Love et al., 2018d). Differences in the stated percentage of rework costs as a proportion of contract value that have been reported in the extant literature vary with the perspective used. A project perspective accommodates 'design changes, omissions, and errors,' and 're-doing work in the field regardless of the initiating cause' (Farrington, 1987). In stark contrast, a

construction perspective excludes change orders and errors caused by off-site manufacture (Rogge et al., 2001; Robinson-Fayek et al., 2004; Love et al., 2018d).

Design changes, omissions, and errors, however, have been identified as primary sources of rework (e.g., BRE, 1981; NEDO, 1987; CII, 1987; Willis and Willis, 1996; Han et al., 2013). For example, Farrington (1987) revealed that design changes accounted for 79% of the total amount of quality deviations (i.e., rework) experienced in projects and 78% of the costs incurred. During construction, design changes tend to materialize as a result of a client requesting additions or deletions to a project's scope (Hwang et al., 2014; Love et al., 2017; Yap et al., 2018). Omissions and errors, however, are likely to emerge due to oversights and mistakes within the contract documentation that have been prepared by design consultants (Yap et al., 2017). When design changes, omissions or errors occur, and rework needs to be performed, a contractor can make a claim and thus be financially compensated for undertaking additional works. This additional cost is typically borne by the client, though in some circumstances a design consultant may be financially accountable for the rework.

Naturally, the reported rework costs from a construction perspective are lower in this instance and are generally the responsibility of the contractor. For example, Love and Li's (2000) examination of 14 industrial engineering and building projects found a contractor's rework costs ranged from 0.14% to 1.2% of the contract value. In a significantly more extensive study, Love et al. (2018e) examined 218 projects revealing mean rework costs to be 0.18% of the contract value. Markedly, Love et al.'s (2018d) analysis of 346 projects completed by a contractor over six years incurred a total of 19,605 NCRs that required rework revealed. Having to attend to this rework resulted in the contractor experiencing a mean profit loss of 28% per annum. At this juncture, it needs to be acknowledged that the methods used to determine the costs of rework vary. Thus, comparisons between studies need to be treated with considerable caution, especially when trying to determine the cause of rework.

### 2.1. Causation: the need for context and understanding

Identifying the cause(s) of a rework event, and the counterfactual thought about how it may have turned out differently do not always correspond (Love et al., 2016). This counterfactual thinking is due to participants in projects distinguishing between the various types of causes and making different inferences from dissimilar ones. In addressing this shortcoming, a contractor may justify a claim for rework by sifting through their available evidence and look for fragments of information that point to a common cause to develop an *a priori* explanation. While this approach is common, Dekker (2006) points out that this is also problematic as:

- details that are relevant to explaining the actions and behaviors of people can be overlooked; and
- the information collated is meaningless outside the context where it originated. Typically, the piece of information obtained is combined with that of a similar nature, though it may have its own context and *raison d'être*. When data is produced, it may be divorced from other fragments of information that it has been combined with.

Taking information out of context by selecting and combining it in hindsight, or micro-matching it with a view that the contractor knows is not true, is misleading as the original context and meaning become redundant, and a new sense is adopted (Love et al., 2016). As socio-political, cultural, and organizational pressures, rather than the context within which they arose, may have driven their selections. Considering this scenario, Dekker (2006) cogently states a "cause is not something you find. Cause is something you construct. How you construct it and from what evidence, where you look, what you look for, who you talk to, what you have seen before, and whom you work for"

(p.76).

Traditionally, the error prevention paradigm has tended to reside within construction organizations. Error prevention assumes errors can and need to be prevented, and a *priori* explanations are often used to apportion blame (Love et al., 2018b). As a consequence, people worry about making an error and work hard to prevent them. However, when an error occurs, people may become increasingly stressed when attending to it, as they are conscious that they will be blamed and reprimanded for the unintended event. In some instances, people may hide the error, hoping that it will never be detected.

With increased competition and decreasing margins, construction organizations have found themselves being confronted with managing paradoxical demands (i.e., two contradictory things simultaneously), as there is a requirement to ‘do more’ but ‘for less’ (i.e., price versus quality). The result is added pressure placed on-site management teams and subcontractors to deliver their projects in accordance with pre-determined deliverables. When trade-offs between price and quality ensue, the odds are that rework will materialize, as projects are under-resourced, inferior products may be selected and components/items omitted.

Each project that forms part of an organization's portfolio will be faced with competing demands. In constantly weighing up these competing demands, we have observed that project managers within the same organization will manage them differently (Love et al., 2018b). Some project managers adhere to the ‘either-or’ while others will strive to adopt a ‘both-and’ situation in their projects irrespective of the demands being made by the organization. We have observed that when an ‘either-or’ scenario is being played out, it is to satisfy the drive to secure their margins (Love et al., 2018b). In this instance, project managers tend to ignore organization-wide procedures and at their discretion, amend them to suit their own goals.

Understanding the context and making-sense of rework causation provides a purpose to introduce some degree of objectivity towards creating a better awareness of how events are linked to one another. For this to happen, an organizational mindset that acknowledges errors happen (i.e., acceptance of human error) and a belief that learning can be engendered from their occurrence is required (Love and Smith, 2016). Possessing such mindfulness provides the basis for objectivity to pervade in a line of inquiry, as there is a willingness to learn from the experiences and perspectives of people who were involved in the rework event.

### 3. Containment and reduction framework

In this paper, we focus on construction rework, as it can adversely impact the bottom-line of the organization charged with building an asset. So, in light of the above discussion, we suggest that a subtle shift from an operational to a strategic focus is required by construction organizations to remedy rework across their portfolio of projects. Here consideration is equally given to the organization, its processes, people, and the portfolio of projects. The upshot being the establishment of a strategy that can be uniformly implemented throughout all levels of the organization, which aims to create a workplace conducive to ‘getting it right first time’ (Fig. 1).

In support of a strategy that aims to ‘get it right the first time,’ we have developed a rework CORE framework presented in Fig. 2, which comprises four enablers (Love et al., 2018a, b, c, d). As mentioned above, we have advocated that to redress rework construction organizations need to institutionalize an error management culture and provide an environment for psychological safety under the auspices of authentic leadership. Adding to this mix, there is a need for a psychological contract to be created not only between the construction organization and its employees but also with the site management team and their sub-contracted workforce to ensure positive quality outcomes. The underlying principles of the enablers identified within the CORE framework are presented in Table 1.

Our quantitative analysis of 19,314 NCRs requiring rework and 17,783 injuries that occurred in 569 construction projects revealed a positive association between them ( $r^2 = 0.70$ ) (Teo and Love, 2017). To add context to these findings, we examined in depth the nature of several rework events where safety incidents and occurred. We demonstrated that if we can reduce rework in construction, then safety outcomes will also be improved in projects (Love et al., 2018c). Notably, the underlying precursors of errors that contribute to both rework and safety incidents are akin. The CORE framework places equal attention on quality and safety and therefore provides managers with an ability to develop a more nuanced understanding of the nature of conflicting purposes that may exist within their organization and across their project portfolio (Smets et al., 2015).

Construction organizations operate in a highly competitive and dynamic market that is subject to ever-increasing change, which is influenced by an array of political, economic, social, legal, and technological

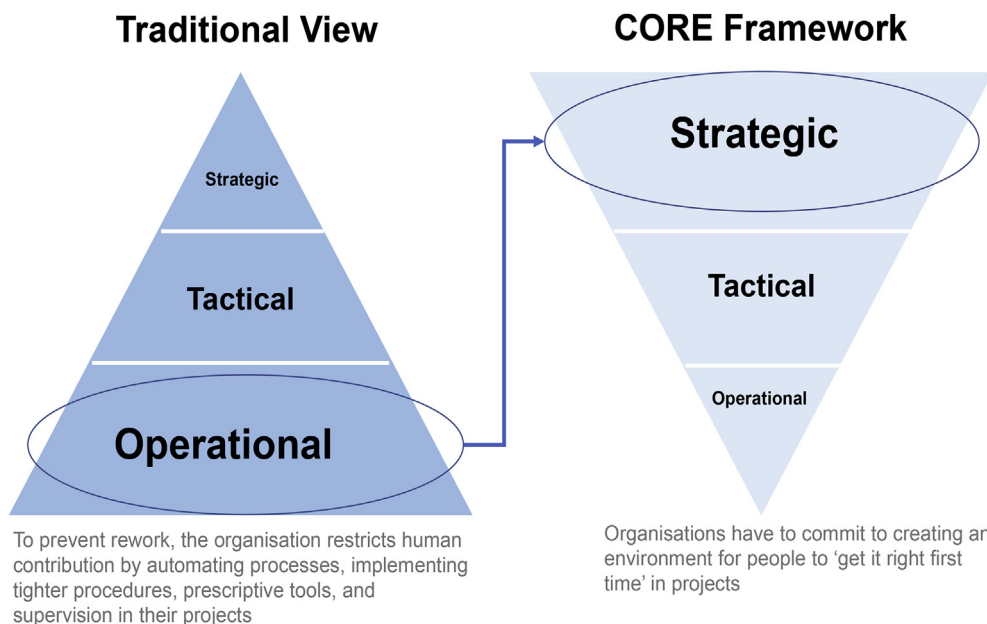


Fig. 1. A shift from an operational to a strategic focus.

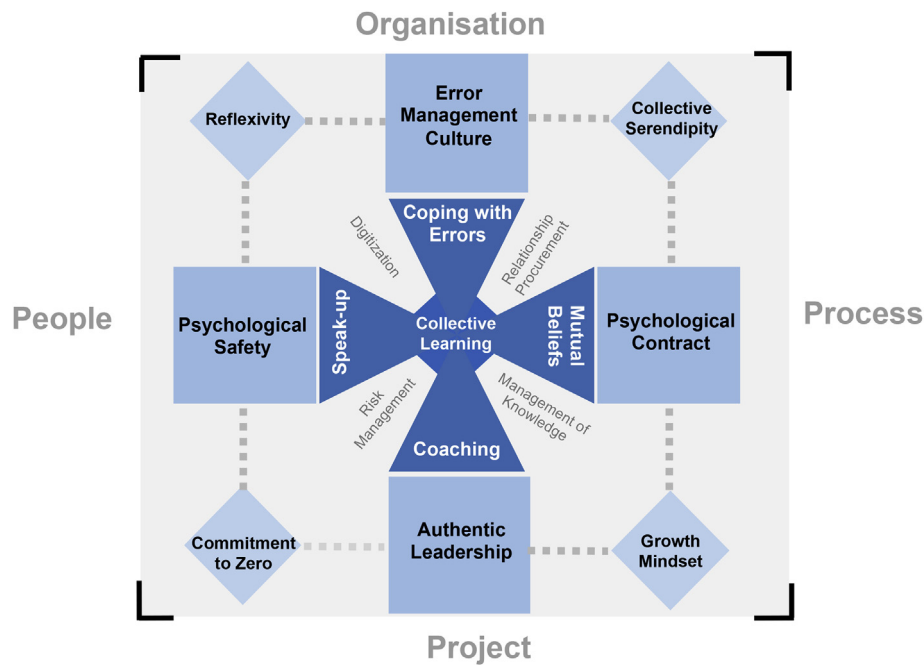


Fig. 2. Enabler functions to contain and reduction rework.

factors. If a construction organization is to be competitive, then it needs to accept, adopt, and implement changes to its business model according to changing trends, technologies, client preferences, and future concerns. The corollary, for example, of the United Kingdom (UK) government's 2016 mandate for a building information model deliverable (i.e., minimum of 'Level 2' for all public sector works over the value of £5 million) has resulted in construction organizations having to significantly invest in new technology and software, up-skill and educate staff, and reconsider their risk exposure in projects.

As a consequence of the 'Independent Inquiry into the Construction of Edinburgh Schools' (Cole, 2017) and 'Grenfell Tower Inquiry' in the UK, quality is now in the spotlight. During the 1990s, we saw a drive to engender quality in construction (e.g., Burati et al., 1991; Hellard, 1993; Jaafari, 1996) with the aim of "harnessing everyone's effort to achieve zero defects at lowest cost and continually satisfying customer requirements" (Turner, 1994: p.164). Explicitly, in light of the current evidence, this is an aim that construction organizations have not been able to achieve adequately.

It was during the early 1990s that the Australian government began to require construction organizations to implement quality assurance (QA) systems for public projects, particularly those that received Federal funding. Contractors were required to accept responsibility and assure the quality of their operations through established systems and associated control procedures. Manually-laden paper-based QA systems that contain complicated administrative procedures tended to proliferate at a high cost for many construction organizations.

The introduction of ISO9001:2015 resulted in 'management commitment' being replaced with 'leadership and commitment.' In this instance, there is an expectation for senior management to be accountable for the effectiveness of their quality management system's (QMS) and promote a culture of quality throughout their organization. While the standard makes explicit this requirement, our observations from the case studies and interviews we have undertaken suggest that QA has become a simple 'checkbox' process. Within many construction organizations, we have observed that the goals and principles identified in ISO9001:2015 have not been given serious attention by senior management (Love et al., 2018b).

Unfortunately, quality has become the poor cousin to safety due legislation and various acts being enacted. Increased legislative requirements has resulted in construction organizations diverting resources

away from quality to meet their immediate workplace safety obligations and responsibilities. If quality is to improve, then construction organizations may need to re-evaluate their business strategy, leadership, and management practices to create an environment and the conditions for 'getting it right the first time.' While the enabling dimensions we have identified in Fig. 1 can meet this aspiration, expected products of the CORE framework are:

- **Reflexivity:** In this instance, what are the mental, emotional, and value structures that legitimize a person to 'drop their guard' and 'make an error?' Addressing this meaningful and insightful line of questioning can stimulate learning. Such deep questioning can be overlooked if the person merely undertakes reflection as a practical problem-solving exercise by simply asking: what happened, why, what did I think and feel about it, how can I do it better next time?
- **Growth mindset:** People have an underlying belief that their learning and intelligence can grow with time and experience. In this instance, learning from experience and engaging in process reflexivity where individuals create frameworks for interpreting and responding to rework events that they encounter is warranted. Research has demonstrated that empowered teams that operate with a growth/learner mindset are more productive, motivated, and engaged (Bunderson and Sutcliffe, 2002).
- **Collective serendipity:** Where an unexpected finding leads to a positive change that corresponds to a win-win outcome for the organization, its projects, and supply chain; and
- **Commitment to zero:** Prevailing evidence indicates that a declaration of a zero-vision "can reduce operational knowledge, lead to manipulation of incident and injury figures and restrict organizational learning" (Dekker, 2017: p.125). As construction projects are goal-conflicted, dynamic, and resource-constrained, it is unreasonable to assume that zero vision is achievable (Dekker, 2017). Drawing on the words of wisdom provided by Dekker (2017), having "zero commitment is worth striving for. A zero target isn't. Or, put differently, I have zero commitment to a zero target" (p.129)

By embedding the proposed rework CORE framework within the fabric of a construction organization, we proffer that collective learning can be legitimized and institutionalized throughout all its levels.

**Table 1**  
Characteristics of the CORE framework's enablers.

Enabler	Definition	Description
Authentic Leadership	“A pattern of leader behavior that draws upon and promotes both positive psychological capacities and a positive ethical climate, to foster greater self-awareness, an internalised moral perspective, balanced processing of information, and relational transparency on the part of leaders working with followers, fostering positive self-development (Walumbwa et al., 2008: p.94).	“Leaders exemplify directness, openness, commitment to the success of followers, a willingness to acknowledge their own limitations, transparency and a commitment to be held accountable for their actions and reward honesty and integrity (Avolio et al., 2004: p.10) An authentic leader “is one who is (1) is self-aware, humble, always seeking improvement, aware of those being led and looks out for the welfare of others; (2) fosters high degrees of trust by building an ethical and moral framework; and (3) is committed to organizational success within the construct of social values” (Whitehead, 2009: p.850) Characteristics of an authentic leader include: 1. Awareness and development of personal strengths 2. Awareness and acknowledgment of personal weaknesses 3. Integrity 4. Values-based decision-making 5. Empathy and respect for others 6. Courage 7. Emotional management
Error Management Culture	Error management suggests that it is not possible to altogether avoid errors; instead, one should aim for avoiding or reducing negative error consequences. This has several implications—negative consequences can be reduced or even eliminated if people quickly catch an error and immediately deal with it (Frese and Keith, 2015).	Encompasses the following organizational practices (an Van Dyck et al., 2005: p.1230) 1. Communicating about errors; 2. Sharing error knowledge; 3. Helping in error situations; 4. Quickly detecting and handling errors; 5. Analyzing errors; 6. Coordinating error handling 7. Effective error handling.
Psychological Safety (Individual/Team)	Psychological safety is a shared belief that the team is safe for interpersonal risk-taking. It can be defined as “being able to show and employ one’s self without fear of negative consequences of self-image, status or career” (Kahn, 1990: p.708). Team psychological safety is defined “as a shared belief that the team is safe for interpersonal risk-taking. For the most part, this belief tends to be tacit-taken for granted and not given direct attention either by individuals or by the team as a whole (Edmondson, 1999: p.354)	In an environment that supports psychological safety, teams view errors as learning opportunities. Team members are encouraged not only to embrace feedback but also to seek it out in a genuine attempt to better the team’s outcomes. The climate of openness that results from a pervasive sense of psychological safety is essential for building highly reliable, high-performing teams. When team members feel comfortable admitting errors, discussing vulnerabilities, and providing and receiving feedback from peers and colleagues, they are positioning themselves to learn from failures, prevent more serious mistakes and improve future performance. Psychological safety is about candor, making it possible for productive disagreement and the free exchange of ideas. It enables people on different sides of a conflict to speak candidly about what is bothering them.
Psychological Contract	A psychological contract is concerned with assumptions, expectations, promises, and mutual obligations. It creates attitudes and emotions which form and govern behavior. A psychological contract is implicit. It is also dynamics – it develops over time as experience accumulates, employment conditions change, and employees re-evaluate their expectations (Guest, 2004a, b)	Two fundamental employment relationship questions that individuals pose: 1. What can I reasonably expect from the organization 2. What should I reasonably expect in return Aspects of the employment contract covered by the psychological contract from the employee’s perspective include: • how they are treated in terms of fairness; • security of employment • career expectations and opportunity to develop skills; and • trust in the management of the organization to keep their promises From the employer’s perspective, the psychological contract covers issues such as employment relationships as competence, effort, commitment, and loyalty

**3.1. Authentic leadership**

We can view leadership styles on a continuum with those that are task-focused on one end (e.g., passive-avoidant or laissez-faire styles), the classical types (e.g., autocratic, democratic and situational) being in the middle and at the opposite end of the spectrum being reserved for those that are relational in nature (e.g., transactional, charismatic, and transformational). The appropriate leadership style needed to ensure project success varies with different phases of its life-cycle (Turner and Müller, 2005). All in all, effective leadership is an essential determinant of organizational and project success (Aga et al., 2016). In this paper, we are not taking a ‘project’ perspective *per se* to contain and reduce rework. Here we focus on the leadership needed within a construction organization to deal with the rework that confronts them on-site. After all contractors are responsible for physically building an asset and assuring its quality.

Within project-based organizations, relational leadership styles (i.e., where the leader focuses on the satisfaction, motivation and the general well-being of the team members) such as authentic and transformational

practices have been shown to provide positive workplace outcomes (Lloyd-Walker and Walker, 2011; Tyssen et al., 2014). There are, however, distinct differences between these styles of leadership. Authentic leadership is exclusively reliant of the personal traits of the leader as they are a key leadership multiplier (Avolio et al., 2004; Gardner et al., 2005). Personality traits such as self-awareness, transparency, and ethics are core features of authentic leadership. Contrastingly, transformational leadership is process/behavior-based. The core behavioral components of leaders are inspirational motivation, intellectual stimulation, and idealized influence (Bass and Avolio, 1994). Thus, inspirational motivation provides meaning to the work that followers perform. Intellectual stimulation is used to instill an environment for creativity and innovation and encourages followers to challenge the status quo. Idealized influence is when a leader behaves in such a way to become a role model for their followers, some that followers want to emulate.

An innate feature of transformational leadership is being charismatic, which is not an attribute of being an authentic leader. However, authentic leaders aim to “establish and maintain relationships and to lead with purpose based on values” (Walker and Lloyd-Walker, p. 386).

Furthermore, the positive psychological capacities of authentic leaders mean that they are open to development and change (Avolio and Gardner, 2005). While transformational leaders can be influential in initiating change within an organization, those who are authentic can provide an environment where they can have a direct positive effect on voice behavior, empowerment and the development of employee trust (Wong and Cummings, 2009; Wong et al., 2010; Wong and Laschinger, 2013). As we will discuss below, these attributes are critical for establishing an environment of psychological safety and the formation of a psychological contract. Both of these concepts are needed to create high performing and committed individuals and project teams within a construction organization (Table 1).

With the increasing need for construction organizations to effectively manage their competing demands (e.g., quality and safety) throughout their project portfolio, they can no longer afford to depend upon the leadership of an individual or/and a team of senior executives to meet this challenge (Love et al., 2018b). In this instance, we suggest that the organization should harness the ideas, skills, energy, and enthusiasm of all its employees to deliver excellence by ‘getting it right the first time.’ In this instance, line and project managers should be charged with the leadership role in conjunction with the organization’s executive. Authentic leadership, in particular, is positively related to followers’ levels of moral courage, and through that mechanism, their ethical behavior (Hannah et al., 2011).

3.1.1. Ethics and quality

The dynamic organizational context within which construction organizations operate can expose employees and their subcontractors to numerous temptations (e.g., non-reporting of NCRs, and errors/defects), requiring “the inner fortitude to restrain oneself from taking ethical short-cuts or pursuing self-gain over the greater collective (Cianci et al., 2014: p.582). For example, in the case of high-pressure organization contexts, such as construction, which prioritizes performance (e.g., profit maximization) over other values (e.g., ensuring fitness for purpose and customer satisfaction) are prone to experiencing have higher rates of unethical behavior (Robertson and Rymon, 2001). However, by “displaying moral perspective, transparency and other aspects of authenticity that authentic leaders will activate followers’ moral perspectives and thereby reduce their inclinations to make unethical decisions (e.g., cover-up defects) in the face of temptations” (Cianci et al., 2014: p.582). By moral perspective, we draw on Cianci et al.’s (2014) definition who refer to it as the “activation of identity-based structures (e.g., values) and self-regulatory structures that promote ethical decisions and behaviors” (p.582).

The virtue system of ethics, grounded in Aristotle’s *Nicomachean Ethics* (Burger, 2008), should be emphasized by the authentic leader as a way to ensure quality. In this instance, virtues, ethical conduct, integrity, and moral character are brought to the fore (MacIntyre, 1981). By drawing on this ethic, the focus is on developing the individual’s character as the basis for positive moral judgment and action. Virtues may be learned through conditioning, for example, due to the support and advice from coaching and via codes of conduct, constant reminders in meetings (e.g., pre-starts and toolbox) and helping individuals engage in the process of reflexivity. Engaging with reflexive practice can help individuals, and the organization transition from a position of ‘errors can and need to be prevented’ to one where ‘errors happen’. Leadership and coaching however will be required to encourage “individuals and teams to constantly ask questions and learn” (Love and Smith, 2016: p.6). Employees, for example, can imitate the positive virtues of their line manager and project manager who serves as their role model (i.e., leader). Thus, leaders are critical in developing ethics in employees and a quality mentality. When a construction organization is virtuous, it will consider all its stakeholders and the triple-bottom-line and seek continuous improvement, which ultimately resides in the commitment and ethical conduct of its employees and their subcontractors.

3.1.2. Relationship procurement

With an increasing use of use of relational-based procurement methods (e.g., alliances, public-private partnerships, design and construct and variants thereof) construction organizations are required to engage in open, transparent, trusting and commit to establishing a genuine relationship with the design team and their subcontractors and suppliers (Walker and Lloyd-Walker, 2015). When a construction organization can display internalised regulatory processes, balanced processing of information, relational transparency and authentic behavior that is paralleled with an authentic leader, then the propensity to reduce rework in projects increases significantly (Love et al., 2015). When this situation arises, we have observed that altruistic behaviors manifest and learning permeates within a project team enabling it to attend to the underlying causes that have contributed to rework (Love et al., 2015).

3.2. Error management culture

Culture involves the pattern of thought, emotion, and action, which can shape how an organization responds to problems (Westrum, 2004). It has been defined as “a pattern of shared basic assumptions learned by [an organization] as it solved its problems of external adaptation and internal integration, which has worked well enough to be considered valid and, therefore, to be taught to new members as the correct way to perceive, think, and feel in relation to those problems” (Schein, 2010: p. 18). In response to quality and safety problems that exist in construction, a critical issue that has been identified as contributing to their occurrence is the blocking of communicative action (Love et al., 2018b). That is the flow of information flow. According to Westrum (2014) “by examining the culture of information flow, we can get an idea of how well people in the organization are cooperating and also, how effective their work likely to be” in ensuring quality and providing safe operation (p.58). So, when information does not flow, it can adversely affect the functioning of an organization (Westrum, 2014).

An organization’s culture and climate can influence its information flow and quality, amongst other things. Evidence of this was presented in Love et al. (2018b), where managers exercising their power blocked communicative action regarding the reporting of NCRs and the raising of ethical issues associated with undertaking rework. Westrum (2004) identified three dominant organizational cultures that are directly shaped by leaders through their symbolic actions, rewards, and punishments, and what they think and feel is essential to communicate (Table 2): (1) pathological; (2) bureaucratic; and (3) generative. Each of the cultures identified in Table 2 can be aligned to forms of personal power that can affect how information is processed in an organization. In a pathological culture, for example, information is deemed to be a personal resource, which is used in power struggles where it is “withheld, doled out, or used as a weapon to advance particular parties with the organization” (Westrum, 2004: ii23).

In the case of a bureaucratic culture, standard channels and

Table 2  
A typology of organizational cultures.

Features	Cultures		
	Pathological (Power Orientated)	Bureaucratic (Rule Orientated)	Generative (Performance Orientated)
Information	Don't want to know	May not find out	Actively seek it
Messengers	Shoot	Listen to the arrival of information	Trained and rewarded
Responsibility Failure	Shirked Punished or concealed	Compartmentalized Lead to local repairs	Shared Lead to far-reaching reforms
New Ideas	Actively discouraged	Often present problems	Welcomed

(Derived from Westrum, 2004, 2014).

procedures are used to share information, but when a crisis arises, they can be ineffective. For example, in a case, we examined a subcontractor had knowingly installed different valves, which were cheaper than those specified initially (Love et al., 2019). The construction organization's supervisor became aware of the problem but did not communicate with the asset owner that this had occurred. On being installed, and during commissioning the valves failed. The supervisor had an inkling that they would fail. However, the supervisor neglected to inform their management as the reporting of NCRs had not been openly encouraged despite having a QMS in place. Significant rework was required as valves had to be re-installed, which resulted in safety being compromised and additional costs being borne by construction organization and subcontractor.

An organization's climate has been defined as "the shared meaning organizational members attach to the events, policies, practices, and procedures they experience and the behaviors they see being rewarded, supported, and expected" (Ehrhart et al., 2014, p. 69). It supports the effective and efficient flow of information and therefore is likely to encourage cooperative and collaborative patterns of behavior (Westrum, 2004). When errors occur, for example, the pathological climate will apportion blame, the bureaucratic seeks justice, and the generative tries to discover and understand why and how problems materialized (Westrum, 2004). How a construction organization operates, adopts decisions and develops individual relationships with its employees and supply-chain is often based on its prevailing culture. How its employees understand the organization's values will influence their behavior and willingness to express perceptions and opinions of the existing climate at a specific period in time (Ehrhart et al., 2014).

Implementing the most appropriate style of leadership will, therefore, involve reconciling the organization's values with those of its employees. A favorable climate is then, more often than not, related to its leadership style (Bass and Riggio, 2006). Within a project-based organization such as construction, there may be several varying forms of climate and leadership being played out in projects. Moreover, organizational culture may not be uniform across a construction organization. Subcultures can also exist in projects with some being, weaker or stronger than others (Martin, 2002; Love et al., 2018b).

Both organizational culture and climate address the psychosocial, organizational environment. Culture and climate take a macro perspective of organizational context rather than the idiosyncratic experiences of individuals (Ehrhart et al., 2014). Both place considerable emphasis on the shared experiences of employees, the role of meaning, the role of leadership, issues of strength or alignment, and the implications of the context for organizational effectiveness. While culture and climate are hard to change, the deepest assumptions and core values of a culture are more difficult to change than climate. Leadership is, therefore, pivotal for shaping an error management culture and creating a climate that facilitates the adequate flow of information. Ideally, such leadership should be authentic so that an ethical and moral framework is in place to foster a growth mindset (Love et al., 2018c).

Error management has been typically applied at the organizational level through a cross-cultural psychology lens by focusing on norms and practices, and shared practices and procedures (Van Dyck et al., 2005; Frese and Keith, 2015). The practices of error management are identified in Table 1, which we consider to align with Westrum's (2004) generative culture. Both Westrum (2004) and Van Dyck et al. (2005) have suggested that communication, a core feature of organizational climate, is the most important practice for managing errors. This was particularly the case in the Barwon Water Alliance, where there was a high degree of communication and sharing of knowledge surrounding rework events (Love et al., 2015). Alliance members and contractors were encouraged to freely and openly discuss the conditions that manifested in rework, particularly during on-site meetings. The open discussion between the alliance project team members and contractors enabled the development of a "mutual understanding of high-risk situations (i.e., error traps) and effective error handling strategies" to be identified (van Dyck et al., 2005: p.1230).

The Barwon Water Alliance cultivated a systematic approach to facilitate the communication of rework events using a lesson learned register that was available to all project team members in a digital format. Whenever a rework event occurred, it was logged in the system, and an alert was distributed to all project team members and contractors. Contrastingly, we have observed that in some projects, rework presented project managers with 'uncomfortable knowledge' thereby reducing the communication about their occurrence. Four strategies to deal with uncomfortable knowledge are (Rayner, 2012: p.107): (1) denial – there is not a problem; (2) dismissal – it is a minor problem; (3) diversion – I am [we are] working on it; and (4) displacement -the model we have developed tells us that real progress is being achieved. Denial and dismissal appear to be most common strategies embraced by project managers when dealing with rework.

When confronted with 'uncomfortable knowledge' project team members and subcontractors may become hesitant to "talk about their concerns because they know that this likely leads to negative attributions" (Van Dyck et al., 2005: p.1230). A particular goal of error management is to address the hindsight and attributional bias where people are blamed or attributed with undesirable personality traits (e.g., lack of knowledge) by rewarding those who report and communicate about rework (Edmondson, 1999; Van Dyck et al., 2005; Love et al., 2018c).

Error prevention, is intuitively not negative *per se*, but its focus is linked to adverse outcomes such as hiding errors, lowered learning from errors, negative error cascades, lowered psychological safety with teams and poor performance (Edmondson, 1999; Van Dyck et al., 2005). Prevailing evidence has shown that in novel situations involving a series of complex tasks, such those involved in the construction of a project, error management in comparison to error prevention has positive effects on motivation, cognition, and performance (Dimitrova et al., 2015). Furthermore, Dimitrova et al. (2017) have concluded from their study that providing error prevention training can have a detrimental effect for "thinking and adaptive transfer performance", whereas "error management instruction can positively influence people's coping abilities by helping them to lower their worry and increase their perceived self-efficacy when dealing with difficulties" (p.670). We, therefore, believe that if construction organizations engage in error management practices and encourage open communication, then psychological safety can positively contribute to containing and reducing rework, as well as improving a project's safety performance.

### 3.3. Psychological safety

Psychological safety facilitates the sharing of knowledge, provides employees with a 'voice' to suggest areas for improvement, the confidence to embrace innovation, the capacity to identify more productive ways to perform their work and the ability to learn (Edmondson, 1999; Edmondson and Lei, 2014). We identify and present the key features of psychological safety in Table 1. While an examination of the literature in construction reveals the significance of psychological safety has been widely acknowledged, and emphasis has tended to be limited to measuring its safety climate (Andersen et al., 2018).

Even though psychological safety focuses on reducing interpersonal risks that accompany uncertainty and change (Schein and Bennis, 1965), it is also relevant for understanding organizational learning (Edmondson and Lei, 2014). Within construction, learning routinely takes place through interactions between highly interdependent organizations. Though such learning is ephemeral, as it is often confined within the bounds of a project and seldom assimilated with others that are being delivered by a construction organization (Walker and Lloyd-Walker, 2015). However, psychological safety provides the foundation for enabling behaviors for learning and change to materialize throughout the various echelons of an organization. At the individual level, experiences of psychological and outcomes include positive "job engagement, organizational commitment, quality internal auditing, learning from failure and creative work involvement" (Edmondson and Lei, 2014: p.25).

Additionally, psychology safety facilitates an individual's freedom to speak-up and provide a voice to so that any concerns they have are "upwardly-directed by promotive verbal communication" (Edmondson and Lei, 2014: p.27). Within a culture characterized by high levels of psychological safety, which can be enacted by error management, speaking-up is legitimized rather than viewed as being a risky behavior that can have detrimental consequences for the individual. Concerns, for example, about problematic processes, procedures, and practices that are contributing to rework can be shared, rather than having to be openly exposed (Edmondson and Lei, 2014). In line with Detert and Edmondson (2011), we have observed from our studies that voice behavior can vary within a construction organization and their respective projects due to specific leadership responses where managers may encourage or discourage employees from speaking-up (Love et al., 2018b). In the case of the Barwon Water Alliance, for example, contractors were encouraged to speak-up during 'dedicated rework forums' to identify potential risks so that they could be anticipated and incorporated into their risk management strategy for future projects (Love et al., 2015).

Psychological safety at the team (project) level "enables divergent thinking, creativity and risk taking, and motivates engagement exploratory and exploitative learning, thereby promoting team performance" (Edmondson and Lei, 2015, p.31). However, it has found to vary between teams in the same organization (Edmondson, 1999). The variance is somewhat attributable to managers behaviors, "which convey varying messages about the consequences of taking interpersonal risks associated with behaviors such as admitting to the error, asking for help or speaking up (Edmondson and Lei, 2015: p.30). Within a team where there is positive psychological safety cooperation improves, which can promote a problem-solving orientation, and there enable leaders and members to discuss and learn from errors (Tjosvold et al., 2004). At an organizational level, the presence of psychological safety has been found to result in improved performance by creating a social climate of trust that supports the sharing of knowledge (Collins and Smith, 2006). Furthermore, it enables the organization to possess a pre-occupation with failure and an ability to engage with error management (Carmeli and Gittel, 2009; Dahlin et al., 2018; Love et al., 2018b).

### 3.4. Psychological contract

Psychological contracts fundamentally underpin employment relationships and are determinants of employee attitudes and behavior (Andreson and Schalk, 1998). Such contracts are a set of unwritten expectations that exist between individual employees and their employers. In Table 1, we identify the underlying principles of a psychological contract. The concept of a psychological contract is underpinned by social exchange theory and the norm of reciprocity (Walker and Hutton, 2006). Social exchanges are highly dependent on the establishment of trust, and good will (Walker and Hutton, 2006).

The psychological contract has a high degree of 'face-validity' with both employers and employees (Rosseasu, 1996). While it is well-known to exist in organizations, there is no consensus on its actual make-up as terms such as "perceptions, expectations, beliefs, promises, and obligations" are contained in the numerous definitions of a psychological contract that have been propagated in the extant literature (Andreson and Schalk, 1998: p.640). For the CORE framework, we are drawn to Rosseasu's (1995) view where borders between the individual's beliefs about an employer and employee's exchange relationship are framed around mutuality. In this instance, "mutual predictability" becomes possible as "I know what I want from you, and you know what you want from me" (Rosseasu, 1995: p.10).

It has been widely demonstrated that the psychological contract is an essential determinant of the behaviors and attitudes of workers: compliance with, or breach of, the terms of the psychological contract have profound consequences for the employment relationship. Newez et al. (2019a, b), for example, have revealed that establishing a psychological contract for workplace safety where the mutual obligations

between employees/workers and managers/supervisors are fulfilled, can positively contribute to a project's safety climate.<sup>2</sup> Individuals may simultaneously develop multiple psychological contracts (Walker and Hutton, 2006), but in construction, there has been a proclivity to emphasize the creation of psychological contracts for safety (Newez et al., 2019a; b). With regard to the CORE framework, we are suggesting that a psychological contract for quality be explicitly established, which would endeavor to shape behaviors and attitudes toward learning and continuous improvement.

As psychological contracts are based on trust, a violation can result in negative consequences. Such an act may arise intentionally or unintentionally. Breaking rules has generally been associated with deviant behavior, but there may be instances when committing a violation may have arisen out of taking the initiative rather than negligence or malice. Furthermore, a violation may "even be a necessary way of testing rules and the truces around them" (Busby and Iszatt-White, 2016: p.37). To understand the nature of a violation, it is necessary to realize the way people construct the intentions that lie behind it to ensure recidivism is mitigated. Having an error management culture in place and psychology safety to support the psychology contract for safety provides mechanisms for managers and employees to engage in the process of reflexivity, which enables them to have a restless mind and ask questions.

## 4. Implications for practice

Ensuring that research has relevance to practice (i.e., practically and socially applicable) has been a goal of this paper. Thus, we have sought to deal with a pervasive problem that confronts construction organizations daily; that is, *rework*. However, how can we address this problem? Before proceeding, we have previously asserted that "there has been a propensity for researchers to place a silver lining around the problematic events that often transpire in construction and as a result develop strategies to accentuate their positives to industry practitioners. This has contributed to the prevailing gap that exists between rigor and relevance of practice within construction" (Love and Smith, 2016: p.7).

We remain steadfast with our conviction that there remains a paucity of empirically developed strategies that are grounded in practice and evidence-based, which deal with the issue of rework. The proposed CORE framework that we have developed addresses this gap, as it is derived from practices, experiences and observations from organizations and projects we have studied (Love et al., 2018a, b, c, d, e; Love et al., 2019). The implications of the rework CORE framework for practice include:

- the identification of a series of complementary enablers that support the development of a growth mindset. The CORE framework, therefore, provides organizations with a complete picture rather individual pieces of the puzzle needed to address learning from errors. There also needs to be an explicit acknowledgment that errors and resultant rework are a problem with construction organizations and their projects. This is the most significant hurdle that confronts many construction organizations. Ultimately, the recognition of the rework problem is the responsibility of senior management. Indeed, they need to have the desire and willingness to initiate and support the change needed to ensure that learning from error becomes an innate feature of their organization's continuous improvement process. This will require authentic leaders to be selected who can facilitate and guide the process of change, which is enacted through a virtue system of ethics.

<sup>2</sup> Zohar (1980) described safety climate as the "summary of molar perceptions that employees share about their work environment [in relation to safety]" (p. 96). In essence, it is the shared perceptions of safety policies and procedures by members of an organization [project] at a given point in time.



- an ability to cultivate organizational mindfulness whereby individuals and project teams can improvise and handle errors as they are identified and ensure they are not repeated;
- being prepared for errors and not using procedures and systems to shield and screen them out. In preparing for the occurrence of errors, individuals and teams should seek out that which is non-routine, enabling creative and meaningful solutions to be identified;
- a realization that an attitude enacted by a zero vision will produce unsatisfactory quality and safety performance. Such an attitude stifles an organization's ability to change and innovate as learning and knowledge is controlled and constrained by existing routines;
- formal support for speaking-up can constitute a significant opportunity for organizational improvement. However, management needs to be made aware that introducing a culture where employees and subcontractors are encouraged to speak up and voice their concerns can produce tensions and even have the opposite of the desired effect fostering lower levels of psychological safety (Cunha et al., 2018). When tensions do arise, leaders should not neutralize people's voice concerns when the status quo is challenged, but instead become active listeners and engage in productive and meaningful discourse; and
- employees and subcontractors will be motivated to grow, if they are conclusively tied to the organization and project. The construction organization must strive to establish a psychological contract that comprises high-level obligations for ensuring quality between themselves and their employees as well as their subcontractors. Understanding the dynamics whereby the psychological contract arises and is maintained in the employee's mind, and those of subcontractors need to be of central importance for management. If a construction organization fails to understand and adequately fulfil the obligations of the psychological contract, negative consequences may ensue for the direct employment relationship with employees and subcontractors.

The CORE framework is not intended to be prescriptive. It does, however, offer a direction that practitioners may consider to follow in order for them to effectively redress their rework-related issues. We anticipate that immediate outcomes that can materialize from implementing the rework CORE framework for a construction organization are fivefold: (1) increased annual profit; (2) improvement in safety performance; (3) increased levels of productivity; (4) an engaged and motivated workforce that is willing to learn; and (5) an overall improvement in service and product quality and customer satisfaction. Notably, future research will be required to test the proposition that the rework CORE framework can ameliorate the performance and competitiveness of a construction organization.

## 5. Conclusions

We commenced our paper by referring to a call to address the rework problem by a widely recognized thought leader in Australia who has urged construction organizations to recalibrate their approaches to quality to ensure a 'getting it right the first time' environment is created throughout the industry. Rework is a global problem in construction and is an innate feature of operations. In subjugating this issue, a collective effort not only from within a construction organization but also parties throughout their supply chain to mitigate its adverse consequences is required. We applaud Mr. John Morrison for making such a call and initiating a much-needed conversation that has begun to focus not only on abating rework but also improving the overall level of quality in construction.

In making an inroad to deal with rework, we drew upon our previous empirical work to propose four complementary enablers that cogently coalesce to create a robust rework CORE framework. These enablers are: (1) authentic leadership; (2) error management; (3) psychological safety; and (4) psychological contract. Products that are expected to emerge

when these enablers are implemented in concert are: (1) reflexivity; (2) growth mindset; (3) collective serendipity; and (4) a commitment to zero. It must be acknowledged that in some projects, we will see pockets of excellence being played out and aspects of our proposed CORE framework coming to light in practice. Indeed, this was evident in the Barwon Water Alliance project that we examined (Love et al., 2015).

In moving forward, our proposed CORE framework provides construction organizations with the ability to create capacity and willingness to exercise critical reflection about what they are doing, to understand why they are doing it and the ability to determine the consequences of their actions. As a consequence, construction organizations will not only be strategically positioned to contain and reduce errors but also improve their overall business performance.

## Declaration of competing interest

There are no conflicts of interest.

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