Seventh International Conference on Construction in the 21st Century (CITC-VII)
"Challenges in Innovation, Integration and Collaboration in Construction & Engineering"
December 19-21, 2013, Bangkok, Thailand

Thoughts and Musings on the Development of a Theory for Rework Causation in Construction

Peter E.D. Love
School of Built Environment, Curtin University, Perth, Western Australia, Australia
P.Love@curtin.edu.au

Brad Carey
School of Built Environment, Curtin University, Perth, Western Australia, Australia
Brad.Carey@curtin.edu.au

Chun-Pong Sing
School of Built Environment, Curtin University, Perth, Western Australia, Australia
Michael.Sing@curtin.edu.au

Jane Matthews
School of Built Environment, Curtin University, Perth, Western Australia, Australia
Jane.Matthews@curtin.edu.au

Abstract

To learn 'how' to mitigate rework, organizations involved in the delivery of construction projects need to be able to make sense and learn from events that lead to its occurrence. The process of retrospective sensemaking can provide an understanding that can inform and direct actions to eliminate rework, which can threaten project performance. In this paper, sensemaking serves as a conceptual foundation to develop a theoretical underpinning for determining the systemic nature of rework. The use of sensemaking can provide an ameliorated understanding of rework causation and enable theory to be developed, as currently no coherent one exists. There is a need for a general set of assumptions, propositions, or accepted facts that attempts to provide a plausible or rational explanation of cause-and-effect relationships for rework. Having a theory in place and subsequently being able to understand 'how' and 'why' rework arises can provide the feedback required to enable organizational learning to occur and eventually a learning organization.

Keywords

Construction, leaning, rework, retrospective sensemaking

1. Introduction

Rework has been consistently identified as being a chronic problem in construction, engineering, and resource projects for decades (e.g., Han *et al*., 2007). Nevertheless, it has been largely ignored as it was deemed to be a normal function of operations (Love *et al*., 2012), purposefully concealed or ignored (Ford and Sterman, 2003) and in some cases a denial that the problem exists at all (Love *et al*., 1999). As rework fundamentally pertains to correcting errors arising from unanticipated events, the question can be asked: "How do we anticipate rework when, by definition its occurrence is unanticipated? (Pinto, 2013:p.9). Additional costs due to potential rework are implicitly accommodated within a project's traditional cost contingency (Love *et al*., 2012). Though, acknowledging and allowing for the existence of rework is not acceptable to clients. Moreover, if design consultants and contractors allowed for the cost, time and disruption of rework then their tenders would no doubt be uncompetitive. Yet, rework is more often than not their nemesis! With tighter profit margins and falling productivity levels being experienced on-site, particularly in Australia, rework can no longer be ignored, as the competitiveness of organizations is being jeopardized. In an attempt to prevent rework, visualization technologies, modularization, lean construction, relational contracting and the like are being promoted and adopted. While such strategies can potentially improve project performance they may only abate rework, as people are still prone to concealing problems and committing errors (Love *et al*., 2012). The concealment of rework arises as people do not like to inform managers of 'bad news' and present information that does not adhere to their beliefs (Ford and Sterman, 2003). According to Ford and Sterman (2003) the practice of hiding mistakes is institutionalized in many organizations. In fact, Roth and Kliener (1996) observed there is often a tendency for a cultural mandate to be established within engineering organizations of not informing people about a problem unless they had a solution. Thus, in this instance concealment becomes a standard practice (Ford and Sterman, 2003). As a result, knowledge about a problem is withheld, which results in a 'Prisoner's Dilemma'.

By remaining silent about a problem, project team member(s) abrogate their direct responsibility thereby preventing any form of reprimand from their immediate manager. In the case of the Prisoner's Dilemma, managers may question team members about project's progress without being provided with all the necessary information. Team members can "cooperate with one another by concealing the problems that they know exist, or defect by revealing" the issues that need to be addressed to the project manager (Ford and Sterman, 2003:p.215). If the project team members cooperate by concealing known problems, project costs and schedule will remain the same and they avoid blame. If they reveal problems caused by others, the project's cost may increase and the schedule could slip, giving them the opportunity to attend to these issues. Meanwhile, other project team members will be blamed for the cost and schedule overruns that may occur. However, should all team members reveal all the known problems, project cost increases and schedule slips, but all are apportioned blame from the management – a negative outcome for all concerned: a lose-lose outcome.

The refusal to admit to a negative outcome and to continue a course of action has been observed to contribute to rework (Love *et al*., 1999). Such denial is referred to as defensive avoidance (Janis and Mann, 1977). According to Shaw (1981) there are several explanations why such behavior materializes. One is that people pursue a course of action in spite of negative feedback largely because of the negative feedback (Shaw, 1981). This argument suggests that people value tenacity, or perseverance, as they generally admire those who stick to their principles. A second explanation suggests that people will forsake a more rational approach to difficult decision situations out of the concern with establishing consistency, a valued characteristic.

The rework related research within the field of construction has tended to take a narrow focus by identifying specific causation factors (e.g., Hwang *et al*., 2009). This approach is counterintuitive as rework causation can only be understood by looking at the whole project system in which it occurs and how variables dynamically interact with one another (Love *et al*., 2012). An operational system, such as a construction project, can be categorized as having a 'blunt end' and a 'sharp end' (Dekker, 2006). The 'sharp end' is deemed to be at the design office or construction site where people are at the coalface of project delivery process. Whereas the 'blunt end' is the organization or set of organizations that support, drive and shape activities of the design and construction process, for example, governments, regulatory bodies, financial institutions and clients. The 'blunt end' provides resources (e.g., finance and information) to enable the process of design and construction, but invariably places cost and time constraints on the work to be undertaken. Strategic decisions taken at the 'blunt end' can create, shape and stimulate opportunities for errors to materialize (Reason, 1990). Too often, not enough time is initially allowed to complete tasks and processes correctly, particular design related activities (Andi and Minato, 2003), but when rework is required and the constraints of time are imposed the propensity for the formation of 'vicious circles' to arise significantly increases.

In order to learn to mitigate rework, organizations involved in the delivery of construction projects need to make sense and learn from events that lead to its occurrence. The process of retrospective sensemaking can provide an understanding that can inform and direct actions to eliminate rework, which can threaten project performance. In this paper, sensemaking serves as a conceptual foundation to develop a theoretical underpinning for determining the systemic nature of rework. The use of sensemaking can provide an ameliorated understanding of rework causation and enable theory to be developed. Being able to fully understand rework in this way provides the feedback required to enable organizational learning to occur and eventually a learning organization.

2. Nature of Rework

Terms such as quality deviation, non-conformances, quality failures, and defects have often been considered to be synonymous with rework. Moreover, changes, errors, and omissions are implicitly incorporated within these terms. These terms are often used interchangeably and as a result, a degree of ambiguity with the definitions of what actually constitutes rework exists. For example, the terms quality failure and defects have been used interchangeably within the same study (Josephson and Hammarlund, 1999; Josephson *et al*., 2002). Put simply, rework can be defined as "the unnecessary effort of re-doing a process or activity that was incorrectly implemented the first time" (Love, 2002a). The CII (2002) confines rework to the field (i.e. on-site) and define it as "activities that have to be done more than once or activities that remove work previously installed as part of the project". It should be acknowledged, however, that there may be instances where an activity or process has been implemented correctly but is required to be subsequently changed, perhaps due the requirements of a client or end-user.

Ultimately, human error acts as the catalyst for rework. Errors occur due to physiological and psychological limitations of humans. However, it is a matter of contention whether individuals can justifiably be blamed for all errors, as making mistakes is an innate characteristic of human nature (Reason 1990). Human errors occur for various reasons and therefore different actions are needed to prevent or avoid the different sorts of error experienced in construction and engineering facilities. Errors can arise due to mistakes of commission-doing something incorrectly or mistakes of omission -not doing something, they or others, should have done. Regardless of the skill level, experience or training that individuals possess, errors and omissions may occur at any time. But admitting to making an error often results in blame and may result in legal proceedings, which is why design professionals and contractors have been unable to fully realize the potential from learning from errors.

Edmonson (2011) observed that executives, for example, are often faced with a false dichotomy, that is: 'How can they respond constructively to failures without giving rise to an anything goes attitude. If people aren't blamed for all failure what will ensure they try as hard as possible to do their best work?"(p.50). Drawing upon the work of Edmonson (2011), a modified continuum is presented in Figure 1 to determine the rework causes that are blameworthy. Commission and omission errors warrant blame; but having a lack of skill and knowledge does not, as it is the responsibility of the organization to ensure that an individual as the capability to do their job. In the case of task orientation, an employee could be stressed and suffering from fatigue as a result of time constraints being imposed on them. Thus, in this case the manager who assigned the task is the person responsible for the employee not being able to execute their work. However, what circumstances lead to such time constraints being imposed? In this instance, an understanding of context is needed as it "binds people to actions that they must justify and it affects the saliency of information, and it provides the norms and expectations that constrain explanations (Salanick and Pfeffer, 1978 cited in Weick, 1995: p.53). Developing a rich understanding of rework causation and contexts can help avoid the 'blame game' and institute an effective strategy for learning to emerge.

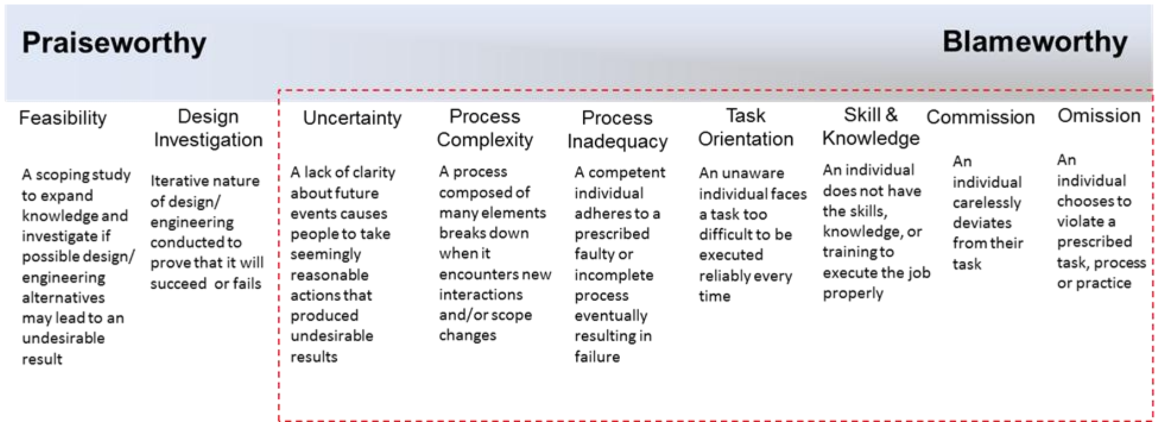

Figure 1. Rework continuum

It is only through the experience acquired from committing an error that can engender learning. Organizations with higher reliability, in this context such as those involved in the construction of Liquefied Natural Gas (LNG) Plants, or Nuclear Power Stations where safety is the priority, may be anxious that errors or potential failures are embedded within ongoing activities and those unexpected failure modes and limitations of foresight may amplify them (Weick, 1995). For organizations participating in such projects to maintain a high reliability status, they will need to continually make sense of their environment and learn from reports and identify the risks embedded within process and systems at the operational, tactical and strategic levels of a project with which they are involved. This is a particularly arduous task when there are multiple organizations involved that invariably have conflicting goals and objective and organizational cultures. Battles *et al*. (2006) states that sensemaking is essentially based upon some existing data. Accordingly, in understanding human error, Dekker (2006:p.71) suggests that:

- past situations should be reconstructed and documented by other people in a way that assertions about unobservable psychological mechanisms cannot; and
- there are systemic connections between situations and behavior, that is, between what people did and what actually happened in the environment around them.

The connection between situations and behavior is considered to be bi-directional, as people change the situation by doing what they do and by managing their processes (Dekker, 2006). Yet, the evolving situation may also alter people's understanding and behavior and thus allow changes to be undertaken. In this instance, connections between the situation and behavior can be uncovered and therefore investigated, documented and represented graphically using techniques such as cause-effect, causal loop, and fault tree diagrams (Dekker, 2006). In understanding human error, it is therefore necessary to acquire knowledge about the environment and situation within which a person is working, the tasks they undertook and the tools and technology that were used. In essence, answers to the question, "what's the story?" are addressed whereby those plausible gain their validity from subsequent activity (Weick *et al*., 2005).

2.1 Quantification: The Need for Context

Studies have generally quantified rework according to its cost as a proportion of contract value, its type (e.g., change, error, omission), by subcontract trade and building element (e.g., substructure, superstructure, internal and external finishes and services) (e.g. Forcada *et al*., 2013). The Construction Industry Development Board (CIBD) in Singapore estimated to spend between 5% and 10% of project costs doing things wrong and rectifying them. The CIDB concluded that if an effective quality management system was put in place then the cost of rework would range from of 0.1% and 0.5% of total project cost. Cusack (1992) revealed that contract documentation errors can typically increase a project's cost by 10%. In a similar vein, Gardiner (1994) has estimated that rework costs stemming from design consultants errors could be as high as 20% of their fee for a given project. Burroughs (1993) reported that a major Australian contractor had experienced rework costs of 5% of contract value on one of their major projects due to errors contained within contract documentation. Within the same project, the concreting subcontractor experienced a dramatic cost increase of 31% due to rework. In accordance with the CIDB (1989), the Construction Industry Development Agency (1995) in Australia revealed that projects without a formal quality system in place and procured using a traditional lump sum contract experienced rework costs in excess of 15% of their contract value. Contrastingly, analysis of 260 construction and engineering projects revealed that rework costs did not significantly vary by project size (i.e. contract value), procurement method and project type adopted (Love *et al*., 2009). Similarly, Hwang *et al*. (2009) analysis of 359 construction projects revealed no significant differences for rework costs by project size, and work type (i.e. construct only or design and construct). However, Hwang *et al*. (2009) identifies an increase in rework costs between light industrial, heavy industrial and various buildings types, probably as a result of varying design and complexity.

The reported costs of rework vary significantly between studies. It is suggested that this is primarily due to a lack of a standardized and robust methodology for its determination. Some studies have excluded change orders and errors due to off-site manufacture that result in rework being undertaken (e.g. Rogge *et al*., 2001). Moreover increasing emphasis has been placed on simply determining direct rework costs and as the result the intangible but real costs that may be associated with disruption and schedule delays that can arise have been neglected and not included in the overall additional cost (Love and Sing, 2013). Tentative research has revealed, however, that rework can have a multiplier effect of up to six times the actual (direct) cost of rectification (Love, 2002b). There is, however, a tendency for such costs not to be borne by the client or contractor, but 'forced' down the supply chain to subcontractors and suppliers. Such additional costs can adversely impact these firm's profitability and survival as they are typically small-to-medium sized firms who are dependent upon having a positive cash flow.

While the quantification of rework has shed some light of the magnitude of the problem at hand, the real costs will continue to be unknown as many organizations are reluctant to expose their inefficiencies and bad work practices. In the case of a publicly listed company, for example, this would adversely impact their share price. With this in mind, it suggested there should be a moratorium on classifying and quantifying rework as it has no context and is therefore meaningless in practice for developing strategies to reduce and contain its occurrence. This is due to systemic issues that avail themselves as a result of strategic decisions made during the formative stages of a project. Dekker (2006) specifically states that "….knowledge of context is critical to understanding error. Answers to why people do what they do often lie in the context surrounding their actions. Counting errors and stuffing them away in a measurement instrument removes that context"(p.68). In this case, the establishment of a context that focuses on 'retrospective decisiveness' should be stimulated, which according to Weick (1995) is similar to learning in reverse (p.184). Through this process people can learn from their errors or they can reconstruct a history that summarizes what they have learned into a single narrative, which can provide them with confidence and enable them to act with more decisiveness in the future. Weick (1995) suggests that confidence is a key determinant for 'environmental enactment'. In this instance, managers can put in place those systems and processes within their workplace so that they can expect to reduce and contain the incidence of rework. As a consequence, this may trigger a process of unlearning that can be used to challenge the underlying concepts, paradigms, and the *Weltanschauung* that has determined their way of thinking in the past.

2.2 Design and Construction: The Known and Unknown

Within the domain of product development Smith and Eppinger (1997) purport that the proportion of money and time spent on rework in the design phase can be significantly higher than the construction phase. This is due to the iterative nature of the design process as engineers try to solve coupled problems with complex relationships. The situation within construction is the opposite as design costs are often less than one percent of the life-cycle cost of a project or less than 10% of the total construction costs (Andi and Minato, 2003). While the cost of design is minimal, it is the single most important influence on total project expenditure. It is during design process that errors and omissions materialize, which have been widely acknowledged as the key contributors to rework, and are made as a result of embedded dysfunctional organizational practices, 'pluralistic ignorance' and unreasonable cost and schedule constraints being imposed upon the project team by clients. Such unreasonableness may be attributable to client's optimism bias and their inexperience with the project delivery process. This may well be expected as most clients only ever build once and even those who construct on a regular basis rarely use the same team to deliver their requirements.

Despite the plethora of academic, industry and government reports produced acknowledging the need for clients to change their approach to delivering projects, there has been a reluctance to embrace the recommendations that have been espoused (e.g., shift away from the use of competitive tendering), despite the possible performance benefits that can be achieved. Regardless of the need to focus on 'value for money', clients have a proclivity to steer themselves toward the lowest price, irrespective of the long term consequences. Thus, in some instance clients may well subconsciously trade-off lowest price (i.e. both with consultants and contractors as a result of a contingency) with the possibility of scope changes, which may eventuate as rework during construction, though the extent to which this may arise will not be known at the time the contracts are signed. The fixing of a project's governance, delivery strategy (including responsibility and risk allocation) and technology influences the ability to establish an effective 'generative project culture' that focuses on accomplishing a common goal and good performance (i.e. doing what everyone is supposed to do) (Westrum, 2004). As a result of empirically based research examining the influence of strategic decisions at the formative stages of a project, Love *et al*. (2012) proposed the following orthodoxy: "competitive tendering for selecting design consultants projects establishes an environment where their services are reduced or omitted to maximize profit. The omission of critical tasks and practices such as design audits, reviews and verifications leads to contract documentation being erroneously produced and therefore increases the propensity for rework occurring during construction' (p.569)

Conventional project planning and monitoring techniques do not acknowledge or measure rework (Cooper *et al*., 2002). Tasks are either deemed 'to be done', 'in process' or done. In contrast, the rework cycle, which is an archetypal dynamic structure (Figure 2), provides a description of workflow that incorporates rework and undiscovered rework. Work rate is determined by staff skills, productivity and their availability, and as project time advances the amount of work remaining reduces. Work is completed (i.e. work really done) or becomes undiscovered rework depending on the quality (the proportion of work undertaken completely and correctly). In the case of undiscovered work this contains errors that have yet to be identified but are perceived to have been undertaken. The quality of work produced may not be to the required standard and errors may still occur. Errors are often not immediately identifiable (latent) and only transpire after a period of incubation in the system. After some time these errors are eventually detected, or they arise in due course and rework is identified, which increases the amount of work to be undertaken by staff (Rodrigues and Williams, 1998). The degree of rework required is dependent on how long the latent error has remained undetected. For instance, a dimensional error or spatial conflict contained within the engineering design may not arise until the project is physically constructed on-site. If the error necessitates a major change to be undertaken, then all the perceived progress prior to the error occurring may be considered wasted. Addressing the error may generate more work for individuals and the possibility of more errors being generated. This is denoted by the main cycle loop in the model by a reinforcing loop (indicated by *R*). Importantly, the balancing loops, denoted by *B*, should however counteract the accumulation of work remaining. The gap between perceived and actual progress may be difficult to close; it may appear that all work is nearly complete, but the project can persistently remain at a frustrating 90% level of completion (Rodrigues and Williams, 1998). Poor rates of progress occur mainly when staff involved with tasks either leave (staff turnover) or become unavailable and replacement staff are needed to complete the tasks. Discontinuity of design staff application significantly impacts upon design process performance (Rodrigues and Williams, 1998). This is because the inherent project knowledge held by each staff member cannot be seamlessly passed directly from one individual to the next, even if a hand-over 'transition' period (and/or de-briefing) occurs. Even staff recruited from the same organization cannot acquire sufficiently detailed project knowledge immediately after commencing work on site. There is an initial project absorption period needed for all staff. In practice, activities are executed at varying levels, depending upon the individual's skill and competence, and as a result, quality can be compromised during this process. Within the rework cycle it is naturally assumed that inexperienced people are more likely to commit more errors. To some degree this may well be the reality, but Reason (1990) contends that it is often the most qualified and highly competent individuals who commit mistakes with the worst consequences.

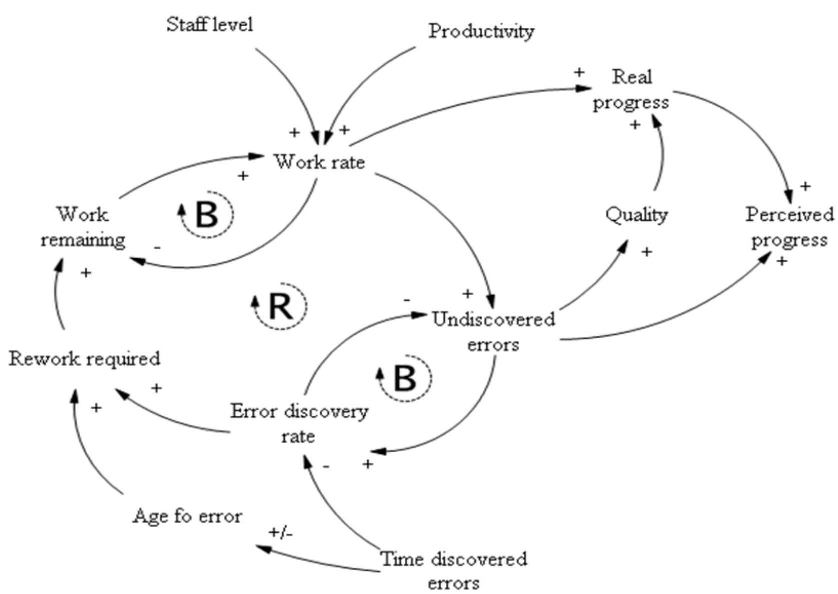

Figure 2. The rework cycle

Cooper (1993) suggests that the quality and the error discovery rate are the most important factors that should be considered. Therefore, bolstering a project with additional resources does not automatically resolve fundamental problems; a more pre-emptive approach should be utilized to reduce the number of errors, or at least to reduce the time taken over their detection (Rodrigues and Williams, 1998). The rework cycle provides a systemic overview of project behavior but it does not provide a context for which rework arises, and therefore, for organizations to learn from experience. Basically, it is the underlying contextual conditions that influence people's ability to learn from errors (Wieck and Ashford, 2001). Dixon (2003) notes it is the very human ability to retrospectively find patterns in the continual flow events that individuals experience daily and hourly in order to give those events meaning. When insights and knowledge are acquired about rework causation within a given context, changes to prevent and reduce its negative consequences can be implemented. A key obstacle in achieving these goals has been the ability to understand how to specify the contexts in which rework might occur in construction projects as previous research has tended to focus upon identifying a singular root cause.

3. Sensemaking

To determine the systemic nature of rework it is proffered that the ontology of 'subjective idealism' should be adopted as there has been limited discourse surrounding its causation (Farrell, 1996). For this approach, subjects construct their own views and opinions on the phenomena under investigation based upon their experiences; an inclination to truth and pragmatism is deemed to prevail. It suggested that sensemaking can then be used to underpin the ontology adopted, as meaning is given to experience, dialogue and narratives about events that have occurred through the process of retrospection (Weick, 1995). The notion of 'retrospective sensemaking' is derived from Schutz's (1967) analysis of 'meaningful experience' where events occur in a moment of time and can exist in pure duration and as discrete segments. Pure duration can be described as a "stream of experience" (James, 1950; cited in Weick, 1995). Experience is a singular construct and is a "coming-to-be and passing-away that has no contours, no boundaries and no differentiation" (Schutz, 1967: cited in Weick, 1995).

Experiences in this context, however, imply distinct, separate episodes (Weick, 1995). The creation of meaning from experience(s) is reliant upon a temporal process of attention being directed backward from specific periods in time; so whatever presently occurs will influence future discoveries when people analyze the past (Weick *et al*., 2005). Furthermore, memories are events that occur in a given period of time, so anything that affects a person's ability to remember will also affect the same sense that is made of those memories. With this in mind, Fischoff (1975) states that 'creep determinism' can prevail, especially "when people already know the outcome of a complex prior history of tangled, indeterminate events remember that history as being much more determinant, leading inevitably to the outcome they already knew" (Weick, 1995:p.28). Consequently, the nature of determinant histories can be reconstructed differently (Weick, 1995) and is akin to a postmodern cultural view, as one person may experience the same phenomenon differently from another (Alvesson and Deetz 1996). For example, if an outcome is perceived to be bad, then antecedents are reconstructed to emphasize incorrect actions and inaccurate perceptions even if they were not influential or obvious at the time (Weick, 1995). In this instance, retrospective sensemaking implies that errors and subsequent rework should be anticipated and reduced through a process of 'good project management'. The future is indeterminate, and the past is reconstructed knowing an outcome, thus past events are rarely recalled exactly as they happened. Reason (1990) asserts that the "knowledge of the outcome of a previous event increases the perceived likelihood of that outcome" (p.91), which can lead people to overestimate their ability to influence future events. This phenomenon is known as the 'illusion of control' (Langer, 1975). Organizations with a strong desire and willingness to reduce rework within projects require an interpretation of past indeterminacy that favors order and oversimplifies causality (Reason, 1990). This approach facilitates a meaningful context as to 'why' and 'how' rework materialized, which provides valuable insights that help construct lessons for the future. That is, real guidance is given to reduce future rework.

4. Conclusion

Key issues associated with rework causation have been examined in this paper. Currently, no theory for rework causation has been established and as a result it remains a problematic issue in construction. Research has focused on its measurement and developing tools and techniques to reduce its occurrence. Such tools and techniques have been ineffective as they do not consider the 'context' within which rework occurs. With this in mind, it suggested that retrospective sensemaking can provide a platform for theory to be developed as an understanding of the 'how' and 'why' is put forward to provide a plausible explanation of cause-and-effect relationships for rework. Reducing and containing rework will result in improvements in project performance, productivity, and safety. In addressing the issue of rework, future research needs to focus on examining its systemic nature and how decisions made during the formative stages of a project's life-cycle (i.e. the blunt end) influence actions and tasks at the coalface (i.e. sharp end). It is suggested that the use of sensemaking can enable the creation of context and meaning that can be used to develop new methods and techniques for its mitigation.

5. References

Alvesson, M., and Deetz, S. (1996). "Critical theory and postmodernism approaches to organizational studies". In A.R. Clegg, C. Hardy, & W.R. Nord (Eds.), Handbook of Organization Studies Sage Publications, London, England, pp. 191-217.

Andi, S., and Minato, T. (2003). "Design document quality in the Japanese construction industry: factors influencing and impacts on the construction process". *International Journal of Project Management*, Vol.21, pp.537-546.

Battles, J.B., Dixon, N., Borotkanics, R.J., Rabin-Fastmen, B., and Kaplan, H.S. (2006). "Sensemaking of patient safety risks and hazards". *Health Research and Educational Trust*, Vol.41. No.4, pp.1555–1575.

Burroughs, G., (1993). "Concrete quality assurance: the contractors role". *Proceedings of the Quality Assurance in the Construction Industry*, Concrete Institute of Australia: Melbourne, Australia

Construction Industry Development Board (CIDB), (1989). "Managing Construction Quality. A CIDB Manual on Quality Management Systems for Construction Operations", *Construction Industry Development Board*, Singapore.

Construction Industry Development Agency (1995). "Measuring Up or Muddling Through: Best Practice in the Australian Non-Residential Construction Industry". *Construction Industry Development Agency and Masters Builders Australia*, Sydney, Australia, pp. 59-63.

Cooper, K.G. (1993). "The rework cycle: Benchmarks for the project manager". *Project Management Journal*, Vol.24, No.1, pp.17-21

Cooper, K.G., Lynies, J.M. and Bryant, B.J. (2002). Learning to learn, from past to future. *International Journal of Project Management*, Vol.20, pp.213-219.

Cusack, D. (1992). "Implementation of ISO 9000 in construction". *Proceedings of the ISO 9000 Forum Symposium*, Gold Coast, November, Australia,

Dekker, S. (2006). *The Field Guide to Understanding Human Error*. Ashgate, Farnham, UK

Dixon, N.M. (2003). *Sensemaking Guidelines – A Quality Improvement Tool*. Med QIC Medicare Quality Improvement. Available at www.medqic.org, Baltimore Centers for Medicare and Medicaid Services, USA

Edmonson, A.C. (2011). Strategies for learning from failure. *Harvard Business Review*, Vol. 89, No.4, pp.48-55

Farrell, F.B. (1996). *Subjectivity, Realism, and Postmodernism: The Recovery of the World in Recent Philosophy*. Cambridge University Press, Cambridge, UK.

Fischoff, B. (1975). "Hindsight does not equal foresight: the effect of outcome knowledge on judgment under uncertainty". *Journal of Experimental Psychology: Human Performance and Perception*, Vol.1, No,3, pp.288-299.

Forcada, N., Macarulla, M., Gangolells, M., Casals, M., Fuertes, A., and Roca, X. (2013). "Post - handover housing defects: Sources and origins". *ASCE Journal of Performance of Constructed Facilities*, 10

Ford, D.N. and Sterman, J.D. (2003). "The lair's club: concealing rework in concurrent development". *Concurrent Engineering: Research and Applications*, Vol.11, No.3, pp.211-219.

Gardiner, J., (1994). "Management of design documentation, where do we go from here?" In *Construction and Management, Recent Advances*, Edited by R.R.Wakefield and D.G. Carmichael, Rotterdam, Balkema, pp. 113–118, 1994

Han, S., Lee, S., Fard, M.G. and Peña-Mora, F. (2007). "Modeling and representation of non-value adding activities due to errors and changes in design and construction projects". *Proceedings of the 39th Conference on Winter Simulation: 40 years! The Best is Yet to Come*, pp.2082-2089.

Hwang, B., Thomas, S.R., Haas, C., and Caldas, C. (2009). "Measuring the impact of rework on construction cost performance". *ASCE Journal of Construction Engineering and Management*, Vol.135, No.3, pp.187-198.

James, W. (1950). *The Principles of Psychology*, Vols 1&2, Dover, NY.

Janis, I.L., and Mann, L. (1977). *Decision-Making: A Psychological Analysis of Conflict, Choice and Commitment*. Free Press, New York

Josephson, P.-E., and Hammarlund, Y. (1999). "The causes and costs of defects in construction. A study of seven building projects". *Automation in Construction*, Vol.8, No.6, pp.681–642.

Josephson, P.-E., Larsson, B. and Li, H., (2002). "Illustrative benchmarking rework and rework costs in Swedish construction industry". *ASCE Journal of Management in Engineering*, Vol.8, No.2, pp.76–83.

Langer, E..J. (1975). "The illusion of control". *Journal of Personality and Social Psychology*, Vol.32, No.2, pp.311-328.

Love, P.E.D., Li, H., and Mandal, P. (1999). "Rework: A symptom of a dysfunctional supply-chain". Europ*ean Journal of Purchasing and Supply Management*, Vol.5, No.1, pp.1-11.

Love, P.E.D. (2002a). "Influence of project type and procurement method on rework costs in building construction projects". *ASCE Journal of Construction Engineering and Management*, Vol.128, No.1, pp. 18-29.

Love, P.E.D. (2002b). Auditing the indirect consequences of rework in construction: A case based approach. *Managerial Auditing Journal*, Vol.17, No.3, pp.138-46.

Love, P.E.D., Edwards, D.J., Smith, J., and Walker, D.H.T. (2009). Congruence or divergence? A path model of rework in building and civil engineering projects. *ASCE Journal of Performance of Constructed Facilities*, Vol.23, No.6, pp. 480-488.

Love, P.E.D, Edwards, D.J., and Irani, Z. (2012). "Moving beyond optimism bias and strategic misrepresentation: An explanation for social infrastructure project cost overruns". *IEEE Transactions on Engineering Management*, Vol.59, No.4, pp. 560 - 571

Love, P.E.D. and Sing, C-P. (2013). "Determining the probability distribution of rework costs in construction and engineering projects". *Structure and Infrastructure Engineering*, Vol.9, No.11, pp. 1136-1148.

Pinto, J.K. (2013). "Lies, damned lies, and project plans: Recurring human errors that can ruin the project planning process". *Business Horizons*, Vol.56, No.5,pp.643–653".

Reason, J.T. (1990). *Human Error*. Cambridge University Press, Cambridge.

Roth, G., and Kliener, A. (1996). *The Learning Initiative at AutoCo Epiloson Program*. 1991-1994. Center for Organizational Learning, Sloan School of Management, Massachusetts Institute of Technology, Cambridge, MA

Rodrigues. A., and Williams, T.M. (1998). "System dynamics in project management: assessing the impacts of client behavior on project performance". *Journal of the Operational Research Society*, Vol.49, No.1, pp.2-15.

Rogge, D.F., Cogliser, C., Alaman, H., and McCormack, S. (2001). *An Investigation into Field Rework in Industrial Construction*. Report No.RR153-11, Construction Industry Institute, Austin, Texas.

Salanick, G.R. and Pfeffer, J (1978). "A social information processing approach to job attitudes and task design". Administrative Science Quarterly, Vol.23, pp.224-253.

Schutz, A. (1967). *The Phenomenology of the Social World*. Northwestern University Press, Evanston, IL

Shaw, B.M. (1981). The escalation of commitment to a course of action. *Academy of Management Review*, Vol.6, pp. 274-297.

Smith, R.P. and Eppinger, S.D. (1997). A predictive model of sequential iteration in engineering design. *Management Science*, Vol.43, No.8, pp.1104-20.

Westrum, R. (2004). "A typology of organizational cultures". *BMJ*, Quality and Safety in Health Care. 13:ii22-ii27

Weick, K.E. (1995). *Sensemaking in Organizations*. Sage Publications, Thousand Oaks, London

Weick, K. E., Sutcliffe, K., and Obstfeld, D. (2005). Organizing and the process of sensemaking. Organization Science, Vol.16, No.4, pp.409-421.

Wieck, K.E., and Ashford, S.J. (2001). *Learning in organizations*. In F.M. and L.L. Putman (Eds.) The New Handbook of Organizational Communications, Thousand Oaks, Sage, California, pp.704-731.