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Peter Rex Massingham,

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Measuring the impact of knowledge loss: a longitudinal study

Peter Rex Massingham

Abstract

Purpose – Knowledge loss caused by employee exit has become a significant corporate risk. This paper aims to explore how to measure the impact of knowledge loss. The paper is based on empirical evidence from a five-year longitudinal study.

Design/methodology/approach – This paper is based on a longitudinal change project for a large Australian Research Council Linkage Project grant in the period 2008–2013. The method was a single case study using a critical realism paradigm. The project was a transformational change programme which aimed to help make the partner organization a learning organization to minimize the impact of knowledge loss. The partner organization was a large Australian Government Department, which faced the threat of knowledge loss caused by its ageing workforce. The sample was 118 respondents, mainly engineering and technical workers. A total of 150 respondents were invited to participate in the study which involved an annual survey and attendance at regular training workshops and related activities, with a participation rate of 79 per cent.

Findings – The results found that knowledge loss has most negative impact in terms of organizational problems including low productivity (morale), strategic misalignment of the workforce (capability gaps), resource cuts (stakeholders unhappy with performance), decreased work quantity and quality (inexperienced employees), work outputs not being used (customers mistrust), longer time to competence (learning cost) and slow task completion (increased search cycle time). The second most significant impact was increased sense of risk associated with work activities and declining capacity to manage the risk. The third main impact was decreased organizational knowledge base: knowledge loss creates knowledge deficit which is unlikely to be filled over time, as shown by the knowledge accounts of surviving employees which remained stable overall. The two remaining measurement constructs – psychological contract and learning organizational capacity – improved, which suggests that the negative impact of knowledge loss may be addressed with appropriate knowledge management.

Research limitations/implications – The research is based on a single case study in a public sector organization. While the longitudinal nature of the study and the rich data collected offsets this issue, it also presents good opportunities for researchers and practitioners to test the ideas presented in this paper in other industry contexts. The complexity and range of the constructs, concepts and scale items is acknowledged. Tables have been used wherever possible to help the reader access the findings.

Practical implications – Knowledge loss is perhaps the greatest corporate risk facing organizations today. This paper provides a method to measure the impact of knowledge loss. Managers may use this to assess the significance of the risk and use this as a business case to take action to minimize the impact of knowledge loss.

Originality/value – Prior research has found knowledge loss has caused decreased psychological contract, lost organizational memory, inefficiency and ineffectiveness and declining capability; however, these concepts are discussed in broad terms only. This paper addresses the need for measurement concepts which helps us understand the nature of the impact of knowledge loss. Five knowledge loss concepts are developed: knowledge resources, psychological contract, learning organization capacity, risk management and organizational problems. The results are based on a large-scale longitudinal study providing empirical evidence of change over a three-year period, situated within the context of a research intervention, i.e. knowledge management programme.

Keywords Knowledge management, Organizational performance, Knowledge loss

Paper type Research paper

Peter Rex Massingham is Director Centre for Knowledge Management at the Department of Management, University of Wollongong, Wollongong, Australia.

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Organizational knowledge loss has emerged as one of the most important corporate risks today (Massingham, 2010). Knowledge loss occurs when an individual with valuable knowledge exits an organization. The problem is increasing due to workforce mobility and our ageing society. At an organizational level, the impact is felt in terms of shortages in skills and talent. Prior research has found knowledge loss has caused lost organizational memory (Holan and Phillips, 2004), inefficiency and ineffectiveness (Jiang *et al.*, 2009), declining capability (Joe *et al.*, 2013) and decreased psychological contract (Massingham and Tam, 2015). There have also been claims that knowledge loss decreases organizational output (Droege and Hoobler, 2003) and productivity (Osterman, 1987), and that it may undermine organizational strategy and, therefore, increase risk (DeLong, 2004; Massingham, 2010). However, these concepts are often discussed in broad terms only, and we still lack measurement constructs and substantial empirical evidence of the nature of the impact of knowledge loss.

Previous research on knowledge loss may be summarized into three themes. First, there is impact on the employees who remain, called survivors. This may be classified into psychological impact, such as anxiety, stress, job insecurity or anger; or work disruption causing increased workload or lost social networks. This impact suggests knowledge loss affects the survivors' emotional relationship with their employer, called the psychological contract (Agyris, 1960). The outcome may be decreased morale and productivity. Second, there is impact in terms of subject matter expertise. Employees who exit take with them their tacit knowledge or the knowledge in their heads (Polanyi, 1962). This impact suggests knowledge loss involves an object, e.g. know-how, which is gone. The outcome may be decreased experience. Third, there is impact in terms of organizational capability. This may be defined in terms of the ways knowledge creates value, e.g. through innovation, problem solving or creativity. This impact suggests knowledge loss involves a resource. The outcome may be decreased performance and profitability.

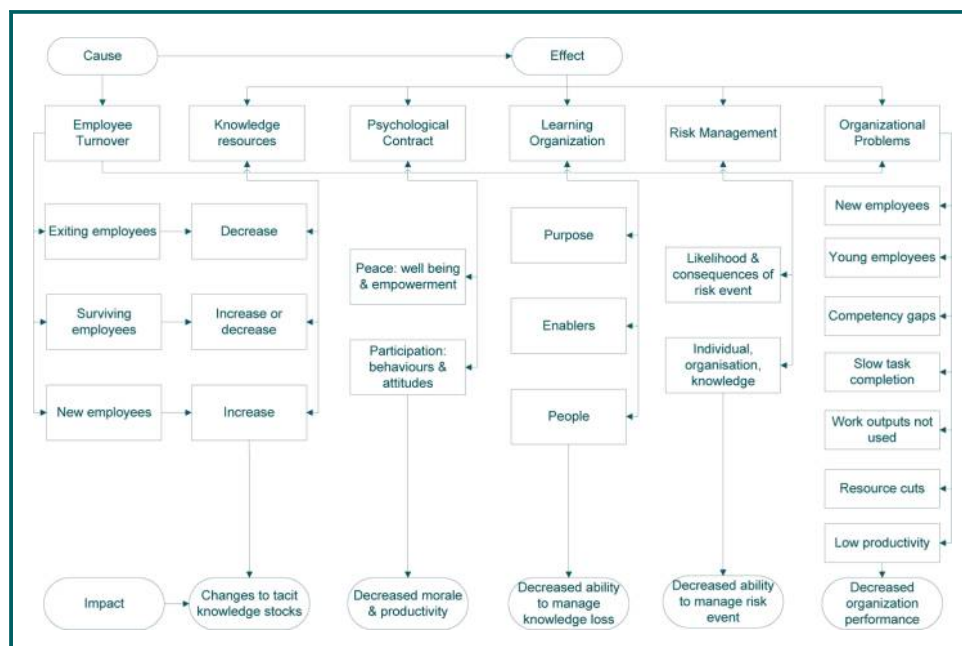
There is an opportunity to examine these broad impacts in more detail and to develop a method which operationalizes knowledge loss. Researchers have made some progress in this area. The well-being discipline provides some theories which may be applied to understand the impact of knowledge loss on survivors' emotional relationship with their employer (Eisenberger *et al.*, 1990). Massingham and Tam (2015) recently found that psychological contract constructs, such as affective attachment, *locus* of control and personal outcome expectancy, may be used to explain the effect of decreased psychological contract on human capital. Intellectual capital theory provides a framework to examine the nature of knowledge as an object lost. Massingham (2008) found lost human capital may result in decreased organizational output and productivity; lost social capital may result in decreased organizational memory; lost structural capital may result in decreased organizational learning; and lost relational capital may result in disrupted external knowledge flows. Strategic management theory provides perspective on knowledge as lost capability. DeLong (2004) identified five ways that knowledge loss may undermine organizational strategy and, therefore, increase risk:

1. reduced capacity to innovate;
2. threatened ability to pursue growth;
3. decreased capacity for low cost strategies caused by reduced efficiency;
4. giving competitors an advantage; and
5. increased vulnerability (DeLong, 2004, p. 31).

These impacts may be summarized as decreases in specialized knowledge, unique experience and competitive position; and increases in mistakes and risk of catastrophic events.

The paper's contribution is to develop a meta-theory of knowledge loss (Figure 1) caused by employee turnover using these five concepts: knowledge resources, psychological

Figure 1 Measuring Knowledge loss conceptual model



contract, learning organization capacity (LOC), risk management and organizational problems. Knowledge loss is conceptualized as employee exit. The paper explores what happens when employees leave and take their knowledge with them. The application of these five measurement concepts is presented in the study of a 150-employee organization within a large public sector organization over a three-year period. The paper continues with a brief literature review, methodology, conceptualization, results showing changes over three annual survey periods, discussion and conclusion.

Knowledge loss

Knowledge loss occurs as a result of employee exit, lost codified knowledge or knowledge decay. In each case, an organization no longer has access to knowledge it previously had. Lost codified knowledge occurs when knowledge that has been captured in a document, report, database, policy or other written format is no longer available. It may have been deleted, discarded or still exists but cannot be located. Knowledge decay involves knowledge losing its value over time. It may have become obsolete or no longer relevant or applicable. Employee exit occurs when an individual leaves an organization, either voluntarily or involuntarily (Carnahan *et al.*, 2012). This includes seeking work elsewhere, redundancy and retirement. This paper focuses on knowledge loss caused by employee exit. Knowledge loss is an increasing corporate risk for two reasons. First, there are demographic changes globally which have significant impact on the workforce. Second, there is increasing employee turnover due to changes in the emotional relationship between employers and their employees. Population ageing is taking place in nearly all countries. Globally, the proportion of older persons (60 years or older) was 841 million in 2013, which is an increase of 400 per cent since 1950, and this will double again by 2050, when it is expected to pass the two billion mark (United Nations, 2013). This creates problems as the workforce is ageing and the experience and wisdom gathered by older people over their careers leaves with them when they retire. Workforce mobility is also a global phenomenon. In Australia, for example, 2.5 million people separated from their job in 2012, which

represents almost 20 per cent of the total workforce; 68 per cent of these separations were voluntary and 38 per cent were involuntary (e.g. retrenchments), and overall around 20 per cent of people were in their first year of their job at their employer (D'Arcy *et al.*, 2012). These data indicate high employee turnover, which is a problem as employees take valuable knowledge with them as they exit and join another organization.

Empirical design

Research context

The research questions were tested in a study funded by the Australian Research Council (ARC) and a large government department. It aimed to measure and manage the impact of knowledge loss. Therefore, the study had two parts. While the data presented in this paper cover the first part, measuring knowledge loss, the results were influenced by the activities in the second part, managing knowledge loss, which was happening at the same time. This enhances the usefulness and generalisability of the results in two ways. The longitudinal nature of the study provides rare opportunity to track change in terms of the impact of knowledge loss. Whereas previous research often considers this problem at one point in time, this study examined the impact over a three-year period. Further, the introduction of a knowledge management programme reflects that managers facing the problem of knowledge loss are likely to take action. It is unlikely that managers would accept studying the nature of the problem for three years before trying to solve it. Therefore, the impact of knowledge loss is studied over time within the context of an organization trying to address the problem at the same time.

Sample

The organization participating in the study was selected because it was a knowledge-intensive organization, with an ageing workforce. An invitation and cover letter explaining the study and assuring confidentiality were sent via email to all 150 engineering and technical staff at the case study organization (CSO). Therefore, the entire population was included in the study. Both management and staff participated. Respondents were allowed to do the survey as part of their work. Participation was voluntary and remained confidential. Therefore, there were no positive or negative consequences for non-participation. The first part of the study, which is the focus of this paper, involved three annual surveys. Respondents were asked to complete and submit the surveys on-line. The survey was conducted in 2009, 2010 and 2011. This allowed the survey results to be tracked over time and for the validity of the constructs to be tested in a three-year longitudinal empirical study. The response rates were 79 (2009), 46 (2010) and 72 per cent (2011). These were excellent participation rates given the study was entirely voluntary and the survey was onerous, i.e. it took 7 h on-line to complete. The lower participation in 2010 was due to organizational upheaval caused by a restructure. The survey results were analysed and the findings reported to management.

Research method

Given the theory building objectives of this study, critical realism was selected as the research paradigm to guide data collection and analysis. Critical realism is not a meta-theory but an epistemology that generates meta-theories rooted in ontology (Hesketh and Fleetwood, 2006, p. 685). The role of meta-theory is to "interrogate the pre-suppositions of any theory" (Hesketh and Fleetwood, 2006, p. 683); therefore, meta-theory is critical examination of theory itself. Critical realists emphasize the transformational nature of the social world of organizations, where agents, i.e. employees, draw upon existing social structures to change these same structures (Hesketh and Fleetwood, 2006, p. 685). Critical realists tend to adopt a systems thinking approach distinguishing between closed systems which are characterized by event regularities, and open systems which lack event regularity (Hesketh and Fleetwood, 2006, p. 685).

Critical realism aims to advance knowledge of the real world. As such the research design encompassed a series of primary data collection, i.e. surveys; followed by an interactive combination of abduction, deduction and induction involving a continual cycle of reflection using discussions with management, and relevant inter-disciplinary literature (Imrie, 2013). The three annual surveys (see sample discussion) involved questions regarding five of the concepts in the study's theoretical framework (Figure 1). The remaining concept, organizational problems, involved working with CSO senior management to evaluate the outcomes of the study. This was not a survey; rather it was an interactive process of deduction, which began with the question:

Q1. How can knowledge management deliver practical outcomes for the CSO?

This involved regular meetings, followed by data gathering, analysis and reporting, reflection and then further meetings. This process continued for six months until the CSO management were satisfied with the results. Unfortunately, there is not space to replicate the surveys here. However, further details may be found in Massingham (2016) on knowledge resources, in Massingham and Tam (2015) on psychological contract, in Massingham (2010) on risk management and in Massingham and Massingham (2014) on organizational problems.

The data collection was based on a single case study methodology. The methodological imperative for critical realism is to explain events by retrodution, not deduction (rationalism) or induction (empiricism) (Al-Amoudi, 2007, p. 546). Retrodution is seeking the unknown, which may be very difficult within the context of open systems, such as the case study in this paper, where there is event irregularity. Critical realism resolves this problem by focussing on moments of crisis or transition because this may involve fewer actualized mechanisms than normal situations and enable using existing (proto) theories as a starting point (Al-Amoudi, 2007, p. 546). This case study's crisis was employee turnover leading to knowledge loss, and the starting theories are outlined in Figure 1.

Yin (2014) argues that construct validity, internal validity, external validity and reliability may be used to judge the quality of research design, particularly for case study research. Construct validity is important in dealing with the criticism that subjectivity is inherent in making case study inferences. Yin (2014, pp. 120-122) argued that one way of increasing construct validity is by triangulating data, which requires corroboration of the phenomenon from multiple sources of evidence. Many of the constructs used in the study were proven scales with construct validity from previous research. Other constructs were validated by other data provided by the CSO. For example, the psychological contract results aligned with cultural change measures from a parallel study conducted by external consultants. This provides evidence of construct validity.

Yin (2014, p. 45) explained that case researchers need to demonstrate the internal validity of their interpretations, by clearly showing how inferences are made, to establish confidence from readers in the conclusions drawn from the research. This is achieved through the process of theory building presented in this paper. Eisenhardt and Graebner (2007) explain that researchers must justify why the research question is better addressed by theory-building rather than theory-testing research. This may be done by explaining why the research question is significant, i.e. crucial for organizations and/or theory, and why there is no existing theory that offers a feasible answer (Eisenhardt and Graebner, 2007, p. 26). This approach is adopted in this paper in the presentation of results. Al-Amoudi (2007, p. 544) explains the features necessary for any theory to be compatible with a critical realist meta-theory. This may be used to further evaluate the internal validity. The first feature is truth. Critical realists tackle truth by distinguishing between transitive and intransitive knowledge (Al-Amoudi, 2007). This is basically the distinction between empiricism and rationalism. This paper adopts the view that transitive knowledge is socially constructed, which privileges empiricism, and a critical realist interpretation of what is truth.

The second feature is ontology. Critical realists prefer an ontology of stratification and emergence because they feel the world is so complex that its behaviours cannot be explained by a single theory (Al-Amoudi, 2007). This stratified view of reality gives critical realism a specific ontological depth in terms of structures, depth and experiences (Leca and Naccache, 2006, p. 630). This study adopts stratification through its multiple theoretical lens (Figure 1) which emerges as layers of perspective about the reality of knowledge loss. The most common ontological levels of knowledge are individual, group, organization and inter-organization (Nonaka and Takeuchi, 1995). The study includes impact of knowledge loss at all four levels. The third feature is epistemology. The main epistemological debates about knowledge involve the clear separation and the unity of tacit and explicit knowledge, and the distinction between intelligence (“knowing how”) and ownership of knowledge (Jakubik, 2007). This study embraces this discussion within the context of the loss of the “carrier” of tacit knowledge, i.e. employees.

The internal validity of case study research also involves prolonged engagement and peer debriefing (Gergen and Gergen, 2000). Evidence of prolonged engagement in this study was the considerable amount of time spent by researchers at the research site (the author spent one day a week at the site over a five-year period) to build rapport and develop trust (Yin, 2014, pp. 110-111). Peer debriefing involves ongoing discussions about analysis and interpretations to derive at findings and conclusions (Lincoln and Guba, 1989, p. 237). The aim is to trigger reflexivity on the part of the case researcher, along with constructive discussions to challenge assumptions, allowing the researcher to make sense of emerging knowledge from the empirical evidence (Lincoln and Guba, 1989, p. 237). This was done in this study by the production of many project reports which were discussed with management and staff to gather feedback. Finally, theory triangulation allows researchers “to understand how differing assumptions and premises affects findings and interpretations” and produce different “theories of actions” (Patton, 2002, pp. 562-3). The paper uses theoretical pluralism to create a more nuanced and complete perspective of knowledge loss in practice. This justifies some overlap or redundancy in construct measurements, e.g. knowledge resources and psychological contract both include emotional relationship variables. This provides evidence of internal validity.

Criticism of case study methodology typically argues that it does not offer convincing support for the generalization of findings, i.e. external validity. However, according to Yin (2014, p. 48), the aim of a case study methodology is not statistical generalizability, but analytical generalizability. External validity may be found in the theory’s explanatory power that may be applied in similar cases (Yin, 2014, p. 45). More importantly, the lessons can be internalized by practitioners (Chua and Mahama, 2012) by improving their problem-solving skills and helping them to recognize the various ways to solve problems. In this study, the researchers worked closely with the industry partners to design, analyse, report and implement theory, data and techniques associated with knowledge loss. The senior industry partner wrote in his final report to the ARC that his organization was grateful for the ground-breaking research this study produced. Furthermore, one of the measurement concepts used in this paper – organizational problems – involves issues which face many organizations, e.g. high proportions of new employees. This provides evidence of external validity. The validity of a theory is whether it makes its assumptions clear and empirically testable (Mir and Watson, 2001). What separates good research from bad, according to Mir and Watson (2001, p. 1170), is “transparency” to make the research contestable. In this paper, the underlying assumptions may be explained by distinguishing between critical realism and constructivism. Critical realism is not constructivism (Mir and Watson, 2001). Whereas constructivism believes that theory may be generated by the researcher from the formalization of the underlying reality of the phenomenon under investigation; critical realism believes that only partial understanding is possible (Mir and Watson, 2001), largely due to the complexity of open systems and therefore the large possibilities of truth or multiple realities. In organizational terms, both critical realism and constructivism believe there are

multiple best practices depending upon the context or situation. Their difference lies in the theory of measurement or evidence. Constructivism believes that evidence is context-specific and, therefore, replication of results is not central to its argument (Mir and Watson, 2001). Critical realism, however, clings to the hope of finding universal truth about a theory by replication. It hopes that other similar studies might find another part of the truth which might be combined to produce a true reality. In other words, while a single study cannot hope to find the complete truth, its generalizability may be found in the capacity to replicate the study, leading to further advancement and, ultimately the complete truth. This paper adopts this approach. The theory developed in Figure 1 may be investigated in further studies leading towards a complete truth about the reality of the impact of knowledge loss. The type of replication would be to use the theory developed in Figure 1 and test with a different population (empirical generalization), rather than the same data set (checking of analysis) or same population (exact replication) (Tsang and Kwan, 1999).

Empirical presentation

Empirical research must present the evidence from which the theory was inducted or deducted. In large-scale deductive studies, theory is presented followed by empirical evidence in numerical tables that summarize statistical analyses of large amounts of data. However, the richness of inductive data makes this difficult. In a single-case study, this is typically addressed by presenting the data as a story within the text. The story typically consists of narrative that is interspersed with quotations and other supporting evidence (Eisenhardt and Graebner, 2007, p. 29). However, more complex case studies, such as the longitudinal study presented in this paper, make narratives unfeasible because the theory is lost as the text balloons (Eisenhardt and Graebner, 2007, p. 29). The best way to address this problem is to develop a theory in sections or by distinct propositions in such a way that each is supported by empirical evidence (Eisenhardt and Graebner, 2007, p. 29). In this paper, the research questions provide this structure. Therefore, the overarching organizing frame of the paper is the theory (Figure 1), and each part of the theory is demonstrated by evidence. Given the spatial constructs of a journal article, Eisenhardt and Graebner (2007, p. 29) accept that the use of extensive tables is necessary to provide the depth and detail of empirical grounding. It is also crucial to write the underlying theoretical arguments that provide the logical link between the constructs within a proposition (Eisenhardt and Graebner, 2007, p. 29). This paper follows these guidelines in the presentation of results.

Conceptual development

The theory building to measure the impact of knowledge loss caused by employee turnover is presented in Figure 1.

Figure 1 begins with the cause of knowledge loss—employee turnover. It then lists five effects of employee turnover (across the top), along with their constructs, which are used to measure the impact of knowledge loss (across the bottom). The concepts in Figure 1 are the organizing frame for the remainder of this paper. Each concept will be introduced, followed by a research question which will be tested inductively, results are then presented using extensive tables to summarize the rich data.

Employee turnover

Employee turnover (ET) is defined as the percentage of employees leaving the organization for whatever reason (Phillips and Connell, 2003, p. 2). This paper's conceptualization of ET captures the flow of knowledge over time and includes the movement of staff exiting, as well as those entering the organization. This leads to the first research question:

RQ1. Does employee turnover cause knowledge loss?

The justification for exploring this question inductively is the quasi-equilibrium model of knowledge loss ([Starke et al., 2003](#)), which argues that employee turnover does not cause the problems expected because the loss of employees is offset by the gain of new employees. This paper challenges this view and proposes that new employees do not automatically replace exiting employees with the same knowledge resources even if recruited into the same jobs.

This paper's contribution to theory development in this area is to track the impact of knowledge loss over time. Our model contains four ET factors which influence the answer to *RQ1*:

1. *Withdrawals*: when employees exit they take knowledge with them.
2. *Decay*: surviving employees, i.e. those who were employed by the organization at the start and the end surveys, may lose knowledge or their knowledge may decrease in value. These both represent decreases to what the organization knows.
3. *Deposits*: when employees enter they bring knowledge with them.
4. *Growth*: surviving employees may gain knowledge or their knowledge may increase in value.

These both represent increases to what the organization knows. The conceptualization reflects that ET is a dynamic phenomenon and that the organization's knowledge is a fluid resource. It also captures the organizational reality that staff come and go.

The empirical results associated with *RQ1* have two parts. First, there is evidence that ET did occur at the CSO. Almost half of the staff (49 per cent) who did the initial survey had exited within two years. Second, there is the effect this ET had on knowledge loss. This is explored through each of our model's remaining five constructs.

Knowledge resources

Knowledge resources measures the type of knowledge exiting employees take with them. This paper's conceptualization of knowledge resources uses [Massingham's \(2016\)](#) knowledge accounts model to measure the value of the individual's tacit knowledge to the organization. This leads to the second research question:

RQ2. How does knowledge loss change the organization's knowledge resources?

The justification for exploring this question inductively is the incomplete nature of previous research. Researchers have conceptualized lost knowledge as experience ([joe et al, 2013](#)) or job-specific or industry-related knowledge ([Gotthart and Haghi, 2009](#)). This paper challenges these measurements as limited aspects of intellectual capital, i.e. representing only a part of human capital.

This paper's contribution to theory development in this area is to include technical knowledge but also cognitive dimensions such as the individual's emotional relationship with the organization, as well as their relationships at work, as important factors in measuring their value to the organization. It provides a more complete picture of the value of an individual's knowledge and, therefore, the impact when lost. [Table I](#) provides the definition of the knowledge accounts measures.

The empirical results associated with *RQ2* have two parts:

1. whether the CSO lost knowledge resources during the survey period; and
2. if so what was the nature of the knowledge lost.

Table I Knowledge accounts measures

<i>Name</i>	<i>Description</i>
<i>Human capital</i>	Combines obvious capability, such as found at job interview, with deeper less visible psychological constructs
HC1: employee capability	Typical job interview responses
Activity	Activity importance by time spent
Qualifications	Number and relevance
Experience	Time necessary to learn the job, how difficult it is to learn and how difficult it is to teach
Skills	Personal efficacy, professional capabilities, learning motivation
Knowledge	Degree of tacitness of their knowledge, the level of complexity
HC2: employee sustainability	Whether the individual is likely to stay at the firm
Trust	Trust in their employer
Careerism	Whether employer is a stepping stone up the career path
HC3: employee satisfaction	Whether the individual is happy at the firm
Affective attachment	The emotional relationship between the employee and the organization
Locus of control	People's perceived control of their lives
Calculative reward	Whether people are willing to work hard for their organization because they feel they will be rewarded
Calculative approval	Whether people are willing to work hard for their organization because they feel they will be recognized
<i>Social capital</i>	Knowledge generated from the size, frequency and quality of the individual's social interactions at work
SC 1: colleagues attitude	How individuals feel about the people they work with
Collective efficacy beliefs	Individual's assessments of their group's ability to perform job-related behaviours
Collective outcome expectancy	Individual's perception of whether the group's performance matches organizational expectations
SC 2: network structure	Who the individual interacts with at work
Internal network size	The volume of social contacts via number of contacts \times seniority
Internal density	The interconnectedness of social networks
Internal heterogeneity	Whether a network membership is inclusive or exclusive
Internal constraints	Whether a network membership is democratic
Internal closeness	Whether an individual is connected to the right individuals within their work environment
Internal betweenness	Whether an individual is a facilitator of key relationship
SC 3: network quality	How the individual is perceived within their social networks
Internal tie importance	Number of internal contacts \times importance
Internal corporate leadership	Whether an individual provides unsolicited contribution to the organization's leadership
Internal volunteering	Whether an individual provides unsolicited help or support to other individuals or groups
Internal mentoring	Whether an individual is willing to mentor others
Internal social dependence	Whether an individual is depended upon by others at work
Internal reciprocity	The importance of "in-kind" exchanges, e.g. favours
<i>Structural capital</i>	Whether the individual values the firm's structural capital and is willing to share their knowledge
StC 1: currency	Whether the individual's knowledge is up-to-date but also the contextual need
Relevance	How up-to-date the respondent's knowledge is
Change	How much the knowledge changes and they try hard to keep track of these changes

(continued)

Table I	
Name	Description
StC 2: usage	Whether the individual uses the firm's structural capital
Sources	The importance of structural knowledge sources when looking for new knowledge
Expert status	Who is the best person to get information about structural capital sources
StC 3: contribution	Whether the individual is willing and able to share their knowledge
Motivation	Willingness to share their knowledge with the organization, i.e. via reports, procedures, policies, etc.
Ability	Capacity to share their knowledge with the organization, i.e. via reports, procedures, policies, etc.
Action	Behaviour in sharing their knowledge with the organization, i.e. via reports, procedures, policies, etc.
<i>Relational capital</i>	External relationships, as opposed to internal relationships. Each relationship in terms of whether it is required by the organization (formal ties) or is voluntary (informal ties)
RC 1: formal ties	Individuals who are required to interact as part of their job tend to build relationships with the position rather than the individual
No. of external contacts	The size of external networks
External contact importance	The importance of external contacts
External frequency of contact	How frequently external contacts personally visit the respondent or vice versa
External relationship	The formal nature of the relationship between the respondent and the external contact in terms of who initiates meetings
Density	The interconnectedness of external social networks
RC 2: informal ties	Voluntary interactions not required by the job, and are therefore based on personal friendships and other deeper motivations (e.g. trust, reciprocity)
External depth	The informal nature of the relationship between the respondent and the external contact in terms of <i>how</i> they help each other
External purpose	The purpose of the relationship between the respondent and the external contact in terms of <i>why</i> they help each other
External knowledge flows	The nature of the knowledge flows between the respondent and the external contact in terms of <i>what</i> they help each other with
External mentoring	The respect in the relationship between the respondent and the external contact in terms of whether they would <i>mentor</i> each other
External social dependence	Social dependence measures the extent to which an individual is depended upon by others in their external network
External trust	The level of trust in the relationship between the respondent and the external contact
External reciprocity	Reciprocity measures the importance of "in-kind" exchanges that are not necessarily economically based, typically "returned favours"
External friendship	Whether the respondent is friends with the external contact outside of work. It is a further measure of relationship intimacy

Were knowledge resources lost?

Of the top 20 employees in 2009 (in terms of their overall knowledge account score), 14 exited by 2011. This means that the CSO lost 70 per cent of its most valuable employees during the study period. Therefore, we may conclude that knowledge *was lost* by the CSO due to ET. However, the CSO also gained knowledge during this period. Knowledge gain occurred in two ways:

1. knowledge brought by new employees; and
2. growth in knowledge in survivors (employees who remained).

If the knowledge gain was similar to that lost, then it may be argued that the situation was managed, and a quasi-equilibrium reached.

The first type of gain was the introduction of new employees. The CSO introduced 53 new employees in the survey period. These employees brought with them a significant amount of knowledge. However, the overall mean knowledge account score (out of 100) for new employees in 2011 was 48.1, which meant they were not as capable as either the employees who left (mean score of 51.1) or survivors (remaining employees) (mean score of 52.3). Of the top 20 employees in 2011 (in terms of their overall knowledge account score), 9 (45 per cent) were new. This means that while the CSO lost 70 per cent of its most valuable employees (see previous section), they were replaced by less valuable employees (only 45 per cent of the top 20). These findings provide evidence that knowledge *was lost* by the CSO despite the recruitment of new employees to replace those that left.

The second type of gain was the growth of survivors. It was expected that these remaining employees would learn and their knowledge accounts (KA) score would increase over the survey period. However, the overall mean KA score for survivors increased only very slightly (0.3 per cent). We might conclude that ET did not impact on survivors. However, at the individual level, about half (53 per cent) of the survivors increased their KA score, while about half (47 per cent) decreased. Clearly, ET affected some survivors more than others. However, these findings provide evidence that knowledge *was not lost* by the CSO in terms of survivors as an overall knowledge resource.

What knowledge resources were lost?

The first step was to look at the type of knowledge resources the exiting employees took with them. Overall, exiting employees were slightly less valuable (mean KA score of 51.1) compared to survivors (mean 52.3), but more valuable than those who replaced them, i.e. new staff (mean 48.1). However, the most visible impact is amongst the most valuable employees. The 14 top 20 employees who left had significantly higher mean KA scores in all four capital types. Relational capital was the biggest loss in capability (101 per cent higher than overall average), followed by structural capital (31 per cent higher), social capital (16 per cent higher) and human capital (14 per cent) higher).

Human capital's biggest losses were with exiting employees with high careerism and affective attachment. Careerism measures people's orientation towards their employer as a stepping stone up the career path (Robinson and Rousseau, 1994; Porter *et al.*, 1973). Losing employees with high careerism is not surprising, as these top 20 exiting employees were more likely to see the CSO as a short-term step in their career, so their mobility is understandable. Affective attachment measures the emotional relationship between the employee and the organization (Eisenberger *et al.*, 1990; Porter *et al.*, 1973). It means that top 20 exiting employees had a strong relationship with their organization. This is surprising but may be explained by the fact that many were retiring and were, therefore, not leaving due to job dissatisfaction. These employees are more likely to have positive work behaviours including loyalty and organizational commitment. Losing employees with high affective attachment would mean decreased morale and productivity.

Social capital's biggest losses were exiting employees with high social dependence and corporate leadership. Social dependence measures the extent to which an individual is depended upon by others at work (Lee, 2005; Stone, 2001). This is a significant problem because employees with high social dependence scores are often central to social networks at work and are the people others turn to for help. Losing employees with high social dependence scores would disrupt internal social networks and leave survivors with no-one to help them when they do not know what to do. Corporate leadership measures the extent to which an individual provides unsolicited contribution to the organization's leadership (Lee, 2005; Stone, 2001). These individuals are respected by colleagues for doing informal leadership, e.g. mentoring and advice. Losing employees with high corporate leadership scores would decrease

the effectiveness of social networks in terms of goodwill and speed of access to important knowledge within the network.

Structural capital's biggest losses were with exiting employees with high usage and action. Usage measures whether the individual uses the firm's structural capital (Massingham, 2016). Individuals with high usage scores are likely to know where best to store their knowledge and how to do it. Losing employees with high usage scores would mean decreased organizational memory about how to use the organization's structural capital, e.g. intranet, policies and databases. Action measures an individual's behaviour in sharing their knowledge with the organization, i.e. via reports, procedures, policies, etc. (Polanyi, 1962). Individuals with high action scores are more likely to codify their knowledge and make it accessible for others. Losing employees with high action scores would mean decreased stock of structural capital, e.g. less lessons learned, less best practice and less organizational memory.

Relational capital's biggest losses were with exiting employees with knowledge flows and reciprocity. Knowledge flows measures the nature of the knowledge flows between the respondent and the external contact in terms of what they help each other with (Edvinsson and Malone, 1997). Losing employees with high knowledge flow scores would mean decreased knowledge flowing from outside the organization to internal knowledge seekers. Reciprocity measures the importance of "in-kind" exchanges that are not necessarily economically based, typically "returned favours" (Edvinsson and Malone, 1997). Losing employees with high reciprocity scores indicates disrupted external social networks causing decreased cooperation.

The second step was to look at the type of knowledge resources the surviving employees lost (i.e. knowledge decay). Approximately half of survivors decreased their knowledge account score. The major reason for this was human capital which decreased for this group of survivors by a mean of 9.0. This is counter-intuitive because we tend to believe that human capability continues to increase over time. For example, some of the factors which contribute to the human capital score, such as experience and qualifications, are expected to only gain value over time. However, the decrease in human capital is explained by changes in employee satisfaction and employee sustainability. The human capital factor with the biggest decrease for these survivors was calculative reward. This indicates that these employees were suffering from feeling unrewarded if they work hard. This finding reveals that these survivors probably had low morale which was affecting their productivity, and also their organizational commitment.

What knowledge resources were gained?

First, we look at the type of knowledge resources the new employees brought with them. The knowledge of the new employees (9) in the top 20 most valuable employees (i.e. highest overall KA scores) is explored.

Human capital's biggest gains were with new employees with high calculative reward and *locus* of control. Calculative reward means whether people are willing to work hard for their organization because they feel they will be rewarded (Eisenberger *et al.*, 1990); it is often called extrinsic rewards. New employees with high calculative reward is not surprising, as these top 20 new employees probably joined expecting to be rewarded, and management would have tried to adjust reward strategies to address the need for better employee retention. Locus of control measures people's perceived control of their lives (Porter *et al.*, 1973). It means that top 20 new employees had a strong sense of control at work compared with other employees. This is also not surprising, as these top 20 new employees were given scope for independence and autonomy as a reaction from management to address employee retention.

Social capital's biggest gains with new employees were network size and density. Network size measures the volume of social contacts via number of contacts times seniority (Lee, 2005). This is a surprising finding because previous research suggests new employees may not have access to existing social networks (Borgatti and Foster, 2003). However, this result shows that new top 20 employees found it relatively easy to become connected to a wide range of social contacts. Density measures the interconnectedness of social networks. Individuals with high density scores are connected with more than one social network (Lee, 2005; Stone, 2001). Both cases are indicators of management addressing the problem of knowledge loss and employee retention. The new top 20 employees were included in multiple formal networks, e.g. committees and task forces, where they could build social networks. This was a result of the organizational culture at the CSO. Employees were aware of high turnover rates and were used to seeing new faces. In response, employees had to build relationships quickly. There was also an expectation that people would cooperate, and this created a culture where employees dealt with positions rather than individuals. This meant that employees worked with people in job roles they were expected to interact with, irrespective of their personal relationship with that person.

Structural capital's biggest gains were with new employees with expert status and high usage. Expert status measures who is the best person to get information about structural capital sources (Reed *et al.*, 2006). This is another surprising finding. It is reasonable to assume that new employees would have less experience of structural capital, such as the intranet, policies, procedures, compared with others, particularly survivors. However, the results indicate that the new top 20 employees quickly assumed expert status. This was an adjustment these employees made to the loss of experience caused by employee turnover. As many employees with expert status had left, these new employees may have felt they needed to learn how to use structural capital to help them access organizational memory. Usage measures whether the individual uses the firm's structural capital (Massingham, 2015). This result reflects that the new top 20 employees quickly learned where best to store their knowledge and how to do it. These findings suggest a shift towards codified knowledge, away from tacit knowledge, as new top 20 employees sought to replace lost organizational memory by rebuilding a new stock of structural capital.

Relational capital's biggest gains were new employees with purpose and depth. External purpose measures why the respondent and the external contact help each other (Edvinsson and Malone, 1997). New top 20 employees with high external purpose scores means they were able to build meaningful personal relationships with external contacts beyond their job requirement to interact. External depth measures the informal nature of the relationship between the respondent and the external contact in terms of how they help each other (Edvinsson and Malone, 1997). New top 20 employees with high external depth scores is a further indicator that these new staff were able to build strong external relationships. These findings are further illustration (see also social capital) of employees working with roles rather than people in the sense that this interaction was a necessary part of their job.

Next, we look at the type of knowledge resources the surviving employees gained (i.e. knowledge growth). In total, 53 per cent of survivors increased their knowledge score between 2009 and 2011. The main reason for this was relational capital. These survivors improved their external relationships, probably in response to assuming responsibilities to interact, thereby filling a gap left by exiting employees. External tie importance increased by a mean of 39.8, which indicates these survivors moved into the gap left by exiting employees by creating relationships with more senior external contacts. They also increased structural capital. This indicates that these survivors relied more upon organizational memory captured in reports, databases, policies, rather than people, which probably reflects that their social networks were disrupted, and they no longer had access to tacit organizational memory held by these exiting employees. In terms of social capital,

their network quality increased. These survivors also established positive social networking behaviours including corporate leadership and volunteering, and also increased their affective attachment or emotional relationship with the organization.

Table II presents a summary of these findings (i.e. the construct table for *RQ2*).

What is the net result of these changes to knowledge resources?

The results provided evidence that knowledge loss caused by ET does have an impact on knowledge resources. It showed that the CSO lost knowledge and gained knowledge over the period of the study, and the type of knowledge involved in these changes. This provides support for the theoretical development underlying *RQ2*. The KA appears to be a useful theory for examining *RQ2*. Our final step is to discover whether ET has a positive or negative impact on knowledge resources. Table III summarizes the net results by overall score and capital type. It also highlights the constructs with the most impact in terms of the changes in the survey period, between 2009 and 2011.

At first glance, the slight decrease in overall KA mean score suggests that ET had only a minor negative impact on knowledge resources. It suggests support for the quasi-equilibrium model of knowledge loss (Starke *et al.*, 2003). This occurred because survivors remained stable and new employees seemed to be relatively good replacements. However, there are deeper issues to consider. First, new employees do not represent a straight swap for exiting employees. New employees represent 91.8 per cent of the mean score of exiting employees. Second, the stability (overall) of survivors is concerning. Management would expect that employees will learn and increase their knowledge resources. The fact that this did not happen, particularly for the 47 per cent of survivors whose KA score decreased, indicate a residual negative impact of knowledge loss. Third, new employees may never reach the level of exiting employees. If survivors remain stable after significant ET, it is reasonable to assume that new employees will too. They might not close the gap over time. Fourth, there were particular cultural issues at the CSO which helped overcome the impact of ET. The requirement to interact with roles, rather than people, offset the impact on social and relational capital. Organizations without this culture may see a more significance decrease in their KA scores.

Psychological contract

Psychological contract measures changes in employees' emotional relationship with their organization (Agyris, 1960). This paper's conceptualization of psychological contract uses the concepts of peace and participation to measure job satisfaction. This leads to the third research question:

RQ3. How does knowledge loss change psychological contract?

The justification for exploring this question inductively is causal ambiguity in previous research. Researchers have conceptualized the impact of knowledge loss on remaining employees in terms of job insecurity and anger, which manifests itself in areas such as decreased performance, motivation, job satisfaction and organizational commitment (Brockner, 1988), as well as disruption due to heavier employee workloads (Durst and Wilhelm, 2012). This paper challenges these measurements as providing only a partial picture of the reciprocal nature of psychological contract.

This paper's contribution to theory development in this area is to include the motivational processes of social exchange theory and the norm of reciprocity (Blau, 1964; Homans, 1961). This means that the more employees perceive an organization gives them, the more they will give to the organization in return. Employees give, in this sense, in terms of quantity and quality of work. Therefore, high PC scores reveal employees with high job satisfaction, which is likely to translate into high productivity and work performance. On the other hand,

Table II Does knowledge loss change the organization's knowledge resources? (RQ2)

Theory	Measure	Evidence	Findings
<i>Were knowledge resources lost?</i>			
KA score	Exiting staff loss	70% of most valuable employees left	Knowledge was <i>lost</i> by the CSO
	New employee gain	Lower mean scores for new employees Less new employees in top 20 employees	Knowledge was <i>lost</i> by the CSO despite the recruitment of new employees to replace those that left
	Survivor growth	Mean was stable Half of the survivors increased scores, half decreased	Knowledge was <i>not lost</i> by the CSO in terms of survivors (overall KA mean)
<i>Summary of relationships: new employees do not offset the loss of exiting employees and survivors remain stable (i.e. do not grow)</i>			
<i>What knowledge resources were lost?</i>			
Human capital (exiting employees)	High careerism and affective attachment	Lost employees with the most positive work behaviours (e.g. loyalty and organizational commitment) (due to retirement)	Losing employees with high affective attachment decreases <i>morale and productivity</i>
Social capital (exiting employees)	High social dependence and corporate leadership	Lost employees who had central roles in social networks and were respected for unsolicited contributions	Losing employees with high social dependence scores leave survivors and new employees with <i>no-one to help</i> them Losing employees with high corporate leadership scores decreases <i>goodwill and speed of access</i> to knowledge within the network
Structural capital (exiting employees)	High usage and action	Lost employees who knew where best to store their knowledge and how to do it, and were also more willing to codify their knowledge and make it accessible for others	Losing employees with high usage scores decreases <i>accessibility</i> to organizational memory Losing employees with high action scores decreases <i>codified knowledge</i> , e.g. less lessons learned, less best practice
Relational capital (exiting employees)	High knowledge flows and reciprocity	Lost employees who had developed purposeful relations with external stakeholders and who were owed "returned favours"	Losing employees with high knowledge flow scores decreases <i>connection</i> between external knowledge suppliers and internal knowledge seekers Losing employees with high reciprocity scores disrupts external social networks causing decreased <i>cooperation</i>
Knowledge decay (survivors)	Low employee satisfaction and employee sustainability	The biggest decrease for these survivors was calculative reward. This indicates that these employees were suffering from feeling unrewarded if they work hard	Low morale which was affecting their <i>productivity</i> , and also their organizational <i>commitment</i>

(continued)

Table II			
Theory	Measure	Evidence	Findings
Summary of relationships: knowledge lost had a negative impact on work performance (morale and productivity), relationships (internal and external), and organizational memory (experience) What knowledge resources were gained?			
Human capital (new employees)	High calculative reward and locus of control	The biggest increase for these new employees was calculative reward. They felt they were rewarded for working hard. Next was locus of control. They felt a strong sense of control at work compared with other employees	Management adjusted reward strategies and allowed <i>independence and autonomy</i> to address the need for better employee retention
Social capital (new employees)	High network size and density	The biggest increase for these new employees was network size. These employees found it easy to become connected to a wide range of social contacts at all levels. Next was density. They were connected with more than one social network	New employees were <i>included in multiple formal networks</i> to build social networks. Organizational culture meant employees <i>dealt with positions rather than individuals</i> . Personal relationships were relatively unimportant
Structural capital (new employees)	High expert status and usage	The biggest increase for these new employees was expert status. They quickly assumed expert status. Next was usage. They quickly learned where best to store their knowledge and how to do it	New employees needed to learn how to <i>use structural capital</i> to help them access organizational memory. There was a shift towards codified knowledge, away from tacit knowledge, as new employees replaced lost organizational memory by rebuilding a new stock of structural capital
Relational capital (new employees)	High purpose and depth	The biggest increase for these new employees was purpose. They were able to build meaningful personal relationships with external contacts beyond their job requirement to interact	New employees were willing to work with external contacts to help each other. They also developed an <i>understanding of why and how they should help</i> external contacts
Knowledge growth (survivors)	High external network ties (relational) and usage (structural)	The biggest increase for these survivors was external network ties. They created relationships with more senior external contacts. Next was usage. They relied more upon organizational memory captured in reports, databases, policies, rather than people	Survivors filled the gap created by exiting employees <i>by moving into the external roles</i> of those who left. Internally, they focussed more on <i>codified knowledge</i> rather than social capital
Summary of relationships: knowledge gained was due to employee satisfaction (reward and autonomy), cultural requirement to interact with jobs rather than people (network size and external purpose) and a move towards codified knowledge rather than tacit (structural rather than social)			
Source: Adapted from Massingham (2016)			

low PC scores can lead to a lack of creativity and sharing necessary to generate value from employees ([Massingham and Tam, 2015](#)). The theory developed for psychological contract provides a more complete picture of an individual's emotional relationship with their organization and, therefore, the impact of knowledge loss on this relationship. [Table IV](#) provides the definition of the psychological contract measures.

Table III Net changes to knowledge accounts due to gains and losses

<i>Measure</i>	<i>Overall KA score</i>	<i>Human capital</i>	<i>Social capital</i>	<i>Structural capital</i>	<i>Relational capital</i>
2009 Mean score	51.4	62.6	65.1	50.6	27.2
2010 Mean score	51.9	61.6	63.9	48.3	33.9
2011 Mean score	49.7	57.8	61.0	55.7	24.2
% difference between 2009 and 2011	-3.3	-7.7	-6.3	10.1	-11.0
Exiting employees mean score 2009	51.1	62.4	65.1	50.7	26.2
Survivors mean score 2009	52.1	63.1	65.0	50.1	30.3
New employees mean score 2011	48.1	56.9	59.9	55.1	20.6
Survivors mean score 2011	52.4	59.2	62.8	56.7	30.7
New employees mean score as a proportion of exiting employees mean score in 2011	91.8%	96.1%	95.4%	97.2%	67.1%
Survivors who increased their score	16 (53%)	11 (37%)	13 (43%)	23 (77%)	12 (40%)
Survivors who increased: mean score increase	6.0	5.0	5.1	10.8	15.3
Survivors who increased: constructs with biggest increase	N/a	Affective attachment (21.0)	Corp. leadership (23.1) Volunteering (23.0)	Usage (23.1)	Importance (39.8)
Survivors who decreased their score	14 (47%)	19 (63%)	17 (57%)	7 (23%)	18 (60%)
Survivors who decreased: mean score decrease	-6.4	-9.0	-7.8	-7.5	-21.8
Constructs with biggest survivor decrease	N/a	Calculative reward (-32.4)	Network size (-21.5) Tie importance (-20.6)	Sources (-33.1)	Purpose (-67.1)

Table IV Psychological contract concepts and measures			
<i>Measure</i>	<i>Definition</i>	<i>Benefit</i>	<i>Example items & literature</i>
<i>Peace</i>			
Work–life balance	Work and family balance	Well-being	My organization helps employees balance work and family Phillips and Connell (2003)
Flexibility	Staff autonomy and control over work decisions	Empowerment	My organization gives people choices in their work assignments Marsick and Watkins (2003)
<i>Participation</i>			
Leadership	Effective listening to staff and communication with staff	Trust	Teams/groups are confident that management will act on their recommendations Marsick and Watkins (2003)
Recruitment & selection	Candidates are targeted for their contribution/fill gaps	Merit	Individuals are hired for their ability to contribute to the development of organizational knowledge Mertins et al. (2003)
Cross-unit cooperation	Inter-group knowledge sharing	Sharing	Teams/groups are rewarded for their achievements as a team/group Marsick and Watkins (2003)
Learning and development	Staff are continually learning (personal mastery)	Learning	My organization makes its lessons learned available to all employees Marsick and Watkins (2003)
Involvement	Staff feel they are consulted and able to provide feedback (empowerment)	Valued	My organization encourages people to get answers from across the organization when solving problems Marsick and Watkins (2003)
Organizational culture	Positive work attitudes, norms and values	Attitude	Knowledge sharing is seen as strength and knowledge hoarding as weakness Mertins et al. (2003)
Rewards and recognition	Staff feel rewarded and recognized	Rewarded	People who work hard are promoted (Eisenberger et al., 1990)
Performance appraisal	Staff are evaluated in terms of desired learning organization behaviours	Contribution	Individuals are evaluated for their contributions to the development of organizational knowledge Mertins et al. (2003)
Career management	Competency mapping	Development	Skills people need for future work tasks are identified Marsick and Watkins (2003)

The empirical results associated with *RQ3* have the following two parts:

1. whether employees were happy with their job; and
2. whether they were happy with management.

Were employees happy with their job?

The peace concept combines wellbeing and empowerment. It has two constructs: work–life balance and flexibility. It measures whether employees feel they have appropriate balance

between work and family life, and autonomy and control over work decisions. These constructs combine to give a sense of calm.

The peace score increased by 6.8 per cent between 2009 and 2011. This indicates that employees' sense of calm, measured by combining wellbeing and empowerment, was higher in 2011 than in 2009. This finding contradicts previous research, which suggested that knowledge loss caused anxiety and stress (Brockner, 1988), and heavier employee workloads (Winkelen and McDermott, 2008). This did not occur at the CSO. In terms of reciprocity theory, management was willing to give employees more in 2011 than in 2009, particularly in terms of work–life balance. This resulted in higher levels of job satisfaction. This finding suggests that management action, in this case improving employees' work–life balance, can offset negative factors associated with psychological contract caused by knowledge loss.

Were employees happy with management?

Participation is perception that the organization is encouraging positive work attitudes and behaviours. It has nine constructs: leadership; recruitment and selection; cross-unit cooperation; learning and development; involvement; organizational culture; rewards and recognition; performance appraisal; and career management. It measures employees' feelings about management in terms of trust, merit, being valued, recognized and rewarded, as well as perception about their workplace in terms of sharing, learning, attitude and personal development.

The participation score also increased, but only slightly, by 2.2 per cent between 2009 and 2011. This indicates that the organization's encouragement of positive work attitudes and behaviours was slightly higher in 2011 than in 2009. This finding contradicts previous research, which suggested that knowledge loss may lead to negative behaviours, such as disrupted social networks (Winkelen and McDermott, 2008). This did not happen at the CSO. The results show that cross-unit cooperation had the highest increase of the nine participation constructs (11.3 per cent). However, there was some negative impact. The two constructs which decreased – rewards and recognition, and performance appraisal – reflected important negative attitudes towards management. They reveal that knowledge loss created negative feelings about employees being rewarded and whether their contribution was being recognized. Table V summarizes the results.

The results provided evidence that knowledge loss caused by ET does not have a negative impact on psychological contract. The results were surprising in the sense

Table V Psychological contract changes 2009–2011 (scale = 1–7)

<i>Construct</i>	<i>2009 Mean</i>	<i>2010 Mean</i>	<i>2011 Mean</i>	<i>% Change 2009–2011</i>
Peace	3.81	3.92	4.07	6.8
Work-life balance	4.28	4.64	5.07	18.5
Flexibility	3.65	3.68	3.74	2.5
Participation	3.71	3.89	3.79	2.2
Leadership	3.76	3.99	4.09	8.8
Recruitment and selection	3.36	3.76	3.66	8.9
Cross-UNIT cooperation	3.53	3.87	3.93	11.3
Learning and development	3.56	3.48	3.62	1.7
Involvement	3.86	4.14	4.28	10.9
Organizational culture	4.23	4.44	4.39	3.8
Rewards and recognition	4.05	3.52	2.85	–29.6
Performance appraisal	3.19	3.46	2.76	–13.5
Career management	4.18	4.32	4.49	7.4
Overall employee engagement	3.76	3.90	3.93	4.5

they contradicted previous research. We expected to find a negative impact on psychological contract. However, the scores increased. This reflects the management action taken to address the low psychological contract scores at the start of the study (i.e. the second part of the study – managing knowledge loss). It reveals that low psychological impact can be addressed. However, the findings also revealed some deeper residual issues. Some of the factors which led to high ET, such as reward and recognition, remained a problem, showing that some parts of the psychological contract are more difficult to address. The peace and participation model appears to be a useful theory for examining *RQ3*.

Learning organization capacity

LOC defines an organization that effectively manages its knowledge resources, responds to forces for change and learns from its experiences (Massingham and Diment, 2009). The origins of LOC come from the work of Garratt (1987) and Senge (1990). This paper's conceptualization of LOC uses three concepts, namely, purpose, enablers and people to measure learning performance. This leads to the fourth research question:

RQ4. How does knowledge loss change learning organization capability?

The justification for exploring this question inductively is the need to operationalize previous research. Researchers have conceptualized the impact of knowledge loss in terms of lost specialized knowledge and unique experience (DeLong, 2004); decreased capacity, quality and productivity levels (Jiang *et al.*, 2009); and lost problem-solving capacity and decision-making (Martins and Meyer, 2012). This paper challenges these measurements as lacking adequate scale items to test LOC performance.

This paper's contribution to theory development in this area is to use three concepts as criteria for LOC performance: purpose, enablers and people. Purpose allows the organization to respond to forces for change. It measures the organization's capacity to be flexible, adaptable and responsive. Enablers allow the organization to learn from experience. It measures how well the organization captures and shares its knowledge. People is the organization's management of its knowledge resources. It measures the capacity to grow human capital through organizational learning. These three constructs combine to measure whether knowledge loss has decreased LOC. Table VI defines the three concepts and their constructs.

The empirical results associated with *RQ4* have three parts. Whether employees felt their organization was:

1. managing knowledge resources well (people);
2. responding to change (purpose); and
3. learning from experience (enablers).

How well was the organization managing knowledge resources?

The people score increased by 10.4 per cent between 2009 and 2011. This indicates that employees' perception of their organization's ability to manage knowledge loss had improved because employees feel they work with people they respect and can learn from. The highest increase was in motivation and initiative, which is a productivity measure. This contradicts previous research which found that knowledge loss caused decreased productivity (Jiang *et al.*, 2009) and increased mistakes (DeLong, 2004). This did not happen at the CSO.

Table VI Learning organization capacity concepts and measures

<i>Measure</i>	<i>Definition</i>	<i>Benefit</i>	<i>Example items and literature</i>
<i>Concept: purpose</i>			
Organizational direction	Focus on learning organization goals	Knowledge management is valued	Managing organizational knowledge is central to my organization's strategy Mertins et al. (2003)
Results focus	Set targets and conduct benchmarking	Measurement	My organization creates systems to measure gaps between current and expected performance Marsick and Watkins (2003)
Mission and values	Shared mental models based on awareness of knowledge management	Understanding	People at all levels have a general understanding of the concept of knowledge management Moilanen (2005)
Role clarity	Staff understand their role and its contribution	Alignment	We have relevant job descriptions that accurately reflect our work Marsick and Watkins (2003)
<i>Concept: enablers</i>			
Resources	Physical environment, information	Connectivity	There are special work spaces for equipment suppliers or other external technology specialists Kluge et al. (2001)
Processes	Procedures and standards aimed to ensure consistency and efficient work flow	Quality	Staff always use or follow our standard operating procedures Moilanen (2005)
Technology	Information technology and information systems	Accessibility	Teams/groups are rewarded for their achievements as a team/group Marsick and Watkins (2003)
<i>Concept: people</i>			
Motivation and initiative	Feeling recognized and rewarded, as well as levels of initiative	Productivity	Employees generally consistently perform at their best Bontis (1998)
Talent	Staff perception of the quality of other staff	Respect	My organization encourages people to get answers from across the organization when solving problems Marsick and Watkins (2003)
Teamwork	Staff work well in teams	Cooperation	Teams/groups focus both on the group's task and on how well the group is working Marsick and Watkins (2003)

How well was the organization responding to change?

The purpose score increased by 10.3 per cent between 2009 and 2011. This indicates that employees' perception of their organization's ability to manage knowledge loss has improved because it can measure the impact of the problem, and it embraces the importance of knowledge management as a solution. There was a particularly strong increase in mission and values, which indicated there were shared mental models based on awareness of knowledge management.

How well was the organization learning from experience?

The enablers score increased by 4.9 per cent between 2009 and 2011, which was the lowest increase of the three performance concepts. This indicates that employees' perception of their organization's ability to manage knowledge loss has improved

because it provides knowledge sharing, codified best practice and technology to facilitate the flow of knowledge. This contradicts previous research which argued that knowledge loss caused less innovation (DeLong, 2004), and inefficiencies related to the duplication of services (Jiang *et al.*, 2009). This did not occur at the CSO. Table VII summarizes the results:

The results provided evidence that knowledge caused by ET does not have a negative impact on LOC. It showed that the CSO LOC mean score increased by 8.5 per cent over the time period of the study, and the type of improvements. The results were surprising in the sense they contradicted previous research. We expected to find a negative impact on LOC. However, the scores increased. It reveals that low LOC can be addressed by knowledge management. However, the findings also revealed some deeper residual issues. Some of the factors which led to high ET, such as results focus (purpose), and processes and resources (enablers), remained a problem, showing that some parts of LOC are more difficult to address. The purpose, enablers and people model appear to be a useful theory for examining RQ4.

Risk management

Risk management examines the knowledge necessary to manage the risks associated with an organization's activities and how knowledge loss affects these risks. This paper's conceptualization of risk management identifies the risk event (risk associated with losing knowledge in important activities); the level of exposure (likelihood and consequences of the risk occurring) and the organization's risk response (capacity to fill the gap). This leads to the fifth research question:

RQ5. How does knowledge loss change the organization's perception of risk and capacity to fill the gap necessary to manage risk?

The justification for exploring this question inductively is the limitations of previous research. Researchers have looked at the risk of catastrophic events (DeLong, 2004). For example, DeLong (2004) explains that knowledge loss may be quantified in terms of mistakes, and uses the example of cleanup costs of nuclear waste at a nuclear weapons facility. This is risk exposure. Researchers have also considered the availability of skills necessary to manage risk (Dychtwald *et al.*, 2006). This is risk response. This paper addresses two weaknesses in these previous models: environmental uncertainty and cognitive constraints (Massingham, 2010).

Table VII Learning organization capacity changes 2009-2011 (scale = 1-7)

Construct	2009 Mean	2010 Mean	2011 Mean	% Change 2009-2011
Purpose	3.58	3.75	3.95	10.3
Organizational direction	3.67	3.78	3.96	7.9
Results focus	3.12	3.05	3.14	0.6
Mission and values	3.66	3.98	4.39	19.9
Role clarity	3.88	4.2	4.30	10.8
Enablers	3.69	3.74	3.87	4.9
Resources	3.47	3.27	3.59	3.5
Processes	3.70	3.84	3.81	3.0
Technology	3.90	4.13	4.22	8.2
People	4.04	4.18	4.46	10.4
Motivation and initiative	3.86	4.11	4.38	13.5
Talent	4.36	4.27	4.72	8.3
Teamwork	3.92	4.15	4.28	9.2
Overall mean score	3.77	3.89	4.09	8.5

This paper's contribution to theory development in this area is to use two concepts as criteria for risk management: risk exposure and risk response. This provides objectivity and cognitive clarity by focussing risk assessment on the knowledge necessary to manage the risk event, rather than the activity. Table VIII summarizes the two measurement constructs used and their five factors.

Table VIII Knowledge risk management measurement definitions

<i>Name</i>	<i>Description</i>
<i>Risk exposure</i>	
Risk managers	Subject matter experts who can understand or manage the risks associated with the organization's work
Risk event	The level of risk associated with each of the organization's main activities. This follows a conventional decision tree method, i.e. the likelihood and consequences of an unwanted event occurring, with the addition of a weighting based on the relative importance of each activity
<i>Knowledge risk</i>	
Individual characteristics	Recruitment effectiveness is determined by the organization's ability to attract suitably qualified staff, which is defined as Necessary Qualification Levels (NQL). NQL is measured by the levels of pre-requisite knowledge (i.e. qualifications) necessary to manage the risk factor (i.e. the unwanted event). The higher the qualification levels, the more difficult it will be to recruit, and vice versa. The higher the qualifications, the greater the risk that human capital cannot be bought Training efficiency is determined by the length of time necessary to train staff, which is defined as Time To Learn (TTL). TTL is measured by the time required to develop necessary human capital. The more time required to learn, the greater the risk that human capital cannot be developed
Knowledge characteristics	Tacitness is determined by the location of the knowledge necessary to manage the risk factor, which we define as Receiver Transfer Access (RTA). RTA is measured by the degree to which individuals who need knowledge can access it. If the knowledge necessary to manage the risk is only found in people's heads, i.e. tacit knowledge, then the organization is vulnerable if they are unavailable. Alternatively, if the necessary knowledge is codified and readily accessible, the risk of not knowing what to do if something goes wrong is much lower Complexity is determined by the amount of new knowledge that must be created to manage the risk factor, which we define as Degree of Creativity (DoC). DoC is measured by levels of knowledge. If the knowledge necessary to manage the risk is highly complex, then the organization is vulnerable because if it is lost or otherwise unavailable it must be recreated. Alternatively, if the necessary knowledge required is simple, it is likely to be more easily replaced. Deeper levels of knowledge require more time to learn and, therefore, increase the possibility of inaction, i.e. when no-one knows what to do
Organizational characteristics	Potential capacity is determined by the organization's stock of knowledge, which is defined as Risk Management Capability (RMC). RMC is measured by the proportion of staff with the necessary knowledge to manage the risk factor (i.e. the unwanted event). If only one or a relatively few staff have sufficient knowledge, the organization has low RMC. It is vulnerable if these staff leave the organization or are unavailable for any reason Realized capacity is determined by the organization's willingness to allocate staff resources, which is defined as risk management motivation (RMM). RMM is measured by the degree to which the organization replaces staff required to manage the risk factor. Knowledge is about action and it must be put to some use in order to create value. The organization might have many staff who know what to do to manage the risk factor (i.e. high RMC), but not release them to perform this role or the staff themselves may be unwilling to take on this role
Overall knowledge risk score	Mean of the scores above to derive a combined score from 1 to 25. This is translated into three codes as follows: 1 = 1-7 is Intolerable 2 = 8-19 is unacceptable 3 = 20-25 is acceptable

The empirical results associated with *RQ5* have two parts: employees rating of their organization's risk exposure and risk response.

Did the exposure to risk change?

Knowledge loss had created a situation where more than half of the CSO activities had no risk manager. This meant that no employee had sufficient knowledge to assess the risks associated with the activity. The outcome was the CSO was highly vulnerable because it does not know the likelihood or consequences of a risk event happening and cannot manage it. The number of activities with no risk rating increased from 34 (23.0 per cent) in 2009 to 84 (56.8 per cent) in 2011. [Table IX](#) summarizes the risk exposure findings.

The table shows that for activities with a risk manager, the average number of risk managers decreased only slightly. These activities had more common knowledge in the sense that exiting risk managers were readily replaced. However, the problem was that knowledge loss left so many activities without a risk manager. These activities had uncommon knowledge.

Further evidence that risk exposure worsened is found in the likelihood and consequences mean scores (the CSO measures risk as 1 being the worst possible score so lower scores are undesirable). Knowledge loss had created perception that bad events were more likely to happen with more serious consequences. These results combined to cause a sense that risk management was declining and the CSO was more exposed to risk.

Did the response to risk change?

The overall knowledge score decreased only slightly from 11.83 in 2009 to 11.65 in 2011. This suggests that things got worse but only marginally so. However, digging below the surface reveals important changes to the knowledge risk management constructs. [Table X](#) summarizes the risk exposure findings.

The main problem area was knowledge characteristics. Knowledge characteristics measures the difficulty in sharing knowledge. It assesses two risks associated with knowledge resources: tacitness and complexity. The overall knowledge characteristics

Table IX Impact of knowledge loss on risk exposure

Year	Risk managers	Activity import	Mean likelihood	Mean consequence	Risk score
2009	5.65	1.99	3.13	2.82	13.79
2011	5.45	2.05	2.77	2.51	9.94
Difference 2009-2011 (%)	-3.6	2.8	-11.6	-10.7	-27.9

Table X Impact of knowledge loss on knowledge scores

Year	Individual characteristics			Knowledge characteristics			Organizational characteristics			Overall knowl. score
	Training time	Recruit. (quals)	Individual charact. score	Access (location)	Complex (difficulty)	Knowl. charact. score	Breadth knowl. (Staff)	Conting plan (leave)	Organisat. charact. score	
2009	2.22	3.41	12.74	2.69	2.84	11.56	2.90	2.62	11.18	11.83
2011	2.17	3.50	13.73	2.52	2.60	10.48	2.94	2.40	10.75	11.65
Difference 2009-2011 (%)	-2.5	2.8	7.8	-6.5	-8.2	-9.4	1.4	-8.5	-3.9	-1.5

score worsened by 9.4 per cent from 2009 to 2011. This means that, overall, the knowledge necessary to manage the risk event associated with the CSO activities was more difficult to share in 2011 compared with 2009. It was more difficult to share because the knowledge was considered more complex and less accessible. Complexity worsened by 8.2 per cent. The result meant that in 2011, employees increasingly had to create new knowledge by refining or improving their existing knowledge to manage the risk event, whereas in 2009 they were more likely to gather knowledge from elsewhere and apply it to the local context. In this case, employee turnover had impacted on knowledge loss because surviving or new employees had to be more creative to manage risk events. It suggests that the employees lost by the CSO were more able to re-use knowledge. Accessibility worsened by 6.5 per cent. The result meant that in 2011, employees increasingly had to access social networks to find knowledge necessary to manage the risk event, whereas in 2009, they were more likely to find it in formal discussions/meetings. In this case, employee turnover had impacted on knowledge loss because surviving or new employees had to depend more on social capital to manage risk events. It suggests that employees lost by the CSO were more likely to share knowledge in meetings rather than just their social networks, meaning their knowledge was more widely shared.

The second problem was organizational characteristics. Organizational characteristics measures the organization's learning capability conceptualized as absorptive capacity. It assesses two risks associated with absorptive capacity:

- insufficient potential capacity (proportion of staff with the knowledge); and
- inadequate realized capacity (allocation of staff to manage the risk).

These two risks are described as breadth of knowledge and contingency planning. The overall organizational characteristics score worsened by 3.9 per cent from 2009 to 2011. The CSO capacity to learn the knowledge necessary to manage the risk event associated with the CSO activities was less in 2011 compared with 2009. The capacity to learn was less because contingency planning was weaker; it worsened by 8.5 per cent. The result meant that in 2011, it was more likely that the lost employee would be replaced but the work would be done poorly; compared with in 2009 when it was more likely that the lost employee would be replaced but the work would be done satisfactorily.

Overall, knowledge loss did not have a negative impact on the third concept, individual characteristics. The overall mean score increased by 7.8 per cent between 2009 and 2011. This indicates that the time it would take to recruit or train a replacement employee was less in 2011 compared with 2009. This contradicts previous research which found that knowledge loss caused decreases in the availability of skills to fill today's jobs and future job requirements (Dychtwald *et al.*, 2006). This did not happen at the CSO.

Organizational problems

Organizational problems measures how well the organization is managing knowledge loss. This paper's conceptualization of organizational problems focuses on seven practical outcomes of knowledge management (Massingham and Massingham, 2014). This leads to the sixth research question:

RQ6. How are organizational problems affected by knowledge loss?

The justification for exploring this question inductively is the limitations of previous research. Researchers have conceptualized knowledge loss in terms of the process of knowledge development (Martins and Meyer, 2012). It decreases capability in areas requiring knowledge resources such as innovation, creativity and problem solving. However, knowledge loss is not limited to these areas, and many organizations now use knowledge management to address problems in capability. This paper takes into account the

organizational context surrounding the phenomena under investigation – employee turnover and knowledge loss – and recognizes they do not occur in isolation.

This paper's contribution to theory development in this area is to examine the impact of knowledge loss on seven common organizational problems (Massingham and Massingham, 2014). It places the study within the organizational reality of having knowledge management to address knowledge loss. Organizations faced with knowledge loss are likely to either have in place existing knowledge management programmes or will introduce them to try to address the problem. The theoretical development is to test the effectiveness of knowledge management within the context of knowledge loss by looking at whether these seven organizational problems continue to exist or have worsened. Table XI summarizes the seven measurement constructs.

The empirical results associated with *RQ6* have seven parts, which look at the impact in each of the organizational problems. Table XII summarizes the results.

New employees

The first organizational problem, new employees, had a negative impact in terms of lowered productivity, while new employees spent time learning on the job to achieve the competency levels of those employees they had replaced. Knowledge loss caused by employee turnover meant these new employees took longer to learn, i.e. they moved up the learning curve. This meant they took an average of nine months to reach competence in 2011, compared with six months in 2009, because the knowledge loss at the CSO slowed their learning. This period of inactivity increased the cost of staff training by \$1.25m in a 100-employee organization.

Younger employees

The second organizational problem, younger employees, had a negative impact in terms of work performance where younger employees produced lower quality work. Knowledge loss caused by employee turnover meant these younger employees were asked to do less important work, i.e. they moved up the experience curve. Experienced employees produce more work than inexperienced employees, and they are also trusted by management to do more complex work. In terms of work quality, the impact at the CSO of losing experienced employees meant that 100 critical tasks per week, almost 4,500 per year, were no longer done due to lost experience. In terms of work quantity, 238 less engineering decisions per week or 12,376 per year were no longer done. Various scenarios to replace this lost experience to complete these unfinished tasks were presented in Table XII. The net effect of recruiting inexperienced employees to do this work and time taken for them to gain experience necessary to complete all tasks, including the critical tasks, was estimated at \$9.1m for a 100-employee organization.

Competency gaps

The third organizational problem, competency gaps, had a negative impact in terms of work performance where incompetent employees did not match job expectations. Knowledge loss caused by employee turnover meant these incompetent employees did not create value expected, i.e. return-on-investment for their salary. Various scenarios to replace this lost experience to complete these unfinished tasks were presented in Table XII. The net effect of strategic misalignment of the CSO workforce caused by knowledge loss was \$10.1m for a 100-employee organization.

Table XI Organizational problems measurement constructs

Method	Lead indicator (examples)	Lag indicator (examples)
<i>Learning curve:</i> it accelerates time to competence	<i>Improved learning:</i> specifically, no. of staff profiles on expert register, No. of staff on expert teams, No. of staff of multiple Expert Teams, frequency of meetings, team decision-making	<i>Net cash flow.</i> Specifically, improved innovation: rate of continuous improvement (e.g. problem solving); increased ROI from staff training (e.g. decreased staff training budget; evidence of training outcomes)
<i>Experience curve:</i> increases sharing of experience	<i>Sharing experience.</i> Specifically, no. of After Action Reviews, No. of staff involved in After Action Reviews, No. of Lessons Learned, Increased sense of work impact, Increased sharing of knowledge via structural capital (e.g. Reports)	<i>Period between the system's acquisition and value delivery.</i> Specifically, increased corporate governance: e.g. knowledge diffused; increased productivity: e.g. cumulative work output
<i>Strategic alignment:</i> decreases capability gap	<i>Reduced competency gap.</i> Specifically, no. of jobs with strategic alignment, no. of staff whose career management plan fits with future capability requirement, no. of staff whose knowledge is considered up-to-date, no. of staff who have demonstrated learning to fix currency gaps	<i>Net cash flow:</i> generated by productivity gains; more specifically, increased corporate governance: e.g. future capabilities requirement understood and gap addressed; stock of knowledge resources is in surplus and growing
<i>Connectivity:</i> increases search cycle efficiency	<i>Increase in the movement of knowledge between entities.</i> Specifically: no. of internal waste points unblocked, No. of contributors to problem solving tasks, No. of staff learning from unblocked waste points, No. of structural sources being used/accessed	<i>Financial return via innovation measures</i> e.g. new product sales (revenue increase) or process improvement (cost reduction). More specifically, increased productivity: e.g. time to find necessary knowledge decreased; increased innovation: e.g. no. of staff involved in problem solving
<i>Risk management:</i> increases confidence in work outputs	<i>Increased customer satisfaction.</i> Specifically, No. of knowledge resources captured, No. of knowledge resources, with meta-data fields, No. of staff contributing why context	<i>Superior performance measured by work output measures.</i> Specifically, improved enablers: e.g. better work tools, improved work quality systems
<i>Value management:</i> improves stakeholder perception of the value of the organization	<i>Increased customer satisfaction.</i> Specifically, changes in socialization attitudes and behaviours; network structure and network quality indicators	<i>Superior performance measured by work output measures.</i> Specifically, improved customer relationships
<i>Psychological contract:</i> improves staff morale and productivity	<i>Reduced employee turnover costs.</i> Specifically, no. of staff with career development plans, no. of staff with succession planning, no. of staff with phased retirement plans, no. of jobs with reinvented recruitment plans	<i>Cost savings:</i> reduced salary costs generated by decreased employee recruitment and retention costs; increased staff motivation, productivity, empowerment

Source: Adapted from [Massingham and Massingham \(2014\)](#)

Slow task completion

The fourth organizational problem, slow task completion, had a negative impact in terms of work performance where employees without access to social capital wasted time learning by doing. Knowledge loss caused by employee turnover meant these disconnected employees did not know where to ask for help and therefore spent unproductive time searching for codified knowledge or trying to develop their own tacit knowledge. The net

Table XII Knowledge loss impact on organizational problems

<i>Problem</i>	<i>Case evidence</i>	<i>Impact</i>	<i>Non-financial measures</i>	<i>Financial Measures</i>
High proportion of new employees	61 new staff started during the period 2009 to 2011, which represented 83% of the total employees in the 2011 survey	Decreased learning causes: Lost productivity Sunk coordination costs (supervision) Mistakes Poor quality work	New staff were learning on the job and produced limited work output until they reached competence This period of learning and inactivity was an investment by the organization to develop competent staff	At an average salary of \$100,000, a 6-month time to competence (2009) represented an investment of \$50,000 by the organization. A 9-month time to competence (2011) represented an investment of \$75,000. For a 100-staff organization with 50% employee turnover over two years (e.g. the CSO), the sunk investment cost had increased by \$1.25m (50 × \$25,000, i.e. difference between 50 and 75% @\$100,000 p.a. average salary)
High proportion of younger employees	Younger employees were recruited to replace older employees who had retired or resigned	Decreased experience sharing causes: Less productivity Less work Lower quality work Higher cost per work output	In 2011, the organization spent most time, on average, working on Level 3 activities (on a scale of 1-5). Little time was spent on Level 5, i.e. critical activities, meaning that this work was not done or the few remaining staff capable of doing this work were overloaded and there was slow task completion Work quality: 87 critical tasks were not completed each week or almost 4,500 less per year Work quantity: 238 less engineering decisions per week or 12,376 per year In 2009, the overall competency deficit was 20% In 2011 it was 34%. The organization's capacity to meet its current operational requirements had declined by 14% in three years	Scenario 1: recruit replacement experienced staff. The cost to perform these 12,376 work tasks by experienced staff would be \$4.95m. Scenario 2: recruit inexperienced staff. The cost to perform these tasks by inexperienced staff (e.g. if new staff were recruited and asked to learn on the job) would be \$9.07m The financial impact of moving down the experience curve could cost the CSO \$4.12m per annum
High proportion of employees with capability gaps	Employee turnover meant that high proportions of new employees did not have the competency required by their job	Competency gaps cause: Longer learning time Coordination costs Inefficient work flow Customer dissatisfaction		Scenario 1: was 100% value adding or where every employee is strategically aligned with their job or is fully competent = \$41,910,000 of value. Scenario 2: was 80% value adding or where, overall, employees were 20% less capable than their job required. This was the scenario in 2009 at the start of the project = \$37,299,000 of value Scenario 3: was 65% value adding or where, overall, employees were 35% less capable than their job required. This was the scenario in 2011 at the end of the project = \$27,241,000 of value

(continued)

Table XII

<i>Problem</i>	<i>Case evidence</i>	<i>Impact</i>	<i>Non-financial measures</i>	<i>Financial Measures</i>
Slow task completion	<p>Staff took too long trying to figure out how to do something new, or trying to locate someone who could help them. The lack of trust in relationships meant that there were many blockages in the knowledge flows at the CSO, particularly between different sections</p> <p>In 2011, 67% of employees had disrupted social capital and weak connectivity. This was measured by decreases in their social capital scores</p>	<p>High proportions of staff, isolated from social networks cause: less work Lower quality work Higher cost per work output</p>	<p>Increased search cycle time was calculated as follows. Connected employees (social capital) produce 10 engineering decisions per week or 2 a day, which equates to 3.5 h per decision Disconnected employees (isolated) produce three engineering decisions per week or 0.6 a day, which equates to 11.7 h per decision</p>	<p>Disconnected employees spend 1,206 h of search cycle time per week, or 62,712 h per annum. This cost the CSO a total of \$3,888,144. Connected employees cost \$978,120 in search cycle time. The total search cycle cost was \$4,866,264 If all employees were connected, the cost would be \$2,934,360. Therefore, in 2011 the impact of having 67% disconnected employees was \$1,931,904 in search cycle time</p>

(continued)

Table XII

<i>Problem</i>	<i>Case evidence</i>	<i>Impact</i>	<i>Non-financial measures</i>	<i>Financial Measures</i>
Work output not used (i.e. waste)	<p>Employee turnover meant that risk management declined.</p> <p>Decrease in no. of risk managers, i.e. staff who had knowledge necessary to manage risk events (know what to do when things went wrong)</p> <p>The CSO could not explain the quality of its work outputs to its customers, i.e. the users of its advice.</p> <p>The result was that customer demand decreased due to lost confidence in work outputs</p> <p>Staff morale then declined due to customer dissatisfaction with their work and negotiation costs associated with customer disagreements with work</p>	<p>Decreasing numbers of risk managers cause: Vulnerability in key areas</p> <p>Mistakes</p> <p>Poor quality work</p> <p>Customer dissatisfaction</p>	<p>Increased agency costs were the economic cost of monitoring and managing inter-personal conflict resulting from different goals and understanding about a risk.</p> <p>Agency costs were calculated as follows:</p> <p>Activities with accepted risk factors, e.g. with trusted risk managers, created little negotiation time, i.e. 0.5 h per engineering decision. Activities with disputed risk factors, e.g. no trustworthy risk managers, created significant negotiation time, i.e. 6.0 h per engineering decision</p>	<p>The agency cost for trusted activities was \$592,800: 20% accepted risk factors mean 200 decisions at 0.5 or 100 h per week. 5,200 h per annum, \$592,800 (experienced staff rate). The agency cost for untrusted activities was \$16,068,000: 80% disputed risk factors mean 800 decisions at 6.0 or 4,800 h per week, 249,600 per annum, \$15,475,200 (inexperienced staff rate)</p>

(continued)

Table XII

<i>Problem</i>	<i>Case evidence</i>	<i>Impact</i>	<i>Non-financial measures</i>	<i>Financial Measures</i>
Resource cuts	<p>Employee turnover meant that stakeholder perception of organizational performance declined. The result was that resources decreased due to dissatisfaction with the organization's value. This was measured by the decline in workforce budget</p> <p>In 2009, the CSO had a workforce of 150 employees; in 2011 this was 115</p> <p>The inability of senior government executives and customers to appreciate the value of the organization was a significant barrier to accessing the full funding sought</p>	<p>Decreasing satisfaction with organization performance</p> <p>Decline in workforce budget</p> <p>Decline in staff numbers</p> <p>Reduced staff training</p>	<p>Decreased organization performance was calculated as follows: Discretionary services decreased (i.e. non-core). This meant that employees had to tell customers they were too busy to do work not considered a priority</p> <p>Continuous improvement declined (focus on outputs). This meant that staff were too busy to reflect on work practice and innovate. Organizational learning stagnated</p> <p>Customer dissatisfaction (improvements not socialized). This meant that staff were too busy to build relationships with customers</p>	<p>The difference between a scenario where the case study organization was performing well (e.g. 100% connectivity) and was rewarded with 20% new employees, compared with the 2011 scenario with poor performance and was penalized with 20% less employees; was a total of 729 less engineering decisions per week or 37,908 less decisions per year</p> <p>Scenario 1: recruit replacement experienced staff. The cost to perform these 37,908 12,376 work tasks by experienced staff would be \$15.16m.</p> <p>Scenario 2: recruit inexperienced staff. The cost to perform these tasks by inexperienced staff (e.g. if new staff were recruited and asked to learn on the job) would be \$27.78m</p> <p>The net effect to address the decline in organizational performance caused by resource cuts could cost the CSO \$12.62m per annum</p>

(continued)

Table XII

<i>Problem</i>	<i>Case evidence</i>	<i>Impact</i>	<i>Non-financial measures</i>	<i>Financial Measures</i>
Low productivity	<p>Employee turnover meant that employees' emotional relationship with their organization declined.</p> <p>In 2011 morale decrease led to employee turnover of 50%, and in the case of a 100-employee organization, this involved losing 25 experienced employees and 25 inexperienced employees</p> <p>A measurement of employee passion had increased from 3.1% in 2009 to 17.0% in 2011, however, organizational commitment was still considered very low</p>	<p>Decreased psychological contract cause: Low productivity which was measured by less work output (engineering decisions)</p> <p>High employee turnover which was measured by recruitment and training costs</p> <p>Low quality work which was measured by proportion of 1, 2 and 3 rated activities compared with 4 and 5 rated activities (less value added)</p>	<p>Direct impact was reduced motivation and employee exit. Indirect impact was lack of cooperation, slow task completion, and unresponsiveness.</p> <p>Low psychological contract was characterized by 'too busy syndrome', i.e. employees complained they did not have enough time to complete the work requested</p>	<p>Value decreased by \$6.8m based on losing 25 experienced staff @ \$200,000 pa \times 3 for value adding equalling \$15m (withdrawal), and gaining 25 inexperienced staff @ \$110,000 pa \times 3 for value adding equalling \$8.3m (deposit)</p> <p>The recruitment and training costs were calculated @ \$10,000 \times 50 for recruitment equals \$500,000; training costs were time to competence: \$75,000 \times 25 new inexperienced staff equals \$1.9m</p> <p>There were no productivity gains to offset these recruitment and training costs of \$2.4m. There were no productivity gains to offset these losses. Therefore, net effect was costs of \$9.1m</p>

effect of disrupted social networks caused by knowledge loss was \$1.9m for a 100-employee organization.

Work outputs not used (i.e. waste)

The fifth organizational problem, work outputs not used, had a negative impact in terms of employee morale where activities without trusted risk managers created high agency costs. Knowledge loss caused by employee turnover meant customers were dissatisfied with the work being produced by the CSO and employees had to spend demoralizing time trying to persuade customers to follow their advice. The net effect of the agency costs (i.e. wasted negotiation time) caused by knowledge loss was \$15.5m for a 100-employee organization.

Resource cuts

The sixth organizational problem, resource cuts, had a negative impact in terms of employee morale where activities without trusted risk managers created high agency costs. Knowledge loss caused by employee turnover meant customers were dissatisfied with the work being produced by the CSO and employees had to spend demoralizing time trying to persuade customers to follow their advice. The net effect to recruit to address the decline in organizational performance caused by knowledge loss was \$12.6m for a 100-employee organization.

Low productivity

The seventh organizational problem, low productivity, had a negative impact in terms of employee value creation including being inefficient and ineffective. Knowledge loss caused by employee turnover meant employees suffered from less organizational commitment and job satisfaction. The net effect in terms of lost value caused by knowledge loss and recruitment and training costs was \$9.2m for a 100-employee organization.

Discussion

The paper set out to develop theory to measure the impact of knowledge loss caused by employee turnover. The five theoretical concepts proved useful. The main results are discussed.

Employee turnover

This paper challenged the view of the quasi-equilibrium model by proposing that new employees do not automatically replace exiting employees with the same knowledge resources even if recruited into the same jobs. The four employee turnover factors – withdrawals, decay, deposits and growth – provided answers to *RQ1*. The paper's contribution to theory development in this area is to explain the fluidity of knowledge resources and the dynamic impact of employee turnover on knowledge loss.

Knowledge resources

This paper challenged previous research's limited focus on human capital by proposing that lost knowledge includes not only technical knowledge but also cognitive dimensions such as the individual's emotional relationship with the organization and their relationships at work. The results identified what knowledge was lost in specific detail. They also showed that knowledge loss caused by employee turnover had positive and negative impact on survivors' scores. However, the impact tended to even out and, overall, survivors remained stable. New employees did bring new knowledge to replace exiting employees, but it still

resulted in a knowledge deficit. The answer to *RQ2* is that a knowledge deficit exists after the addition of new employees, and this is likely to continue.

The paper's contribution to theory development in this area is to measure the type of individual tacit knowledge lost by employee exit and whether this is able to be replaced by new employees and/or growth in surviving employees.

Psychological contract

This paper challenged previous research's failure to consider the reciprocal nature of psychological contract by including the motivational processes of social exchange theory and reciprocity. The results identified showed how knowledge loss affected survivors and new employees in terms of their emotional relationship with the CSO. The theory developed enabled testing of previous research claims that knowledge loss had a negative effect on: employee morale, such as anxiety and stress and heavier employee workloads, and on work attitudes and behaviours, such as disrupted social networks.

There were two main groups of findings. Overall, knowledge loss did not have a negative impact on psychological contract. However, this may be explained by the introduction of a parallel knowledge management programme at the time of the survey. For example, the highest increased constructs – work-life balance and cross unit cooperation – were a direct result of actions taken by management to address problems with psychological contract at the start of the study. There was improved perception that the organization was willing to give to keep employees happy and receive productive work outcomes (i.e. social exchange theory). The other main finding was that some constructs, e.g. reward and recognition, did not improve. This suggests underlying issues which led to the problem of employee turnover remained despite the introduction of knowledge management. The answer to *RQ3* is that potentially negative impacts of knowledge loss may be managed by appropriate action that address the cause of employee turnover.

The paper's contribution to theory development in this area is to measure changes in employees' emotional relationship with their organization from a social exchange theory perspective.

Learning organization capacity

This paper challenged previous research's lacking of adequate scale items by proposing three concepts as criteria for learning organization (LOC): purpose, enablers and people. The results identified showed how knowledge loss affected survivors and new employees in terms of their perception of how well their organization was managing knowledge loss. The theory developed enabled testing of previous research claims that knowledge loss had a negative effect on strategy, such as lack of awareness of knowledge management and its solutions; capability, such as decreased productivity and increased mistakes; and on change, such as less innovation and inefficiencies related to the duplication of services.

Overall, knowledge loss did not have a negative impact on LOC. Employees' perception improved because their organization provided knowledge sharing, codified best practice and technology to facilitate the flow of knowledge. The answer to *RQ4* is that the ability to respond to change (purpose), learn from experience (enablers) and grow resources (people) may all be improved, despite knowledge loss if appropriate knowledge management is introduced. The paper's contribution to theory development in this area is to measure changes in LOC performance to assess management of knowledge loss.

Risk management

This paper addressed weaknesses in previous models by using risk exposure and risk response to provide objectivity and cognitive clarity in risk assessment. The results identified that knowledge loss caused significant risk problems. More than half of the CSO activities no longer had a risk manager. This meant there was no-one left (including new employees) who felt they could understand or manage the risks associated with the CSO's work. The results showed that the likelihood and consequences of a risk event occurring increased; it became more difficult to share knowledge; the knowledge was considered more complex and less accessible, and the time it would take to recruit or train a replacement employee increased. The answer to *RQ5* is that knowledge loss has a significant negative impact on the capacity to manage risk. The paper's contribution to theory development in this area is to provide a more objective and complete assessment of the risks associated with knowledge loss.

Organizational problems

This paper provides a system-thinking approach by including organizational context to measure the impact of knowledge loss on seven common organizational problems. The results showed that despite efforts to manage knowledge loss, the CSO suffered an increase in the problems which had already been established at the start of the study in 2009. In financial terms, the cost to address the problems caused by knowledge loss was estimated at \$60m for a 100-employee organization with an annual salary budget of \$20m. In non-financial terms, impact of knowledge included decreases in productivity, work performance, employee morale, efficiency and effectiveness. The answer to *RQ6* is that the situation was worse for the CSO in 2011 compared to 2009, in each of the seven practical outcomes, despite the introduction of a successful knowledge management programme. The situation may have been much worse if the programme had not been introduced. The paper's contribution to theory development in this area is to identify the impact of knowledge loss in practical terms via seven common organizational problems.

Conclusion

The paper has contributed to our understanding of the impact of knowledge loss in several ways. First, it has used five measurement concepts to measure knowledge loss: knowledge resources, psychological contract, LOC, risk management and organizational problems. They combine to provide a new meta-theory on knowledge loss which enables the impact to be measured in financial and non-financial terms. It extends previous research which had discussed the topic in broad terms such as decreased productivity, morale and performance, translating these into specific measurable constructs which may be used to properly appreciate the potentially destructive nature of knowledge loss.

Second, the findings present an interesting range of impacts. The results found that knowledge loss has most negative impact in terms of organizational problems including: low productivity (morale), strategic misalignment of the workforce (capability gaps), resource cuts (stakeholders unhappy with performance), decreased work quantity and quality (inexperienced employees), work outputs not being used (customers mistrust), longer time to competence (learning cost) and slow task completion (increased search cycle time). The second most significant impact was increased sense of risk associated with work activities and declining capacity to manage the risk. The third main impact was decreased knowledge resources. Knowledge loss creates knowledge deficit which is unlikely to be filled over time. The two remaining measurement constructs – psychological contract and learning organizational capacity – improved, which suggests that the negative impact of knowledge loss may be addressed with appropriate knowledge management. The outcome is a meta-theory of knowledge loss from a critical realism paradigm.

The paper has weaknesses which provide exciting opportunities for further research. First, the research is based on a single case study in a public sector organization. While the longitudinal nature of the study and the rich data collected offsets this issue, it also presents good opportunities for researchers and practitioners to test the ideas presented in this paper in other industry contexts, e.g. as argued by a critical realism perspective. Second, the model of knowledge loss presented in the five constructs is complex and includes a range of theoretical concepts and scales. Further research might further test the validity of these scale items and how the constructs interact, e.g. partial least squares or similar method.

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Further reading

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About the author

Dr Peter Rex Massingham is from the University of Wollongong's School of Management, Operations and Marketing within the Faculty of Business. Before joining the University in 1998, he was a management consultant, most recently with KPMG. He works with a range of Australian organisations on their business strategy, particularly focusing on knowledge management. Most recently, he has completed major research projects with the Australian Department of Defence on knowledge loss (2008-2013) and Saudi Arabia Government on their research institutes (2008-2012). He is currently working on a project about sharing retirees' knowledge. Peter Rex Massingham can be contacted at: peterm@uow.edu.au

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