THE METHODOLOGICAL FRAMEWORK FOR A RESEARCH STUDY ON THE ROLE OF KNOWLEDGE IN MANAGING CONSTRUCTION PROJECT CHANGE

S. Senaratne and M. G. Sexton
The Research Institute for the Built and Human Environment,
University of Salford, Salford, M7 1NU
E-mail: s.senaratne@pgr.salford.ac.uk

ABSTRACT: Setting a sound and structured methodological framework to guide a research process from its start to the end, enhances the rigour and the validity of that particular research. In general, the literature on research methodology guides researchers with various approaches to research design. However, it is imperative to develop a distinctive methodological framework that is most appropriate for a given study, based on the nature and context of the study. The aim of this paper is to develop such a distinctive methodological framework to guide a doctoral research study on the role of knowledge in managing construction project change. This methodological framework is presented at the former sections of the paper, which is progressively justified in the subsequent sections. The research process is identified broadly in five stages following the formal sequence namely, the literature review; problem definition & theoretical propositions; methodology design; data collection; and data analysis. However the overall framework that is presented in the paper captures the iterative nature of the total research process and the flexible boundaries of these formal stages.

Keywords – literature review; problem statement & theoretical propositions; methodology design; data collection, data analysis

1 INTRODUCTION

The aim of this paper is to develop and justify the methodology of a research study on ‘The role of knowledge in managing construction project change’. The paper begins with presenting the methodological framework (refer Figure 1) that depicts the complete research process for this study. It captures the iterative nature of the total research process by showing overlaps between different stages. The research process is identified broadly in five stages within its flexible boundaries. The five stages are namely, the literature review; problem definition & theoretical propositions; methodology design; data collection; and data analysis. Despite the iterative nature, a formal sequence of the research process can be identified as shown in the framework. The subsequent sections of the paper follow this formal sequence and progressively present the development of the framework starting from the literature review and leading to data analysis stages.
2 LITERATURE REVIEW

The development of the framework begins with the literature review stage. The literature review consists of the background study, research problem identification and the detailed literature review stages (refer Figure 2). However the paper excludes the detailed literature synthesis as the focus is on the methodology development (refer Senaratne & Sexton, 2003 for the detailed literature synthesis).
2.1 The Background Study

The construction industry suffers from poor performance and dissatisfied parties, as addressed by Latham (1994). Construction projects often undergo project delays, cost overruns and non-conformance to quality, leading to above problems in the industry. Thus, understanding the driving forces behind these problems is a necessity in improving the industry performance.

Change is a major contributor to above raised problems in construction. The unexpected changes, which occur throughout the design and construction phase, hinder project success to a significant extent (CII-Construction Industry Institute 1994; Lazarus & Clifton 2001). Changes lead to time overruns, cost overruns and quality deviations. The major cost due to change is by the cost of rework and this can amount to 10-15% of contract value (Love & Li 2000). Indirect effects of change are also considerable. Examples of indirect effects are loss of productivity, interruption to workflows and cash flows and may also lead to lower moral, claims and disputes between the parties. These disruptive direct and indirect consequences of project changes demand effective ways of managing them.

2.2 Research Problem Identification

Hence the background study identifies that managing change is a necessity to minimise the disruptive effects of change in construction projects. This is the research problem that will be addressed in this research study. With this identification of the research problem the literature survey extends to the relevant previous studies in search of conceptual issues and gaps. The findings from the extended literature review are summarised next. Refer Senaratne & Sexton (2003) for a complete literature synthesis.

2.3 Summary of the Detailed Literature Review

As stated above, to overcome problems faced within construction projects effective change management needs to be employed. Effective change management allows change to take place in a controlled way so that viable alternatives are identified, developed and the impact is defined before implementation. CII (1994) identifies that a key problem in managing change is due to the ineffectiveness in learning from past lessons. Further studies on learning in construction too identify this problem of ineffective learning from past experience (for example see Barlow & Jashapara, 1998). In order to learn effectively from past lessons, it is important to understand how the knowledge flows among the team members, during and after change events.

The previous approaches to construction project change management (for example see CII,1994; Lazarus & Clifton, 2001 and Kagioglou et al, 2000) attempts to approach the problem from an information-processing perspective, originating from the work of Simon’s (1957) and leading to Galbraith’s (1974). Recently, the theory of the firm significantly changed with the recognition of knowledge as the key asset in delivering organisation’s
competitive advantage. This resource-based view of the firm (Grant 1996; Spender 1996) opens new avenues to approach effective project change management in construction. That is by understanding the role of knowledge during and after change process.

Construction project management literature shows a slow trend towards this knowledge-based approach. For example Winch (2002) explains the problem in construction projects, due to lack of managing knowledge that is created throughout the construction process. Especially knowledge and learning are generated in solving problems that involve team discussions and dialogues during the construction process. But this is mostly limited to individuals involved and is not widely diffused in the organisation (Winch 2002; Barlow & Jashapara 1998). However the existing construction project management literature is limited in providing a full understanding on the role of knowledge during change management situations in construction projects. To this end, knowledge management literature aids in understanding the fuller role of knowledge during problem situations that is facilitated by team interactions.

In problem situations, various forms of knowledge are brought into the situation and it is captured, created and shared by the team members (Leonard & Sensiper, 1998). As such, this study looks into the knowledge management literature in an attempt to understand the role of knowledge during managing change events in construction. The literature review with respect to knowledge management includes areas such as the nature of knowledge at a team level (Leonard & Sensiper 1998); knowledge conversion and learning during team interaction (Nonaka & Takeuchi, 1995); inter-project learning and knowledge re-use (Gann and Salter, 2000). This detailed literature review on knowledge management, leads to identify the role of knowledge during problem situations in terms of knowledge capture, conversion and re-use.

Further, literature survey expands to contextual factors in the construction project settings. The contextual factors are classified as process specific, group, organisational and wider environmental characteristics. Refer Senaratne & Sexton, (2003) for a complete literature synthesis.

In summary, the literature review of this study identifies the problem of construction projects with disruptive effects due to unplanned changes. Even though managing these changes has become a necessity to minimise these disruptive effects, the gap with regard to previous approaches were identified. That is previous approaches had reached the problem from an information processing view and had ignored the significant role of knowledge in managing change. This leads to explore the role of knowledge during team interaction as explained in the knowledge management literature. Consequently, the complete literature review directs to define the research problem statement fully in terms of the aim & objectives of the study and the research questions (refer Figure 3).

3 THE RESEARCH PROBLEM STATEMENT
3.1 Aim and Objectives of the Study

As emerged from the literature review, the aim of this study is to explore the role of knowledge capture, conversion and re-use in managing change in construction projects.
Given that the management of construction project change significantly differs at the construction phase from the design phase (CII, 1994), this study controls the phase variable by focusing on the reactive changes during the construction phase of the projects. Though unplanned changes at a later stage of a project are costly there are common in construction projects. Therefore when late changes are unavoidable, the remedy is to manage them reactively, to minimise their disruptive effects.

The broad aim stated above will be achieved by four objectives. First; the causes, effect and nature of unplanned changes during the construction phase of projects will be identified. Second; the contextual factors in managing these changes will be explored. Third; how knowledge is captured and converted during the change situations will be studied. Finally; the study will explore what knowledge is created during the change process and how this knowledge is stored for future re-use.

3.2 Research Questions of the Study

Based on these aim and objectives the key research questions established for this research are as follow:

1. How does the project team capture different forms of knowledge in managing reactive changes in the construction phase of projects?
2. During this change process to what extent does knowledge conversion take place?
3. What knowledge is created during this change process?
4. How is the knowledge gained from this change process stored for re-use?

The next step of the methodology is to develop hypotheses based on the identified research questions and to represent the whole problem statement through a conceptual model (refer Figure 4). This theoretical understanding in terms of the hypotheses and the conceptual model provides direction for the empirical data collection.

4 THEORETICAL PROPOSITIONS

4.1 Hypotheses Development

Based on the theoretical understanding gained from the literature review the hypotheses and conceptual models are developed for this research as explained in this section.

The hypotheses of this study are,

H1 - The project team uses both tacit and explicit knowledge in managing change. But the tacit knowledge is not well-captured and used compared to explicit knowledge.

H2 - In managing change team interacts with each other. During this process knowledge conversion modes take place. But knowledge barriers will limit the full cycle of knowledge conversion and learning.

H3 - New knowledge such as sympathised, conceptual, systematic or operational knowledge can be created during the knowledge conversion modes in change events.
H4 - The knowledge that is gained during change events is not identified and properly stored for re-use in and across the organisations. These hypotheses are shown in the conceptual model, which is described next.

4.2 The Conceptual Model

The conceptual model (refer Figure 5) depicts the role of knowledge capture, conversion and use, during reactive change process in construction phase of projects, based on the theoretical understanding gained through the literature review.

The core of the model represents change process as an input-output model. Knowledge conversion where the tacit and explicit knowledge is captured, shared and converted to new knowledge, is taking place during the transformation stage of this change process (This correspondence to hypotheses H2 & H3). The knowledge created during the process can be captured and re-used in future projects. In order for this to happen, this knowledge should transfer from project team members to the multiple-organisations. Therefore this project-to-project knowledge transfer is represented by arrows that link project to organisation layer through the project team layer ((This correspondence to hypotheses H1 & H4).

The context of this problem statement is shown in four layers as derived from the literature findings. The characteristics corresponding to each layer is shown along that respective layer. The change process in the inner layer is influenced by the process characteristics. The second layer represents the construction project team, which is influenced by group characteristics. The third layer represents multiple organisations, which is influenced by organisational characteristics. The outer layer shows the construction environment, which is, affected by the wider environmental characteristics. These contextual factors in terms of the four characteristics are depicted in the model by a triangle to represent the direction of the impact.
This prior development of theoretical propositions in terms of hypotheses and the conceptual model will be tested through an empirical research, using pattern-matching technique, which will be explained, in the data analysis section. Having defined the problem statement and the theoretical standing of this study, the next step is to choose a research methodology for the empirical data collection (refer Figure 6).

**Figure 5: Conceptual Model**

**Figure 6: 'Nested' Research Methodology**

(Kagioglou et al, 1998)

### 5 RESEARCH METHODOLOGY

The research methodology is selected based on the ‘nested’ methodology (Kagioglou et al, 1998), which starts from identifying the research philosophy that is shaped by the assumptions about the ontological, epistemological and axiological foundations. Once the research philosophy has been identified the next stage is to explore research approaches for theory testing and building. This section will explain the research philosophy and the research approach following this ‘nested’ methodology. The research techniques for data collection and analysis are discussed in latter sections of the paper (Refer Section 7 and Section 8).
5.1 Research Philosophy

A research philosophy refers to the assumptions that guide an inquiry in a research study. It is shaped by ontological, epistemological and axiological foundations that need to be explicitly stated (Sexton, 2003). The ontology describes what knowledge is and assumptions about the reality. Epistemology describes how we know it and assumptions about how knowledge should be acquired and accepted. Axiology explains what value goes into it and assumptions about the value judgements.

Key research philosophies can be placed in a continuum, of which the two extreme ends are the positivist paradigm and the interpretive paradigm (Easterby-Smith et al, 1991). The positivism is based, first on ontological assumption that reality is external and objective and second, on epistemological assumption that knowledge is only significant if it is based on observations of this external reality and third, on axiological assumption that research is value-free and unbiased. On the other hand, the interpretive paradigm is based, first on ontological assumption that reality is socially constructed and determined by people, second on epistemological assumption that knowledge can be obtained by being part of what is observed, and third on axiological assumption that research is value laden and biased.

This research study as set out by the aim and objectives, deals with human behaviour in real-life settings, which is context specific. It is focused on a small sample that is reactive changes in the construction phase and not on the broad population. The study requires an in-depth investigation on this small sample in an uncontrolled environment. Taking these facts into account, the study is driven towards the phenomenological paradigm that prefers qualitative approaches.

5.2 Research Approaches

Among the research approaches used in the qualitative approach, for a study that considers context as an essential part of the phenomenon, the methods such as case study research, ethnography and action research are more applicable (Gummesson, 2000). In action research, the investigator solves the problem with the organisation while actively participating in the problem environment. The ethnographic approach seeks to gain a close-up detailed description of the real world by studying a small group of subjects in their own environment. Ethnography approach prefers participant observation as the data collection method and calls for long periods of fieldwork study conducted in a reasonably unstructured manner (Van Maanen, 1982). The case study research is different to pure ethnography and action research, in that it provides an in-depth investigation by studying ‘cases’ in an uncontrollable environment. The method favours multiple data collection techniques and allows both qualitative and quantitative data collection and analysis techniques (Yin, 1994).

The ‘level of inquiry’, the ‘type of research question’ and the ‘reasoning approach’ are considered in choosing the appropriate research approach for this study. The study attempts to explore “role of knowledge in managing reactive change” in a team setting and therefore the inquiry will be conducted at a sociological level. It is not intended to explore the psychology of the stakeholders. As such, the researcher can carry out the study without being an active participant observer or an action researcher within the problem environment. The research questions generate “how” and “why” questions about a contemporary set of events. Even though a qualitative approach is considered, by prior development of a conceptual model and hypotheses to guide data collection, this study leads to deductive processes. According to the theoretical definition of Yin (1994, p13) on case study method, “A case study is an empirical inquiry that investigates a contemporary phenomenon with its real-life context, especially when the boundaries between phenomenon and context are not clearly
evident. The case study inquiry copes with a technically distinctive situation in which there will be many variables than data points and as a result the method will rely on multiple sources of evidence and development of prior theoretical propositions.” According to the definition, the case study method appears to be very suitable for this study and therefore it is chosen against ethnography and action research. Having selected the research approach the next step is to consider the case study design (refer Figure 7).

6 CASE STUDY DESIGN

Following Yin (1994), the unit of analysis and criteria for case selection are considered in the case study design.

6.1 Unit of Analysis

The main unit of analysis in this study is reactive change events within the context of collaborative project teams. Instead of fixing the stakeholder, this study fixes the issue, which is the change event. As such, the stakeholders around the fixed issue will be interviewed. However, the interview guidelines extend to general project data, in order to study the relationship between the considered main unit of analysis and its higher level, which is the organisation level. As the Figure 8 depicts, instead of the common triangular unit of analysis model, a ‘nested approach’ is considered for unit of analysis for this study. The lower level unit of analysis does not arise, as it is the issue, which has been fixed.

6.2 Case Screening and Selection

Multiple cases are favoured against a single case in this study. This provides multiple sources of evidence and replication of findings. Eisenhardt (1989) suggests selecting a population in case study method, which will define the set of entities from which the research sample is drawn. In this study the population selected is the reactive change events at the construction phase of projects. As Eisenhardt (1989) states, the sampling of cases from the chosen population is unusual when building theory from case studies. Random selection is neither necessary nor even preferable in case study method as opposed to quantitative approaches, which call for statistical sampling (Eisenhardt, 1989). As such ‘theoretical sampling’ is considered and better cases are selected for in-depth investigation. The criteria such as
collaborative arrangements, on-going projects at construction phase or recently completed projects, projects that underwent major changes, projects with convenient data accessibility are considered in screening and selecting cases.

Next step of the methodology is to decide on research techniques for data collection (refer Figure 9).

![Figure 9: Research Techniques](image)

7 RESEARCH TECHNIQUES FOR DATA COLLECTION

The data collection will be carried out over a period rather than one-time, so that true longitudinal data can be collected where possible. Triangulation technique will be used, so that the results can be validated through replication of findings. This technique combines more than one data collection technique. Data will be mainly collected by in-depth interviews, analysing documentation and by participating in project team meetings.

7.1 Interviewing as the main Data Collection Technique

The main data collection technique selected is interviewing. In addition data will be collected through document survey and observation techniques. This section will brief the design of interview guidelines and the interview process adopted for this study. The interview guidelines are designed to capture details with regard to a selected change event and are extended to general project data where appropriate.

7.1.1 Interview Structure

The interview is designed in four sections to meet each objectives of the study. The first two sections attempt to meet objective one of the study (refer section 3.1), covering background information of the selected change event and project change management process. The third section attempts to meet the objective two (refer section 3.1) of this study by exploring the variables that affect this change event, in terms of process, group and organisational characteristics. The fourth section of the interview guidelines covers the objective three and four of the study (refer section 3.1) and identifies the existing role of knowledge during the change event. This section is divided into four areas based on the knowledge conversion modes, namely; socialisation, externalisation, combination and internalisation modes and the tasks related to each stage are queried through a series of questions.

Subsequent to the data collection stage is the data analysis, which is depicted in Figure 10.
8 RESEARCH TECHNIQUES FOR DATA ANALYSIS

Data analysis involves data reduction, data display and conclusion drawing. The qualitative data that will be collected through in-depth interviews, documentation analysis and participation at meetings will be analysed by pattern matching technique.

8.1 Pattern Matching

The pattern matching will be between theorised and observed process variables (Yin, 1994). As Eisenhardt (1989) points out during the analysis case study researchers should constantly compare theory and data. The analytical process consists of two stages; within-case study analysis and cross-case study analysis. Within-case study analysis focuses on the isolate theoretical propositions and use replication of logic or pattern matching (literal and theoretical replication). Cross-case study analysis focuses on inter-relationships with other ideas with an explanation building approach. The aim is to analyse data by building an explanation about the case. Cross-case study has a discipline and capacity to reject theories, which are neglected. The best-known problem regarding degrees of freedom in tests of significance is the number of observation against which the hypotheses is checked (Campbell, 1975). This will be considered in pattern matching within and across case study analysis.

It is always important to refine the data collection procedure based on the initial data analysis. In fact, Eisenhardt (1989) states that a striking feature of theory building from case study research is the frequent overlap of data analysis with data collection and flexibility to adjust the data collection techniques.

As Denzin & Lincoln (1994) state the process of data interpretation is an artful and a political process. Alvesson (2003) proposes a reflexive pragmatism view on interpreting data from interview transcripts. In that he suggests to work with alternative lines of interpretation and vocabularies and reinterpreting the favoured lines of understanding in order to avoid the belief that data simply reveal the reality and also to improve creativity. The metaphors that he introduces lead to propose that the context of the interview affects the empirical data to a significant extent. As such, Alvesson (2003) states that it is important to view the subject matter from different angles to avoid a single favoured angle of vocabulary. To this end triangulation of data can also do some justice. However following Alvesson (2003)’s argument, it is necessary to build different interpretations of the empirical data.
The data analysis can be further enriched by tying emergent theory to existing literature (Eisenhardt, 1989). An essential feature at the theory building stage is comparison of emergent concepts with the extant literature to find similarities and differences. This will enhance the internal validity, generalisability and the theoretical level of theory building from case study research. Having set the data analysis approach next step is to identify the tools that are available for data analysis.

8.2 An Integrated Computer-aided Analysis

The qualitative data analysis is often criticised due to its lack of openness to public scrutiny and subjective stance. Therefore it is important to follow a rigorous data analysis technique to enhance the internal validity of this process. Among the qualitative textual analysis techniques, content analysis and cognitive mapping are two popular approaches that carry different strengths and weaknesses.

Content analysis aids to systematically identify emerging concepts through the code-based approach. Content analysis can be used to identify the perceived importance of themes and shifts by looking at the frequency of word usage. More than the frequency of word usage what it does is finding similar cognitions under a same concept (Swan, 1997). On the other hand, cognitive mapping enables to represent an individual’s internal mental representation of the concepts and relationship among the concepts (Tolman, 1948, cited in Swan, 1997). As Ackermann et al (1992) states this technique enables recording qualitative data in a structured pictorial manner based on the casual relationship between the identified concepts.

Both content analysis and cognitive mapping techniques carry limitations. A drawback of content analysis is that it assumes that the meaning of the concepts is not affected by the context. On the other hand in cognitive mapping, the process of linking expression and context is social and depends upon the perspective of the observer (Manning & Swan, in Denzin & Lincoln) leading to less internal validity. However, towards the theory building stage from the emerging concepts the ability to visualise the relationships between data segments is very useful. Considering the strengths and weaknesses of content analysis and cognitive mapping an integrated approach is developed for this study. In that, the concepts will be identified through content analysis using the code-based method and the relationships between the concepts will be analysed by use of cognitive mapping technique.

These qualitative data analysis can be facilitated by computer software. Computer aided qualitative analysis is viewed by some researchers as a double-edged sword (Fielding & Lee, 1991). Analysis involves intellectual and clerical processes. While the intellectual tasks remain with the researcher the clerical tasks can be eased by use of computer software. The main advantage of computer-based analysis is they replace manual tedious processes. However, the disadvantage is that they encourage complex structures and may also limit the analysis by available functions. By computer software the researchers can become mechanistic rather than creative. A further danger is that researcher may work only with de-contextualised data and never return to the original text. These drawbacks are less to do with the software themselves and more to do with how these are used and applied. To overcome, it is important to develop a holistic view based on the initial meaning of the data and visit to this from time to time during the textual analysis. Amidst the above mentioned disadvantages, computer aided qualitative analysis provides a rigorous and a transparent approach to data analysis (Miles & Huberman, 1984) and thereby helps to overcome one of the key criticisms in qualitative research, which is less openness to public scrutiny.
Following this discussion the study will select an integrated computer aided data analysis approach where content analysis will be used to develop the concepts and cognitive mapping to identify the relationships between the concepts, towards conclusion drawing.

9 CONCLUSION

This paper has presented a complete methodological framework to the research study and had justified its development progressively within the inner sections of the paper.

The framework begins with the literature review, in which the background study identifies the research problem and follows to a detailed literature review in search of issues and gaps. Based on the gaps identified in the literature review, the next step defines the problem statement in terms of the aim, objectives and the research questions. Subsequently, the research process leads to summarising the theoretical understanding gained through the literature, in terms of hypotheses and the conceptual model.

The next step is to set the research methodology for the empirical stage of the research. The ‘nested’ approach to research methodology is followed. Based on the ontological, epistemological and axiological assumptions, the research philosophy is identified and a case study research approach is selected for theory testing and building. With this selection, the next step leads to case study design where the unit of analysis and criteria for case selection is set forth. This is followed by the data collection stage using interviewing as the main research technique along with other techniques such as participant observation and document survey. Finally the research techniques, which were chosen for data analysis stage, are explained. The analysis will follow the pattern matching technique to test hypothesis and conceptual model, starting from within case analysis and leading to cross-case analysis. The textual data analysis will be aided by computer applications. An integrated method, which will use content analysis for concept identification, and cognitive mapping to develop relationships between concepts, is chosen. This way the validity of the process is enhanced by triangulating research techniques of data collection and data analysis.

The overall framework provides a sound and structured approach within which this research study will be conducted. It has set an explicit and transparent approach to the total research process while adding features such as overlaps and the flexible boundaries to the formal sequence to represent the iterative process.

REFERENCES

CII - Construction Industry Institute, (1994), Project Change management, Special publication 43-1, Austin, Texas


