THE ADOPTION OF THE REPERTORY GRID TECHNIQUE IN CAPTURING KNOWLEDGE FOR REFURBISHMENT IN THE CONSTRUCTION INDUSTRY

Cynthia ChinTian Lee and Charles Egbu
School of Built and Natural Environment, Glasgow Caledonian University, G4 0BA
Email: leec@gcal.ac.uk

Abstract: Refurbishments projects are generally considered to be of higher risk, more complex and in need of greater coordination than new build projects. In refurbishment work, there are many tasks where decisions are shaped not only by external factors but also by experience. In such situations, one is likely to find that experts rely on relatively unstructured methods in arriving at a decision. For the reason that there are proportionately more risks in refurbishment and renovation projects than in new-build, because of the associated degree of uncertainty and complexity, knowledge plays an important part in bringing the project to successful completion. Based on an on-going doctorate study which aims to develop an appropriate methodology to match the project requirements with the knowledge of project team members in refurbishment projects, this paper explores the applicability of a repertory grid technique in capturing knowledge for refurbishment in the construction industry. The need for knowledge in refurbishment projects is highlighted and a review of the available knowledge acquisition techniques pertaining to the research is made.

Keywords: Knowledge management, refurbishment projects, repertory grid technique

1 INTRODUCTION

The satisfaction of the client has long been acknowledged as a much needed issue to be addressed and the importance of including ‘client satisfaction’ in the measurement of project success factors was also emphasised by Pinto and Slevin (1988). In order to achieve client satisfaction two objectives have to be met, first, the translation of client needs into a design, which specifies technical characteristics, functional performance criteria and quality standards; and secondly, the completion of the project within a specified time and in the most cost effective manner (Bowen, et al, 1999). The briefing process, where the client’s desire for a built product is documented into a clear ‘brief’ has been identified as an avenue to improve client’s satisfaction. In the development of a project brief, a wide variety of skills are drawn upon including those of architects, planners and engineers who can envisage the options for the final product (Winch, Usmani, and Edkins, 1998).

Knowledge as quoted by Martensson (2000) is something that resides in people’s mind and is one of the most important resources to an organisation (Nonaka and Takeuchi, 1995). Othman et al (2005) has indicated that project team members are the originators of brief development, with their knowledge or the lack of it; they can be a value source or a risk source to the project. This view is echoed by Hatten and Lalani (1997) who suggest that by selecting an appropriate consultant team the chance of delivering a project on time and within budget might increase. Cooley (1994) concurred that good consultants should bring genuine and lasting value to the organisation they serve. The requirements of the client are difficult to interpret by the project team and to reduce
client’s requirements to a textual form is clearly impractical. For refurbishment projects where the clients are very dependent on the knowledge and skills of the project team (Smith, Love and Jackson, 1999), it is all the more important that the project team are able to understand and interpret client’s requirements and rely on their knowledge and experience to meet client’s requirements.

Through our literature review, we discovered that the use of the term knowledge capture very often appears in literatures on knowledge management whilst knowledge acquisition is often used in knowledge engineering. Based on Newman’s (1996) definition of the role of a manager and an engineer, we construe that knowledge management is concerned with the knowledge needs of the enterprise and it is concerned with the understanding of what knowledge is needed to make what decision and enable what actions. Knowledge engineering, on the other hand, would be the research of technologies needed to meet the enterprise's knowledge management needs. In the context of this paper, knowledge acquisition shall also mean knowledge capture and both terms shall be used interchangeably.

Based on an on-going doctorate study which aims to develop an appropriate methodology to match the project requirements with the knowledge of project team members in refurbishment projects, this paper explores the applicability of a repertory grid technique in capturing knowledge for refurbishment in the construction industry. The need for knowledge in refurbishment projects is highlighted and a review of the available knowledge acquisition techniques pertaining to the research is made.

2 THE NEED FOR KNOWLEDGE IN REFURBISHMENT PROJECTS

In refurbishment work, there are many tasks where decisions are shaped not only by external factors but also by the experience based capabilities and future workload of the firm’s personnel and it general policy. In such situations, one is likely to find that experts rely on relatively unstructured methods in arriving at a decision (Okoroh, M.I., & Torrance, V.B., 1999). The Technology Foresight Report (OST, 1995) emphasized the importance of the acquisition of appropriate skills, knowledge and competencies through appropriate education and training. Lansley (1990) has suggested that the construction industry now requires greater ‘knowledge workers’ than in the past.

Knowledge is the ideas, wisdom and facts mangers acquire through experience, theory and practice; the acquisition of which gives them an ability to understand. Knowledge can be potential or manifested in performance. Management skills and knowledge should complement one another (Egbu, 1999).

In refurbishment, with the increase in contract labour, together with a corresponding increase in fragmented specialised work and the difficulties associated with labour on site, the skills of leadership and communication become even more necessary. Also, with an increasing need for speed of response to address the issues arising from variations to the works, the skills of communication becomes vitally important.

Koehn and Tower (1982) are of the view that refurbishment work demands greater supervision than new build work.
Willenbrock et al (1987) are of the view that the nature of refurbishment work, coupled with a long working week and overtime work by construction personnel, leads to low morale and low productivity of refurbishment work. Thus, the skill/knowledge of motivating others is needed.

Demolition work can involve the disposal of hazardous substances such as asbestos and lead. Statistics from the Health and Safety Executive (HSE, 1998) show that the repair and maintenance sector, including refurbishment, accounts for about 43% of the total number of construction fatal accidents in the UK. The need to understand and be able to control substances hazardous to health, such as asbestos and lead, especially by the site management team, is of the utmost importance. Egbo (1996) argued that appropriate management strategies need to be developed to cope with the safety risks and hazards especially for works carried out with tenants in occupation.

Refurbishment work is characterised by high risk, uncertainty and high numbers of variation orders to the works. Working under such situations, and at the same time attempting to achieve the stipulated time for project completion, managers would have to make impromptu and sound decisions. The skill of decision making therefore is of great importance at all levels of management. In an environment of uncertainty, increased variation to the works and costs likely to escalate at short notice and controlling the financial requirements of refurbishment processes is considered to be important, thus the skills and knowledge associated with forecasting and planning is very important.

Because refurbishment often involves working in confined site, the knowledge of site organisation is important. In addition, there is a need to understand the nature and qualities of the materials used originally so as to match them exactly or look for a material which blends in and harmonise with the existing environment (Aldous, 1978)

The nature of refurbishment work with a high level of uncertainty in the works, lends itself to project time over-run. The skills and knowledge associated with managing time therefore are necessary. The relatively high degree of importance attached to managing time is supported by Jothiraj and Fellows’ (1986), who observed that time performance, was the major factor in determining clients’ overall satisfaction with commercial refurbishment projects.

The ability to cope with unexpected, changes, conflicts and crisis is needed in refurbishment work. The skill/knowledge associated with the analysis of project risk/uncertainty is also of high importance. The high degree of importance attached to project risks/uncertainty by all levels of management reflects the high levels of risk and uncertainty associated with refurbishment works (Chapman, 1980; Quah, 1988; Teo, 1990). Refurbishment work therefore demands requisite skill/knowledge associated with being able to assess and analyse risks/uncertainty in construction work.

In summary, the most important management skills/knowledge for refurbishment are: leadership, communication (oral/written), motivation of others, health and safety, decision making and forecasting and planning.
3 CONCEPTUAL FRAMEWORK

In this section, the key issues identified in the literature review are summarised and synthesised for the identification of major research questions to be explored in the research study. Research questions identified in this research are:

1. Is there a formal and systematic way employed by project teams or clients in matching client’s needs and expectations with the requisite knowledge of the project team in refurbishment projects?
2. Do the types and complexities of refurbishment projects have an impact on the types and sources of knowledge that the project team draws upon to address specific refurbishment tasks in order to meet client’s needs and expectations?
3. Do the types and complexities of refurbishment projects affect the choice of knowledge capture tools and techniques employed by the project team to meet the needs and expectations of the client?

The developed framework shown in Figure 1 below is based on three of the five knowledge creation processes, namely knowledge sharing, knowledge generation and knowledge integration proposed by Fong (2003) in his modified model of Nonaka and Takeuchi’s knowledge creation model (Nonaka and Takeuchi, 1995). The modified model takes into consideration social construction and communication within multidisciplinary project teams which Nonaka and Takeuchi do not look into in their knowledge creation model. Given that the construction project team in the construction industry is made up of multidisciplinary members, the modified model is deemed suitable and adopted in this research.

Project team members of differing knowledge domains share their uniquely distinct information and knowledge when the design issues and problems influence the project under each discipline domain. Knowledge is shared amongst the project team using each of their experience and perspectives. At the requirements elicitation and analysis stage for refurbishment projects, knowledge gap exists when the project team members posses insufficient knowledge to reconcile client’s requirements with the constraints in refurbishment projects. To meet the client’s requirements, the knowledge required had to be identified. With the identification of the required knowledge, the project team shall proceed to the next process of knowledge generation. Knowledge is generated through acquisition and creation (Marr, 2003), thus knowledge from various sources is acquired or created to fill the knowledge gap.
With respect to refurbishment projects at the construction stage, the required knowledge is identified when a problem arise. The knowledge sharing and generation processes are repetitive until sufficient knowledge is found to meet the client’s requirements. Once the knowledge gap is filled, knowledge integration happens when all knowledge from the project team members are combined. Clients’ requirements are met and this brings about client satisfaction. In order for knowledge to be elicited at the knowledge generation process, knowledge capture techniques need to be used and in this paper various knowledge capture techniques shall be examined.

**4 TOOLS & TECHNIQUES FOR KNOWLEDGE CAPTURE**

Boose (1990) has differentiated knowledge acquisition tools and techniques under manual and computer-based and under computer-based this is further classified into interactive and automated. Little methodology is practised beyond unstructured interviewing and automated methods are, for the most part, still in the research stage (Boose, 1990). Coupled with the fact that the recognition of the benefits of IT is slow in the construction industry, therefore only manual knowledge acquisition techniques shall be discussed in this paper. The most commonly used human-centred techniques for knowledge acquisition (in descending order of frequency of use as stated by Edwards (2003) are: interviews, protocol analysis, repertory grid analysis, case study observation and introspection. Another method for knowledge acquisition as proposed by Gregory (1992) is the Soft System Methodology.

Interviews are a process where a knowledge engineer either informally or formally debriefs an expert. Interviews are the most frequently used way of acquiring concepts and terminology as used by the expert, and is more efficient than observation methods. Sixteen different types of interview have been identified by Neale (1988) but the more
common types of interviews are structured, unstructured or semi-structured interviews. Structured interview is where the knowledge engineer asks at each interview the same questions in the same order and manner. This type of interview is useful when there is some particular knowledge that must be collected and when the problem characteristics and answers are predictable. Unstructured or semi-structured interview is similar to structured interviews where a set of questions are posed to the expert by the knowledge engineer, however, the order of the questions or the way they are posed differs from one interview to another. Such kind of interview gives flexibility to the knowledge engineer to adopt whenever required the vocabulary to the questioned expert and record the answers even if these answers can be derived from the answers to different questions.

Protocol Analysis involves inspecting verbal records of experts describing their own thought processes as they solve a typical problem. The verbal record usually in the form of tape record is transcribed in every detail into a ‘protocol’ and then analysed for valid associations from which corresponding production rules are derived.

Repertory Grid Analysis (Kelly, 1955) is also referred to as Kelly grids or personal construct theory. It is a way of representing the expert’s perception of a problem in a matrix of constructs and elements. The elements are the domain concepts (or other entities/objects) whose relationship is to be investigated.

Case study observation is used for acquiring essential tacit knowledge which cannot be articulated. It is an acquisition process where an observer determines useful information by observing an expert complete a typical task.

Introspection is used in knowledge engineering as the technique of last resort (Edwards, 2003). In introspection, the knowledge engineer interrupts the human expert during the performed task with questions such as ‘tell me what you are thinking now’ or ‘how would I do that myself?’ This method could be seen as offering the benefit that the expert is for the most part in charge of the session while the knowledge engineer can immediately ask for clarification. On the other hand, however, the interruptions by the knowledge engineer tend to ‘spoil the flow’ of the consultation.

It has been acknowledged that it is problematic to evaluate knowledge acquisition tools and methodologies (Cao and Compton, (2005); Menzies & Hamelen, (1999); Shadbolt and O’hara, (1999)). Thus in this paper, the authors shall not attempt to do so but instead look at the application the repertory grid technique as a knowledge acquisition method in this study.

5 REPERTORY GRID AND ITS APPLICATION IN THIS RESEARCH

Three routes for knowledge elicitation are identified by Okoroh and Torrance (1999). The psychological route, which involves some kind of interaction between the knowledge engineer and the domain expert; the machine induction route, which the computer induces rules from examples automatically and the route in which the domain engineer plays the role of the domain expert. The route in which the domain engineer plays the role of the domain expert is not adopted for two main reasons (Hart, 1986):
the expert normally will not have sufficient knowledge about programming and knowledge based systems techniques and the experts will find it difficult to describe their knowledge fully. As each refurbishment projects are unique and cannot be completely encapsulated the machine route is not used. Hence only the psychological route is considered in this research. Some of the knowledge acquisition techniques have been discussed in the earlier section. The repertory grid technique is chosen as it offers an extremely flexible methodology for obtaining the mental maps of the project team members. Access to such map is of vital help in any research which involves people and decision making and in this research, it is deemed appropriate.

The main purpose of the Repertory Grid knowledge elicitation exercise was to establish which of the given knowledge types can be obtained from the knowledge sources in order to meet client’s project requirements in refurbishment projects.

There are a varieties of grid in use today which include grids using ranking, grids using rating, bipolar implications grids, resistance-to-change grids, dependency grids to name a few. Dependency grids, sometimes known more generally as Situation-Resource grids shall be used in this research. In this grid form, the subject relates situations (constructs) with people (resources/elements). The situations are those which are essentially situations which any of us might encounter and the people are those upon whom we may call for help or on whom we may lean on.

Given the need for strength of authority on the client side and the breath of expertise from the project team in a refurbishment project, knowledge elicitation shall be from several experts ranging from the client to the contractor with experiences in hotel, hospitals, office and retail refurbishment.

Repertory grids can enable an interview to be carried out to some detail and reduce observer bias, but this depends very much on how the grids are administered e.g. the provision of constructs by the interviewer will not eliminate observer bias and if the constructs are not familiar to the interviewee, the distinctions made will be reduced (Oppenheim and Stenson, 2003). The issue of supplied versus elicited constructs has been a basic concern for the use of personal constructs in repertory grid. Adams-Webber (1998) has found that elicited constructs are significantly more accurate then supplied constructs; Fansella (2003) however argued that accuracy also depends on the context in which the grid is being used. From a purely Kellyian perspective, the technique would seem to demand that the constructs be elicited; in this research however, the constructs are supplied because the research demands aggregated data and data cannot be aggregated without commonality.

Rating level from the range of one to five is considered to be appropriate in this research because more or fewer categories appear to be either too many or too few for user friendliness and accuracy for evaluation. Also, these five ratings can mesh readily with the levels of importance attached to each construct. Further, in Bell et al. (2002) testing of mean interclass correlations, supplied constructs and elements with ratings from one to five indicates no significant difference and since in this research both constructs and elements are supplied, a rating level of one to five is adopted.
6 CONCLUSION

Given the complex nature of refurbishment projects, knowledge is a valuable source of commodity which not only assists the project team to bring the project to a successful completion but also bring satisfaction to the client. The need for knowledge in refurbishment projects has been highlighted in this paper. The most commonly used human-centred techniques for knowledge acquisition are also reviewed.

Based on the modes of knowledge creation, where knowledge can be externalised, socialised, internalised and combined, the repertory grids technique is chosen for this research. This technique shows in a very compact way what an expert knows and can be used by an expert to think about what is important, create new insights by providing opportunities for reflection and provide a checklist of things to look for in a specific context in terms of creating knowledge through externalisation. In terms of creating knowledge through combination, repertory grids allow the manipulation of externalised knowledge in a variety of ways to think, reflecting and invite the questioning of assumptions.

7 REFERENCES


Aldous, T. (1978), The Good, The Bad And The Ugly, Building Magazine

Bell, R.C., Vince, J., Costigan, J., (2002), Which vary more in repertory grid data: Constructs or Elements?, Journal of Constructivist Psychology, Brunner-Routledge

Boose, J.H (1990), Knowledge Acquisition Tools, Methods & Mediations Representations, Proceedings of the 1st Japanese Knowledge Acquisition for Knowledge-based systems Workshop: JKAW-90, Ohmsha, Ltd, Japan


Cao, T., M., and Compton, P., (2005), A Simulation Framework for Knowledge Acquisition Evaluation, 28th Australian Computer Science Conference, The University of Newcastle, Newcastle, Australia, Australian Computer Society


Cooley, M.S., (1994), Selecting the right consultants, HR magazine, Vol. 39 No. 8, pp 100-103.


Fong, P.S.W., (2003), Knowledge creation in multidisciplinary project teams: an empirical study of the processes and their dynamic relationships, International Journal of Project Management, Pergamon

Fransella, F., (2003), International Handbook of Personal Construct Psychology, John Wiley & Sons Ltd


Hatten, D.E. and Lalani, N., (1997), Selecting the right consultant team, Institute of Transportation Engineering Journal, Vol. 67 No. 9, pp 40-46
Repertory grid technique in refurbishment


Lansley, P., (1990), *Trends in graduate education for the construction professions*, Chartered Builder, March April, 9-11


