Tacit Knowledge: How Can We Capture It?

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Abstract

The importance of knowledge transfer or mentoring as a way to pass tacit knowledge (experience) across generations is discussed widely. Within project management this tends to rely on proximity and mutual exchange. The sender/receiver approaches used to transfer learning from one project to another is inhibited by the context of the projects, and the lack of time, which may obscure its relevance or purpose. There is concern that the knowledge captured in the minds of senior project managers is not being passed on to the next generation. Conversely it may be that much of the knowledge senior project managers have is obsolete or has been superseded by new methods and systems. This study used a grounded theory approach when interviewing 25 construction project managers from Australia on the management of project risk. Experience accumulated over time was considered by almost all interviewees to be the most important way of accumulating knowledge. Methods such as lessons learnt and close off reports are poorly used; most tacit knowledge is transferred through mentoring with very limited use of technology in this process. Changing construction technology did not concern the PMs as they perceived their job as managing processes and their role being flexible enough to adapt to change. From an industry perspective this lack of concern with the sharing of tacit knowledge and the lack of effective systems to capture it is going to be detrimental for its future. Project managers tended to still rely on traditional and the often poorly utilized methods such as lessons learnt and mentoring to capture this knowledge. Using this information, the study examines the key issues around knowledge management in project organizations and possible avenues for capturing tacit knowledge. Tacit knowledge will potentially be lost unless better systems are developed. This paper questions how Building Information Modelling, IT systems and the more visually based techniques such as pod casting, 3D photography, time-lapse cameras, web-based methods can to be used to accumulate and enable more effective knowledge transfer. The conclusion derived is that experience accumulated to generate tacit knowledge is essential for the successful management of future projects.

Keywords

Knowledge management • Project management • Tacit knowledge • Experience • Grounded theory

23.1 Introduction

Knowledge and organizational learning are important factors in optimizing risk management and decision-making within a project. The terms knowledge management (KM) and organizational learning have various interpretations. Knowledge and the learning attributed to knowledge, is highly subjective and dependent upon the perception of the individual, as demonstrated by a change in behavior [1]. KM in a project context is '*the management activities required to source the knowledge stock, create the enabling environment, and manage the knowledge practices to result in an aligned set of*

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project-based knowledges' ([2], p. 665). The project management body of knowledge ([3], p. 709) defines knowledge as '*a mixture of experience, values and beliefs, contextual information, intuition, and insight that people use to make sense of new experiences and information*'. Other authors apply different attributes to knowledge including '*the leveraging of collective wisdom to increase responsiveness and innovation*' from Frappaolo ([4], p. 8). The aim for KM is to create an asset based on information and expertise and to turn this asset into a competitive advantage [5]. The stock of knowledge is important [2] and its reuse is significant for stimulating creative and innovative outcomes [6, 7].

Knowledge is the most important resource needed by project managers (PMs) [8]. The rising complexity of projects has increased the need to manage knowledge better. The increasing complexity of projects is attributed to a number of factors. These include the growth in the size of projects, rising competitive and dynamic environments and the transit nature of programs and projects [9–11]. The management of complexity in projects includes: setting up contracting and procurement processes, developing temporary organizational structures, managing new legislative controls, keeping abreast of changing technology, managing a multicultural workforce, cultivating talent, providing leadership, and generating flexible resilient workforces [12].

This paper builds on the experiences of 25 PMs in the construction industry who demonstrated from their conversations the importance of experience (tacit knowledge (TK)) in shaping their ability to manage projects. A literature review was conducted to compare their experiences as captured through this research with literature. This paper provides an explanation for what TK is, offers evidence of its importance, reveals how it is transferred and whether there are more effective ways that project organizations can use to transfer knowledge. The following section provides an outline of the importance of KM, what it is and how explicit KM differs from TK. The subsequent sections of the paper explain the research method used, a discussion as to the findings of this research and finally the concluding remarks.

23.2 The Process of Knowledge Transfer

23.2.1 Explicit Knowledge and Tacit Knowledge

Knowledge can be categorized as a mix of explicit knowledge and tacit knowledge. Both are critical for further knowledge creation. Explicit knowledge is universal in its character, and accessible through conscious learning [13]. It tends to be the knowledge that PMs learn through their application of systems and processes usually via their learning through academic courses, corporate systems and processes, their Project Management Offices and via the PM Associations qualifications [14]. Explicit knowledge is particularly important when managing multiple projects and the time/cost/quality constraints of the organization. This knowledge needs to be made explicit, so that it can be examined, verified, shared and there is consistency between the multiple projects. [2, 15]. This type of knowledge is important for enabling PMs to establish the formal boundaries, processes and systems of good practice. Explicit knowledge is much easier to transfer as it can be taught. Todorovic [16] found that the best way to improve KM in projects was by applying a systematic approach to analyzing the projects factors and providing good documentation and information for future projects. This finding however, focuses on only explicit knowledge systems and does not allow for added benefits that could be obtained by including methods for TK to be accumulated by the PM and their team [17].

This paper looks at TK and some of the issues and suggestions as to how this type of knowledge can be transferred. Nonaka and Krogh ([13], p. 635) suggest that '*the concept of "tacit knowledge" is a corner-stone in organizational knowledge creation theory and covers knowledge that is unarticulated and tied to the senses, movement skills, physical experiences, intuition, or implicit rules of thumb*'. TK is accumulated via experience and is related to a specific context. TK is deeply rooted in individual's actions and experiences, their ideals, values, and emotions. '*The subjective and intuitive nature of tacit knowledge makes it difficult to process or transmit the acquired knowledge in any systematic or logical manner*' according to DeSouza ([18], p. 86). TK is what people possess, which cannot be made explicit using standard written based methods, yet it influences how people think, act and make decisions [17, 19, 20]. TK is what distinguishes a successfully run project from one poorly run [19, 21–24].

Experience is what provides TK and it is this form of knowledge that is important to the PMs and their organizations. Experience allows for professionals to find patterns in situations and to differentiate what information is relevant to a decision. The cognitive abilities of the unconscious mind are integrated with the conscious mind and are particularly relevant in complex and novel situations [25]. PMs use this experience to make decisions based on unconscious reasoning or intuition. As indicated by Elbanna [26] intuition enhances the outcomes of project management decision-making.

Experience is the knowledge or mastery of an event or subject gained through involvement in or exposure to it, plus experience enhances the knowledge transfer [27].

23.2.2 Knowledge Transfer

There are many factors that assist the successful transfer process, whether explicit or tacit. Bakker et al. [28] demonstrated with his case studies that successful knowledge transfer between the project and the parent organization relied upon multiple factors including the absorptive ability of the project owner; their proximity and communication ability. Interestingly, the authors imply that the responsibility for knowledge transfer lies with the parent organization, not with the PM. This is supported by Lindner and Wald [29] who found that the cultural factors are the most significant factor in KM success. As temporary organizations, the project management team's positive values, their attitudes and expectations, the willingness to share knowledge and to trust in knowledge from other persons become significant factors. Akhavan and Zahedi [22] attributed successful knowledge transfer to: aligning strategies to encouraged knowledge sharing among employees, providing a suitable knowledge structure, educational initiatives and access to advanced gather and share tools, plus a positive organizational culture with appropriate rewards and incentives.

TK is associated with informal learning. Informal learning includes: learning recorded and passed on to the uninitiated by mechanisms such as non-credited learning, work-based learning, volunteerism and service learning, mentoring and coaching, community of practice and on the job training [17]. Typically, project organizations use mentoring or lessons learnt as part of the process of capturing experience in projects. This sender/receiver approach to the transfer of learning from one project to another appears to be restricted by the context of the project, with associated time restrictions, and project team membership. For knowledge transfer to be successful it needs to be aligned to the needs of the recipient. Bresnen et al. [30] concluded that to be effective in the transfer of TK organizations needed to allow for the nature of projects, and the replication of common properties to enable experience building but also allow flexibility to adjust for the unique and unpredictable nature of new projects.

It is difficult to measure the efficacy of TK but productivity improvements are one possible measure [29, 31, 32]. The construction industry has made some changes to improve its productivity by shifting from onsite construction to onsite assembly, changing from traditional paper based documentation to the use of computer-aided systems, and adopting more sophisticated project management practices [33]. Naoum [31] suggests that advances in technology that lead to increasing site productivity are associated mainly with pre-construction activities, and the experience of PMs. However, even with advancements in the construction industry, the core technologies and systems appear to have changed little over the past twenty years with many technologies and systems that emerged post-World War II remaining dominant [34].

23.2.3 The Construction Industry in Australia

In 2015, the Commonwealth Government report on the Construction Industry [35] indicated that construction is the third largest industry in Australia employing over a million workers. Australia's national construction code (NCC) integrates all on-site construction requirements into a single code. The Building Code of Australia (BCA) is produced and maintained by the Australian Building Codes Board on behalf of the Australian Government and State and Territory Governments [36]. Each State in Australia has a different composition of its construction industry with some States heavily into mining, while others focus on heavy civil or built construction. South Australia has a higher proportion of mining and building construction and less civil construction [37].

The Australian Industry Group 2015 Report [35] indicated that the construction industry generally tends to attract a young workforce with 43.3% being under 34 years, but with a rising number of older (over 55 years) participants growing. Added to this is an apparent loss of skills and the potential for a skills shortage particularly among the trade skills [38]. The traditional career paths of moving up the ranks of an organisation from the trades, is being replaced by the higher stream employees coming in as graduates with limited or no practical experience. According to AIQS report Report [39], commencements with a Bachelor and Master's degrees in building construction management have increased strongly from 682 in 2005 to 965 in 2015. Employment outcomes for graduates in building construction management remains strong with fulltime employment for those completing bachelor's degrees in this field at 95.6% in 2016, compared with 71.0% for all bachelor degree graduates.

There is growing apprehension that the lack of effective KM between different groups of workers and the potential for a loss of relevant knowledge associated with an ageing workforce [40–42]. Vocational and university graduates bring with them new skills and explicit knowledge. Integrated into most of these tertiary programs are structured BIM courses enabling graduates to apply this in their work, to interact with, interpret, and potentially update information available on the BIM database. Research has shown (BIM) is becoming an increasingly important factor in both the efficiency and international competitiveness of the Australian construction industry [43, 44]. Most graduates lack the work experience that older workers have but conversely they bring with them new skills/knowledge that the older workers lack. The lack of these skills in the older workforce potentially increases a need for up-skilling and re-skilling of existing construction workers. Thus the transfer of knowledge needs to be between different groups in the workforce.

23.2.4 How Tacit Knowledge Can Be Transferred

Explicit knowledge can be acquired, written down, codified, and stored. It can, therefore, be easily transferred between projects, teams and within the profession or organization. TK transfer is more problematic. As Terzieva [17], p. 1088 explains '*tacit knowledge is usually subconscious, internalized, and the individual may or may not be aware of what he or she knows or how he or she accomplishes particular results*'. This usually necessitates that the PMs have extensive personal contact and regular interaction via the process of learning through reflection on experience (their own and others), through work placement and exposure and by the advice and guidance provided by a mentor. Most contemporary research focuses on understanding learning through collaboration, the value of a reflective practitioner and the growing use of big data [7] and not on how it is transferred.

The recommendations of appropriate tools and techniques for risk management from the PMI [3], and the ISO 31010:2009 include qualitative techniques such as lessons learnt, mentoring, brainstorming and nominal group techniques to capture this knowledge. All rely on the experience of the PMs, the project team and other experts. Lessons learnt relies on other PMs perception and their evaluation of whether to include them in their summative reports. Li et al. [14] suggested these methods provide useful tools for allowing the documentation of experience, but the use of them requires extensive expertise as they structure and formalize the experience making it less useful for inquiring PMs because it is static and deterministic.

More recently with the use of technology, there is potential to improve and expand the transfer of TK to those not in personal contacts with the dispenser of that knowledge. This can be achieved through the use of verbal, visual and internet-based communications. Contemporary technology has enabled new mechanisms for the transmitting of TK with time-lapse photography, 3D photography, case studies, games, interviews, and more mobile applications such as 'face timing' and podcasting. This means mentors can be on the other side of the world, communications need not to be synchronized, historical knowledge can be capture permanently and comparative projects can be sourced easily; however unique they may be. Learning can also be through simulations, interactive case studies, computer-based methods and other modern forms of education. Terzieva [17] provides a list of ways to transfer TK: via networks (social or sharing platforms/forums), interactive PM training, coaching and mentoring, videotaping, storytelling, after action reviews, post mortem sessions, exit interviews, and emeritus or alumni programs. Podcasts are increasingly being used for reflective learning with success. Much of the tacit learning is based on reflection, which enables participants to reflect on their approach and the practice of others [45].

Information Systems (IS) are also commonly used to capture knowledge though they are considered to be much better at transferring explicit knowledge than for transferring the less easily documented TK [20]. The standard way for corporations to access accumulated knowledge is via extensive software systems that store the knowledge as tables or other documents. Project Management Information Systems (PMIS) are software applications that help managers track projects from their inception to their closeout. PMIS act as KM systems to provide PM and their organizations with pertinent information, a systematic methodology and an effective communication platform [46]. The applicability and coverage of PMIS is likely to increase with the complexity of projects and when the users are physically separated [47]. The quality of the PMIS information was directly related to the quality of decision making and the satisfaction of multi-PMs with that system [23]. There also appears to be a clear positive relationship between the effectiveness of these systems and positive project outcomes [47]. Traditional analytical modelling approaches only present a static and mono-perspective image of a highly dynamic industry and do not allow for a more collaborative approach; which is required in the construction industry [48].

An additional way that research papers discuss the transfer of knowledge is via Building Information Modeling (BIM). BIM has all the potential to be a unique KM system [49]. BIM is an all-embracing term to describe a variety of activities in

object-oriented Computer Aided Design, which supports the representation of building elements in terms of their 3D geometric and non-geometric functional attributes. BIM facilitates inter-organizational cooperation in the construction industry [48] leading to improved productivity by enhancing design, construction and asset management practices. BIM applies a format, which allows for complexity, enables revisions and provides a visual perspective to the design, construction and maintenance of projects [50–52]. BIM has been an important KM application for improving risk management in construction projects [53]. The potential for improvements capturing learning in risk management with better KM systems such as BIM was strong, particularly with the development of 4D versions [52, 54].

23.3 Research Method

This study applied the grounded theory (GT) method. GT approach is the discovery of emerging patterns in information gathered by discussing specific experiences directly with the research participants allowing them to understand, interpret and then express their opinions [55]. The semi-structured interviews were particularly appropriate for this enquiry, as they drew on the knowledge and experience of a diverse range of topics. Analysis of the interview conversations enables the development of themes that reflect the richness and truths far more than the other structured methods such as by survey, questionnaire or quiz. Qualitative research methods with their emphasis on experiences are appropriate for locating the meanings around the events, concepts and the social context within which a PM operates [55]. Research questions were open requiring respondents to describe and explain their own experiences.

Interviews were conducted with 25 PMs. A series of open-ended questions were asked of the PMs including what tools and techniques they used to manage risks, their level of confidence and ability manage the all types of risks, what they considered important to their ability to manage risk, their planning or risks and how important they considered their experience to be. Using Nvivo 10 software to provide an intensive analysis of this qualitative information, data was sorted so the latent social patterns were conceptualized and structured to develop a theme related to the use of experience. Building on this research and the knowledge, that experience was fundamental to their ability to identify and manage risks, the author undertook a review of literature on how this TK was captured and transferred. The choice to interview 25 PM was based on the concept of purposive sampling; whereby data saturation and the cessation of interviewing was determined when no additional information was gained by undertaking further interviews [56].

The selection criteria for the interviewees were based on the following criterion: involved in or recently retired from project management positions/roles; at least 4 years PMS experience, and had managed one or more projects valued over $500,000. Participants were from South Australia. Half had worked on interstate or national projects. Participants were also chosen for their variety of employment experience (30% of the participants had over 30 years, 32% has between 20 and 29 years, 20% 10 years to 19 years and the remaining 20% less than this) and varied areas of industry. Participants represented: 11% residential building construction, 34% non-residential building (commercial/industrial), 29% heavy and civil engineering construction and 26% construction services (including services in land development and site preparation, building structure, building installation, building completion, and other construction areas). The organizations in which they were employed varied in respect to employee numbers.

23.4 Research Findings and Discussion

The semi-structured interviews have been analyzed into themes that showed common aspects. The common aspects are summarized in the list below.

1. Capturing of tacit knowledge not the focus of organizations

The interviews reinforce Terzieva's [17] finding that explicit KM methods are more commonly applied. TK methods such as videotaping, storytelling, exit interviews and emeritus or alumni programs were less visible and less frequently used. His conclusion was that this was due to the more sensitive nature of TK and the effort required to capturing it.

2. Experience accumulated over time was considered by almost all interviewees to be the most important way of accumulating knowledge

This is consistent with the finding that management of risks in a project depends on in-house knowledge and experience [57]. The '*processes of knowledge capture, transfer and learning in project settings rely very heavily upon social patterns, practices and processes in ways which emphasize the value and importance of adopting a community-based approach to managing knowledge*' [13, p. 157]. The PMs relied on experience because they are in an industry which uses temporary structures, has changing teams, is faced with constraints of time and cost, and is constantly exposed to new construction techniques and processes. PMs used their accumulated experience and that of their team to better identify and manage risks in subsequent projects. However, TK is seen by some as a source of their power so there was some reluctance to transfer all knowledge to other members.

3. Lessons learnt and close out reports poorly used

There was a clear understanding by the interviewees of the purpose of lessons learnt with all but one participant indicated they collected some form if this or close out reports but not all applied them to their future projects. Some PMs used previous project lessons learnt as a checklist for future projects or referred to them prior to commencing their next project. Several interviewees, however, openly stated that they did not consult other PMs lessons learnt, as their projects were too unique to learn from. Time constraints also limited their capacity to gather quality information and their ability to apply lessons learnt. This is similar to the results found by Tserng, [58] who concluded that the nature of the construction industry makes projects unique, often with transient ad hoc project teams, on-site production, and a corresponding high turnover of staff especially those with low skills. Making it problematic for the construction industry to coordinate, store, and reuse relevant knowledge from past projects for future projects.

4. Tacit knowledge is transferred through mentoring

Main mechanism to accumulate knowledge according to interviewees is via mentoring and accumulating experience over time. The importance of TK transfer inter-generationally was discussed widely. Common methods such as work placement and mentoring rely on the proximity and mutual exchange within the PM context [5]. This is consistent with the findings of this study.

5. Limited use of technology to transfer knowledge

Interviewees commonly utilized the internet or accessed experts to provide information where they perceived a gap in their knowledge. Technology is progressively altering the visibility of and changing way knowledge is transferred. The interviewees relied on PMIS and some used IT systems to source lessons learnt. Most interviewees criticized their organization's processes and systems for managing lessons learnt and the lack of practical access to lessons learnt from others. PMs also indicated their organizations did not use BIM due to the cost and complexity of implementing it but also due to the lack of training and knowledge. This was consistent with the summation that the potential for investment in innovation is restricted to the relatively few large companies who deal with sophisticated clients who procure buildings on a frequent basis,. Smaller construction projects clients/companies were too focused on attaining the lowest price to make effective innovation possible [59]. The adoption of BIM appeared to be resisted by many in the industry, due to the poor perception of BIM and the belief by many that it is an unrewarding burden for construction managers [60]. Smaller firms tend to equate BIM with purely 3D modelling and unjustifiable costs, while large organizations seem to understand the benefits of its ability to improve managing design and construction, managing costs, schedules and as a mechanism to exchange of information; though whether they equated this with KM was hard to determine. The biggest gains, from the introduction of enhanced BIM technologies, appeared to accrue to larger companies [51, 61].

6. Changing construction technology did not concern the PMs as they perceived their job as managing the processes and their role was flexible enough to adapt to change

The shortening of the knowledge value lifespan is evident in the construction industry, which is moving to adopt new technology, materials and manage in an increasingly complex world. This view is consistent with the project manager's perception, that construction projects are increasing using innovative methods and experiencing increasing rates of change. However, the issue of whether the use of lessons learnt is increasingly less relevant to future projects due to the adopted new

construction techniques or new work practices was not accepted by the interviewees. The concept of 'knowledge risk', which implies that the value or useful relevance of knowledge is becoming shorter, did not appear to be of concern for the interviewed PMs [62]. This is consistent with previous studies [1, 59]. They managed any unknown by bringing in new team members or sourcing expertise. It was their ability to do this effectively and to draw on their experience that enables them to ask the right questions. From an industry perspective it appears that this lack of concern with the passing or sharing of knowledge plus the lack of effective systems to capture and pass on TK is going to be detrimental for its future.

23.5 Conclusions

This research paper focused on explaining what TK is, its importance, and how it is being utilized in the Australian construction industry. This paper outlines how TK is transferred and whether there are more effective ways that project organizations can seek to transfer knowledge. Through empirical research and a GT strategy employed, it was concluded that experience was of utmost importance for construction project managers. However, past knowledge was not always documented effectively in systems or processes of their organizations. There was some evidence that knowledge storage was slowly happening in some organizations with BIM and with some visual records being adopted. The interviewees provided no evidence of any effective commercial or bespoke IT/digital systems used by PMs for capturing experience. In cases where knowledge was captured, this relied on systems that captured lessons learnt as part of a closeout report or similar. This reliance on traditional methods for transferring TK did not seem to be effective as the new project management team members had to be mentored or had to learn though observation. KM systems appear to be poor or none existent. This raised major questions as to how the construction industry is going to manage its changing profile of its workers in terms of age and education. There is clear evidence that those at management level in the construction industry are increasingly gaining employment through university qualifications, not the traditional career progression pathway. A divide between educated employees with no TK and ageing employees with TK and a lack of technical nous is emerging. The need to adopt effective TK KM processes is needed for industry growth. The suggestion is that organizations in this industry need to develop a more sophisticated approach to capturing TK to utilizing. Organizations need to utilize more technically flexible methods such as video recording, time-lapse photography, 3D etc. Further research remains to be done on how these sophisticated methods can actually improve TK communication.

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