Collaborative Knowledge Management – A Construction Case Study

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Abstract

Due to the new threats and challenges faced by the construction industry today, construction companies must seek new solutions in order to remain ahead of the competition. Knowledge has been identified to be a significant organisational resource, which if used effectively can provide competitive advantage. A lot of emphasis is being put on how to identify, capture and share knowledge in today's organisations. It has been argued over the years that due to the fragmented nature of the construction industry and ad-hoc nature of the construction projects, capture and reuse of valuable knowledge gathered during a construction project poses a challenge. As a result critical mistakes are repeated on projects and construction professionals have to keep "reinventing the wheel". Given the nature of construction projects, collaborative knowledge management seems to be the most appropriate solution to capture project based knowledge. Information and communication technologies offer a number of solutions to implement collaborative knowledge management solutions. This paper discusses a range of these solutions and presents a case study where a collaborative Knowledge Management solution is implemented across a multi functional construction company.

The work presented in the case study was carried out while the first author was employed by the case study organisation. A social web application was implemented to solve a particular knowledge sharing problem within the organisation's concrete pumping business. The new solution provided an effective and simple way to create knowledge by taking employees' ideas through an iterative cycle of discussion.

Keywords: Knowledge Management, Social web applications, Construction

1.0 Introduction

Knowledge is seen as one of the most important resources in any organisation [1][2]. The success or even the survival of any organisation depends on how effectively it manages the knowledge present internally and externally [3][4][5]. Reuse of existing organisational knowledge gained via past experience can greatly reduce the time spent on problem solving and increase the quality of work. Two types of knowledge exist within organisations; tacit and explicit. Significant efforts have been made by the construction sector to develop and implement systems to manage capturing, storing and retrieval of explicit project related information. Some examples of explicit knowledge are procedure manuals, organisation maps, work breakdown structure, document management systems, collaborative intranets and extranets, etc. However, not enough attention has been paid towards managing tacit knowledge. [6][7]

Management of tacit knowledge is of utmost importance to construction industry due to the fragmented nature of the industry and also due to the fact that each construction project is unique and generates a significant amount of knowledge during its execution. Also, as a result of the dynamic nature of construction project, new challenges are faced every day for which solutions are devised by the project team where possible. However this knowledge

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mostly remains stored in minds of project team members and is not transferred across the organisation for reuse in future projects [8].

Many tools and techniques have been discussed over the years for knowledge management within organisations. Recent developments in ICT (Information and Communication Technology) have prompted organisations to utilise platforms such as corporate intranets and collaborative extranets for collaborative knowledge sharing. Almost all large size organisations today have a corporate intranet where information such as contact lists, standard forms and databases, company news, and other relevant information is shared on a web based platform. Companies are also implementing extranets to share information with the supply chain. Although these technologies have certainly transformed how knowledge is shared across organisations, they mainly address explicit knowledge rather than tacit knowledge.

On the other hand, emerging technologies such as social networking applications, web based forums, wikis, folksonomies which are often referred to as Web 2.0 technologies, are transforming the way people share knowledge and ideas with each other. These technologies are increasingly finding their way into organisations who are seeking innovative ways of sharing tacit knowledge. The ease of use and informal characteristics of these technologies have made them very popular in a very short period of time. The increasing availability and quality of internet and underlying communication technology are some factors which are also responsible for such a sudden explosion of these applications. Originally designed as social applications on the internet, these technologies are certainly making an impact within organisations' corporate networks. Many corporate intranets now include a blog and wiki to engage people in active knowledge sharing. Instances of an employee designated to write for a corporate blog are quite common.

This paper discusses the importance of collaborative knowledge management in organisations, of knowledge creation and transfer, types of knowledge management systems and classification of knowledge work. Various ICT based knowledge management solutions are discussed with a specific emphasis on upcoming Web 2.0 solutions. A case for knowledge management in the construction industry is then provided. This is followed by a case study of a construction SME (Small to Medium Enterprise) where a collaborative knowledge management solution was applied.

The work presented in the case study refers to the work carried out by the first author when employed at Pochins PLC (case study organisation). The Knowledge Management solution was implemented to solve a particular knowledge sharing issue within the organisation's concrete pumping business. The new solution provided an effective and simple way to share knowledge gained during daily work. Due to its social nature, the solution provides a way to capture tacit as well explicit knowledge.

2.0 Knowledge management in organisations

Knowledge management has existed long since. People frequently come across and use different forms of common wisdom which they acquired from a large scale, social, collaborative knowledge transfer. If things are put in the organisational context, knowledge management has existed in one form or another from quite some time; some examples of organisational knowledge management are, training manuals, procedure and policy documents, forums for innovation, safety registers, etc. When organizations are approached from a knowledge-based perspective, one of the key issues of concern is how to integrate the disparate knowledge of individual organizational members into products, services, processes and routines that benefit the organization as a whole [9]. Also the intellectual capital of a firm has become an important differentiation factor with respect to other organizations [10].

2.1 Knowledge transfer and creation

From the organisational perspective, knowledge transfer is one of the most important aspects of knowledge management; and to leverage competitive advantage, the organisations need to facilitate effective knowledge transfer between employees. According to Nonaka and Takeuchi [11] the knowledge conversion proceeds through four different modes:

  i.   Socialisation (conversion of tacit to tacit);

  ii.   Combination (conversion of explicit to explicit);

  iii. Externalisation (conversion of tacit to explicit); and

  iv.   Internalisation (conversion of explicit to tacit)

In the model, the basis of knowledge creation in organizations is continuous interaction (transfer) among individuals, and continuous conversion from tacit into explicit knowledge (and vice-versa) by individuals, supported by the group. The knowledge conversion process is represented as a spiral, the conversion modes succeeding indefinitely, creating new knowledge in the organizational environment.

In reality, however, there is no formal agreement about what knowledge management actually involves and how it is actually related to transfer of Knowledge. "Organisational knowledge management" means different things to different people [13]. The definition of the term 'knowledge management' usually points in the direction of increased output or efficiency whilst 'knowledge transfer' is synonymous with the transmission of information to a learning person [12].

Two available definitions of "knowledge management" are:

  i.   "Knowledge management represents a systematic and organised approach of using knowledge for storing and extending knowledge in order to increase companies' output and performance." [14]

  ii.   "Knowledge management is equivalent to the strategies and processes for knowledge identification, documentation and influence with the aim of making companies competitive." [15]

In today's information centric world, workers in organisations deal with a great amount of information every day. There are many different kinds of information systems which interpret data and transform it into some kind of information. Technologies such as the Internet, Intranet and World Wide Web present today's worker with enormous amounts of information, important and unimportant. It is therefore quite difficult to make a distinction between important and unimportant information. From this context, knowledge can be seen as the means to extract and capture the available information which can be used to provide a better way of doing things. It is this next step which separates information management from knowledge management, the one essential to make for organisations. This is where the collaborative knowledge management applications make their biggest impact within organisations.

2.2 Types of Knowledge Management systems

To differentiate organisational maturity towards knowledge management, experts try to distinguish knowledge management systems. McElroy [16] has defined a generational approach to understanding knowledge management. According to McElroy, first generation knowledge management systems centre around people sharing ideas and knowledge with

each other. This could consist of documents, letters, emails other media, etc. Systems which support these within organisations today are emails, document management system (DMS), content management system (CMS), intranet, information portals, etc where employees can share their knowledge with others.

Second generation knowledge management, according to McElroy, focuses on employees working together to create knowledge. This approach promotes innovation in the organisation and is more sustainable. It is however worth noting that knowledge sharing is the first essential step towards knowledge management and is equally important; however sharing knowledge alone does not lead to innovation. In many organisations such kind of shared knowledge becomes stagnant and is often ignored or unused. Second generation of knowledge focuses on knowledge creation and is a social process, which can be supported by software systems. Knowledge creation starts off with an employee bringing an idea across and other members of the organisation take the idea through a lifecycle of feedback and refinement. Software systems such as wiki, forum (bulletin boards), blogs, etc. support this approach. Second generation knowledge management promotes knowledge creation through a lifecycle feedback and refinement, and it may also go through a process of approval within the organisation.

2.3 Classification of knowledge work

To implement any kind of knowledge management solution within an organisation, one has to study what kind of knowledge work is taking place, as there are different solutions for different types. Davenport [17] has suggested a classification of knowledge workers to understand this better. The following matrix provides a broad classification of knowledge work:

Insert Figure 1 here

According to Davenport, collaboration work is the most difficult to address from the knowledge management context as this type of work is very iterative and improvisational. This type of work is mostly done by workers who are experts in their roles and who may have a certain degree of experience or education behind them. To improve this type of knowledge work, organisations may put workers in new teams or make more knowledge available to them.

3.0 ICT Solutions for Collaborative Knowledge Management

Although technology has an important role to play, experts have argued that knowledge management cannot be implemented using technology alone, Anumba et.al., Davenport and Lawrence, and Ruikar et.al.[18][19][20] very effectively pointed out that IT alone cannot take form of knowledge management on its own, it is the way IT has been implemented to support knowledge management that is important. It has also been argued that non IT knowledge management solutions can also be quite effective within organizations. Al Ghassani [21] criticizes knowledge management technologies for using expensive IT infrastructure which is difficult to implement and has an increased emphasis on explicit knowledge. In fact, research has shown that information management tools, such as emails, intranet, extranet and document management systems may have negative impact on organisation's knowledge management capabilities. This is due to the fact that such tools cause information overload due to unorganised and ad-hoc information exchange.

McAfee [22] divides information technologies used by knowledge workers for communication in two categories; channels, and platforms. Emails, direct messaging,

document management system, etc where information is created by anyone and degree of commonality is low, are called channels, whereas intranet, extranet and information portals are called platforms. In platforms, the content is generated by a selected group of individuals which is approved and then made widely available. Here the production is controlled and centralised and the degree of commonality is high. Davenport [17] has argued that knowledge workers are not happy with channels or platforms currently available to them, some even feeling that their productivity actually diminishes due to the ineffectiveness of the solutions available. The type of tools most usable for collaborative work are knowledge repositories and collaboration aids, however their use remains voluntary.

Even though the limitations of ICT have been discussed widely by researchers, one must not take an entirely negative view of what ICT has to offer within the context of knowledge management. Majority of the problems associated with ICT seems to be around how it is implemented and managed rather than what the technology has to offer.

Web 2.0

The World Wide Web has been expanding at a rapid pace ever since it was launched in 1989, with a number of web based technologies continually making a significant impact on people's social and professional lives. Because of the uncontrolled, open and widespread nature of Internet, new technologies constantly make their way to the social and professional scene. In recent years, a set of new Internet technologies have found a growing popularity within the social and professional world, which are called among others Web 2.0 or Social Web. Technologies including wikis, blogs, folksonomies, web based forums and social networking sites fall within this category. They are called Web 2.0 because they are perceived to be the second generation of web based technologies which are anticipated to have a significant impact on people's lives after the launch of original World Wide Web.

Although these applications initiated as social networking and collaboration technologies, they have made a significant impact on how organisations manage their intellectual capital. Many organisations have implemented one or a combination of these technologies to capture and distribute knowledge within and outside the organisation; some even appointing dedicated resources to manage these. Although still early in its role as knowledge management systems, it emerges from early discussion that some benefits the Web 2.0 technologies offer over the traditional knowledge management technologies are [22]:

Ease of use: Informal, unstructured format which is ideal to capture tacit knowledge

Search capabilities: Advance search capabilities make it easy to retrieve knowledge

Promotes discussion: Hence offers the possibility of the knowledge creation lifecycle

Availability: Anytime/anywhere and widespread availability as opposed to legacy enterprise applications

Open source and self managed: Hence low cost of implementation and maintenance. No need to invest in sophisticated database or application design. Majority of these applications are open source, constantly updated by the user community.

4.0 Knowledge Management in Construction

4.1 Nature of the industry

Construction is a project based industry where each project is unique and brings a number of stakeholders who collaborate with each other at various stages during the project lifecycle. Each construction project can be considered a multidiscipline organisation which may or may not continue to work together once the project is completed [23]. This temporary nature of construction and heavy fragmentation makes construction a significantly complex process. Construction is also an information intensive industry where stakeholders communicate a large amount of information across various stages of the project lifecycle. The combination of the two makes information management and knowledge management a very difficult task for the construction industry, resulting in poor efficiency of the overall process.

The industry has been under considerable pressure to improve the efficiency of the construction process [24][25]. Pressure is also increasing from clients who demand better products in shorter duration and using fewer resources. In this context knowledge management has been viewed as a strategy to promote innovation and enable improvement of the construction process.

It has also been debated over the years that the construction industry has been relatively slow in adopting the innovative solutions offered by the developments in the ICT sector. The construction industry has always maintained a sceptical view of the ICT offerings, while other industries, such as automobile and manufacturing, have successfully utilised ICT to improve the efficiency of its processes. However in the last decade the construction industry has made significant efforts to embrace ICT solutions.

4.2 A case of Knowledge Management in construction

Construction projects are of unique and dynamic nature where each step in the project lifecycle presents a number of potential opportunities to capture knowledge. If this knowledge can somehow be captured and reused it will reduce the waste caused by of "reinventing the wheel" and improve the process efficiency in general [26]. However due to heavy fragmentation the industry as a whole is not able to capture and share knowledge via a common platform, valuable knowledge is being lost as a result. As stated above the industry relies heavily on storage of explicit knowledge, however to gain a competitive advantage the industry needs to capture and reuse tacit knowledge. It emerges from previous literature and practices that capture of tacit knowledge remains a major challenge. Also, the current systems and processes within the construction industry do not readily support the capture of such tacit knowledge. However, the emergence of technologies such as Web 2.0 provide an opportunity to apply innovative ways to generate and capture tacit knowledge by social interaction over the Internet. The following are some of the key benefits of knowledge management in the construction industry [23]:

Enable knowledge transfer: Construction projects require knowledge to flow through various stages such as; requirements capture to design, design to estimating and estimating to actual construction and so on. This is a very important aspect of knowledge management in construction as the industry suffers from heavy fragmentation. In most projects, there are different organisations involved with varying responsibilities towards project tasks. This makes the smooth flow of knowledge across project stages a big challenge. As a result problems such as contractual disputes, extensive rework and time and cost overrun are experienced. Knowledge management can play a key role by facilitating effective knowledge transfer across various stages of a construction project enabling smooth flow between processes.

Capture and reuse project knowledge: There has been a general consensus that the industry fails to retain project knowledge for future reuse. Some common factors behind this are; personnel changing companies or industry, teams being separated after completion of a project, lack of a standard platform to capture and share knowledge, lack of motivation, etc.

Many companies have documentation processes such as post project reviews, in place to capture such knowledge, however in most instances these are not properly documented, and if documented they remain locked in archives. There is a need for knowledge management systems which will enable capture and reuse of knowledge during and after the completion of project. Such a system will also help build a database of best practices.

Enable better communication amongst stakeholders: Due to fragmentation, the construction industry suffers from weak communication between stakeholders. From a knowledge transfer perspective this is one of the most important aspect, as many construction projects run into problems such as contractual disputes, cost and time overrun and rework as a result of miscommunication or lack of communication. An effective knowledge management system will help in communicating and preserving knowledge effectively across various stages of a construction project.

Even though the benefits of knowledge management are well documented, there are not many practical examples of solutions being applied in this area. The following case study discusses a practical example of a collaborative knowledge management solutions applied within a construction company.

5.0 Case Study

The following case study adopts design science method guidelines [27] as overall approach. Table 1 shows how the guidelines relates to the case study.

Insert Table 1 Here

5.1 Company Background

Founded in 1935, Pochins PLC is a construction company operating mainly in the North-West region of England. Apart from construction, which is its main business, Pochin Group has other subsidiary companies dealing in Concrete Pump Hire and Commercial and Residential Property Development. Pochin enjoys a unique market position as a result of this diverse yet complimentary nature of businesses under one umbrella. Pochin employs around 500 employees including all offices and subsidiaries, out of which around 300 are based in its Cheshire based office. The company had a turnover of £77.7m in year 2005 and £130m in the year 2006.

Pochin Construction Services, which operates the pump hire business, enjoys a market leading position with a wide fleet of concrete pumps and depots across the country. The company has workshops at Middlewich, Bathgate, Tamworth and Colnbrook to service and maintain pumps.

Pochin promotes innovation within the organisation and it reflects in their business strategy. They have implemented a system called "Innovation Forum" where an employee can submit an idea to the forum, and if it is accepted, he/she receives a small incentive in return. Also, Pochin had recently undertaken a business process reengineering project to review their current processes with a view to improve efficiency and eliminate waste.

Pochin implemented an Intranet solution in 2001 called "Pochinet" which was designed internally using ASP (Active Server Pages) as the scripting language and MS Access databases for information storage. The Pochinet hosts information such as daily notices, contact lists, standard forms, health and safety information, QA documents, standard work procedures and various other commonly used information. Over the years Pochinet has established itself as a

widely used information sharing platform within Pochin which is updated on a regular basis. Pochinet is available to all Pochin's staff via the company's local and wide area network which is available to all offices, depots, workshops and majority of construction sites.

5.2 Problem Discussion

Pochin Construction Services operates two geographically dispersed workshops to maintain concrete pumps and other machinery. During the monthly meetings and general supervision it was observed that the operators in both workshops regularly identified innovative solutions to solve problems of varying complexity. However due to a lack of formal documentation and sharing procedure, this knowledge was not retained and operators kept "reinventing the wheel" on a regular basis. It was also identified that a significant amount of commonly used information could be shared across the depots, however due to the lack of a sharing platform this could not be achieved. Needless to say this resulted in organisational waste of resources. Hence, it was clearly understood that an active exchange of knowledge between technicians and management staff at these workshops will improve their efficiency and performance. The following figure shows the knowledge creation process prior to implementing the solution.

The majority of workshop operators had vocational qualifications obtained in mechanical plant maintenance, and had varied degrees experience of using information systems. All operators had either direct or indirect access to company's information systems.

Insert Figure 2 here

As it can be seen from the figure, any new knowledge created stays limited to the person (or a group) implementing the new idea or solution; it is not shared across the organization. There is also a risk of losing valuable knowledge as it is not captured and stored for future use. For any future reuse, the only possibility is personal consultation with knowledge creator, who may or may not always be available.

Although Pochinet was currently used to post interesting documents and links containing knowledge, the following issues were identified, which limited its use in this context:

- Knowledge is only captured in form of documents, which are static in nature and don't support the knowledge creation lifecycle

- Operators, other than who created knowledge, can't comment or update documents

- Rich content (i.e. picture, multimedia) is not easy to embed or associate with knowledge

- Searching within the knowledge base is not efficient

- Multiple versions of same documents exist leading to confusion

- Social interaction is important aspect of knowledge creation, this is not supported by the existing platform

From the literature review, it was evident that social interaction between knowledge workers is a more important aspect than technology or tools being used, and it should be considered when selecting/implementing a new solution.

5.3 Methodology for solution development

5.3.1 Requirements capture

Following the problem identification, a thorough review of user requirements was needed. It was also necessary to identify the type of knowledge being created, and the work environment surrounding it. The matrix (shown in figure 2) developed by Davenport [17] which provides a classification structure for knowledge creation processes, was used to identify the type of knowledge creation process at Pochins.

The first author identified during regular interaction with the pump operators that the knowledge creation process at workshops and depots falls between the "expert" and "collaboration" model. The maintenance and repair work is a highly judgment oriented work which requires a significant amount of individual expertise and experience, however at the same time, there are teams which work together to carry out a particular task. Additionally, considering the specific problem of geographically dispersed nature of depots and workshops, the desired solution was inclined towards the collaboration model.

It was clear that a better understanding of user requirements was needed to identify the solution for the given situation. A series of workshops and interviews were carried out with the operators and managers. From the workshops and interviews, the following requirements emerged:

- Share ideas in real time

- Ability to collaborate on a common platform

- Ability to discuss an idea in a simple way

- Post documents and other media such as photographic evidence, sketches etc.

- To search within solutions and previous exchange/documents

- The solution should not consume much time due to the busy nature of work

- Less resource intensive system, as not all computers on shop floor are of latest specifications

- Ease of use and intuitive interface

Collaboration work is of iterative and unstructured nature; hence the technologies suitable for such environments are knowledge repositories and collaboration aids, which have to be used voluntarily.

Given the requirements, the next task was to identify potential solutions available that can be applied to reach a solution. There are a number of technologies which support the collaborative knowledge creation and sharing. Table 2 shows a comparison between the technologies selected for evaluation.

Insert Table 2 here

From Table 2 it can be seen that the discussion board and Wiki are two technologies which satisfy most of the requirements. These two technologies were shortlisted for further review.

Wiki: Wiki is a software that allows users to create, edit, and link pages together. Wikis are often used to create collaborative websites and to power community websites. These wiki websites are often also referred to as wikis; for example, Wikipedia is one of the best known wikis. Wikis are used in many businesses to provide affordable and effective Intranets and for Knowledge Management. Although the wikis are a possible collaborative knowledge sharing platform, there is a learning curve associated with it. A significant amount of training, dedication and resource are required to implement such a solution across an organization.

Internet Forum: An Internet forum is a web application for holding discussions and posting user generated content. Internet forums are also commonly referred to as Web forums, message boards, discussion boards, (electronic) discussion groups, discussion forums, bulletin boards or simply forums. The terms "forum" and "board" may refer to the entire community or to a specific sub-forum dealing with a distinct topic. Messages within these sub-forums are then displayed either in chronological order or as threaded discussions. Early web-based forums date back to 1996. A sense of virtual community often develops around forums that have regular users. Discussion boards are easy to use and implement and do not require significant amount of training to be effectively used.

Due to its ease of use and relatively low resource requirement, Internet forum was selected as a collaborative knowledge management solution within Pochins. After an initial study of available solutions, it emerged that majority of the Internet forum software are developed by the open source community, most of which are developed using php (a scripting language) and mySQL (open source database engine). Open source software have a distinct advantage of being actively developed by users/developer communities around the world, and they can be customised locally as the source code is available for modification. Forum software called phpBB (www.phpbb.com) was selected due to its market leading position, ease of use, active community development and support. A schematic diagram representing the architecture of the phpBB system is presented in Figure 3.

Insert Figure 3 here

5.3.2 Implementation

Due to its existing availability and familiarity within the company, Pochinet was selected as the platform to host the forum. The implementation details are shows in table 3. Following steps were carried out to ensure smooth implementation:

1. Following the initial setup and testing, a pilot run was carried out to ensure the compatibility with existing systems and performance against requirements.

2. A word censoring add-on (additional software created by user community) had been applied to make sure inappropriate language was filtered.

3. Internal champions were identified who would help promote the system internally and act as a bridge between users and implementation team

4. After the successful pilot run, full implementation was carried out. The main page of the forum can be seen in Figure 4.

5. An email asking all users to register on the forum, along with a simple guide was sent.

6. The managing director and operations manager sent a message to all users introducing the new system and requesting them to make full use of it.

7. A workshop was carried out to train the users on how to use the system efficiently.

Insert Figure 4 here

Insert Table 3 here

5.3.3 Post implementation review

It is essential to carry out post implementation review for a project of this nature to achieve a sustainable solution. However, it is difficult to assess knowledge creation as it is subjective and context specific. There is no single performance measure for knowledge work; one has to determine what measures make sense for each individual situation [17]. Also, benefits from such solutions are only realised once a sizable amount of knowledge has been put into it. To simply evaluate the solution in a short duration after implementation would not give accurate results. However, it is understood that monitoring usage and providing continuous support in the initial stages of the project is also very important. Hence it was decided that the first evaluation will be carried out six months after the implementation. In the meantime regular monitoring of forum and discussions with users will be carried out to ensure any operational difficulties are dealt with and user feedback is well received. To evaluate how the project is performing, following criteria were defined:

- Number of new topics started

- Number of posts per each topic

- Quality of content – number of posts with rich information, e.g. photographs, sketches, video, documents etc.

- Are the operators reaching consensus through the forum for the given problem, i.e. are they discovering any solutions.

Initial review

During the first month of post implementation review it was noted that the initial signs were quite positive. Operators had created 3 new topics and posted 14 messages within those topics. At least 5 posts had rich information attached. Figure 5 shows an example of a post with rich content.

Insert Figure 5 here

During the early discussions, the operators mentioned that soon after the implementation they had started posting questions for the problems they had come across with a machine part or a component during repair or maintenance or started discussing potential solutions they already found to such problems. At the same time the managers had started posting information related to common issues such as health and safety, training and operation manuals.

There was no time spent in getting to know other employees or trying to establish the level of trust with each other (within the context of capabilities and organisational politics). This was possible as the technicians from all depots/workshops had already known each other from prior interactions; hence a certain level of trust was already present. This coupled with the support from senior management enabled them to openly share knowledge and problems with each other.

Six month review

The following was observed in the six month post implementation review:

1. An active exchange of ideas was taking place through the new solution

2. A total of 14 new topics had been started which had 84 messages posted within it

3. Knowledge was being generated through lifecycle of feedback and refinement

4. User participation remained high with 90% of worker involvement; this was apparent from the statistics generated by the software, for example, number of views for some topics were quite high.

5. The knowledge created within the forum was being applied straight into the workplace. Hence the impact factor was quite high.

6. Compared to the knowledge creation process prior to implementation (Figure 1), a much improved process was taking shape which can be seen in Figure 6.

Insert Figure 6 here

6.0 Discussion

Social interaction/collaboration between workers is one of the most appropriate ways to capture tacit knowledge. Development of new social applications such as the one discussed in this paper offers an effective and practical way to manage tacit knowledge within construction and other industries. The construction industry has realised that the biggest asset it posses is knowledge and experience associated with its human capital [23]. The increasing pressure of cost and time reduction, delivering better projects and fighting ever increasing environmental challenges has made the effective use of intellectual capital even more important. Managing explicit knowledge has been the core focus of the construction industry in past few years. However, it is the capture of tacit knowledge within construction which remains a challenging area of research and development.

From the case study it emerges that even when identified as important, it is not simple to implement a system to manage tacit knowledge. Key success factors for emerging from the case study are:

- Knowledge Management system should be easy to use and implement,

- Information retrieval should be efficient.

- Knowledge sharing happens more efficiently if there is a level of trust existing between employees

- Implementation of knowledge management system should be treated equally as important as core systems such as Enterprise Resource Planning, Document Management or Design and Estimating within construction organisations.

- The top management has to put equal emphasis on knowledge management and integrate it within the business strategy to realise higher rate of success.

The work presented in this case study represents one of the few examples of active knowledge sharing within the construction industry. Many other industries such as oil and gas, automobile, pharmaceutical, IT, and general consulting have successfully implemented and exploited benefits from knowledge sharing [20]. However, as discussed previously, construction still relies on sharing explicit information rather than looking for ways to implement innovative knowledge management solutions for strategic benefit. More research and pilot studies are required to propagate the use of innovative use of techniques such as demonstrated in this case study.

7.0 Conclusion

In this paper, we discussed the basic concepts behind knowledge management and its implementation within the industry. We discussed different generations of knowledge management and various solutions associated with it. IT enabled knowledge management solutions were discussed with a particular emphasis on collaborative knowledge management solutions. A case study at Pochins was presented where we discussed the implementation of a collaborative knowledge management solution.

The ultimate goal of the work carried out was to provide an effective way to share knowledge between the operatives carrying out maintenance work at geographically dispersed depots. This objective was satisfied by the solution implemented. The solution also provided a searchable knowledge repository capturing both tacit and explicit knowledge and requiring minimal maintenance. The exchange of explicit knowledge could have been possible without implementing any new solution by simply creating a new space on the existing Intranet system where documents could be exchanged. However, this would not have made it possible to exchange ideas and create knowledge by taking these ideas through an iterative cycle of discussion. Web 2.0 solutions such as blogs, wikis, and one described here, can be applied in a general context within other organisations in the AEC sectors to suit variety of situations to enable knowledge capture and reuse.

In conclusion, knowledge management is a core competency for construction industry, and it should be integrated within company's business strategy. Given the nature of construction industry, collaborative knowledge management is of particular importance as it addresses the issue of capturing knowledge within teams/groups of workers. With the advances in IT and communication sector, majority of construction projects are now connected to their corporate networks and have access to internet. This makes the idea of collaborative knowledge management even more lucrative and practical. There are a number of potential knowledge management solutions emerging for collaborative knowledge management. The most promising solutions are those which offer rich social experience where knowledge exchange is happening in an open and informal way. A significant amount of transparency and cultural change is required to implement such a solution, but if successful it can bring significant benefits to the company.

References:

[1] Ofek, E. And Sarvary, M. Leveraging the customer base: creating competitive advantage through knowledge management, Management Science, (2001) 47 (11), 1441-1456

[2] Smith, E. A. The role of tacit and explicit knowledge in the workplace, Journal of Knowledge Management (2001) 5, 311-321

[3] Switzer, C. Time for Change: Empowering organisations to succeed in the knowledge economy, Journal of Knowledge Management (2008) 12 (2), 18-28

[4] Egbu, C.O. The role of knowledge management and innovation in improving construction competitiveness. Building Technology and Management Journal, (1999) 25, 1-10

[5] Drucker, P.F. Post-capitalist society. Oxford: Butterworth Heinemann, (1994).

[6] Lin, Y., Wang, L., Tseng, H.P. Enhancing knowledge exchange through web map-based knowledge management system in construction: Lessons learned in Taiwan, Automation in Construction, (2006) 15, 693-705.

[7] Newell, S., Bresnen, M., Edelman, L., Scarbrough, H. and Swan, J. Sharing knowledge across projects: limits to ICT-led project review practices, Management Learning (2006) 37, 167-185

[8] Kazi, A and Koivuniemi, A. Sharing through social interaction: The case study of YIT Construction Ltd. Real-Life KM, Lessons from the field. ISBN 952-5004-72-4. (2006). pp 63-81.

[9] Poyhonen, A. (2005). KM-factor – A Method for analyzing the renewal capability of organizations. in the proceedings of the 6th International CINet Page 2 Conference: Continuous Innovation – (Ways of) Making Things Happen. 4-6 September, 2005, Brighton, UK.

[10] Lella, L., Dragoni, A.F., Giampieri, G. "Enabling Knowledge Creation Through Associative Networks and Semantic Web Technologies", Proceedings of F.O.M.I. 2005, Castel Nuovo del Garda (Italy), June 9 2005

[11] Nonaka, I. O. and Takeuchi, H. (1995). The knowledge-creating company: how Japanese companies create the dynamics of innovation. Oxford, Oxford University Press.

[12] Hearn, P., Bradier A and Jubert A. Building Communities: Organisational KM within the European Commission´s Information Society Technologies Programme, ITcon (2002) 7, Special Issue ICT for KM in Construction , pg. 63-68,

[13] Fricke, C. and Faust, B. (2006). Knowledge transfer- acquiring implicit knowledge. International Journal - Nuclear KM, Vol. 2, No. 1, 2006. pp. 46-56

[14] KPMG, KM Research Report. (1998)

[15] APQC (American Productivity and Quality Centre) Consortium Benchmarking Study Final Report Executive Summary, (1996).

[16] McElroy, M. W. The New KM: Complexity, Learning, and Sustainable Innovation. Butterworth-Heinemann, 2002.

[17] Davenport T.H., Thinking for a living. How to get better performance and results from knowledge workers. Harvard Business School Press, (2005).

[18]Anumba, C.J., Ruikar, D., Aziz, Z., Carrillo, P.M., and Bouchlaghem, N. Towards a web of construction knowledge and services, 4th ASCE, Int. Joint Symposium on IT in Civil Engineering, Nashville, (2003).

[19]Davenport, T. H., and Lawrence P., Working Knowledge: How Organizations Manage What They Know. Cambridge, MA: Harvard Business School Press, (1998).

[20]Ruikar K, Anumba, C.J., Egbu,- C., Integrated use of technologies and techniques for construction knowledge management. Knowledge Management Research & Practice (2007) 5, 297–311

[21]Al-Ghassani A.M. Literature review on KM tools. Technical Report, July 2002, Department of Civil and Building Engineering, Loughborough University, UK, (2002).

[22]McAfee A.P. Enterprise 2.0: The dawn of emergent collaboration, MIT Sloan Management Review, 47 (3) (2006), 21-28

[23]Kamara, J.M., G. Augenbroe, C.J. Anumba, P.M. Carrillo, Knowledge Management in the architecture, engineering and construction industry, Construction Innovation 2 (2002), 53–67.

[24]Latham Sir M, Constructing the team. Final report of the government/industry review of procurement and contractual arrangements in the UK construction industry, HMSO, London, 1994.

[25]Egan Sir J, Rethinking construction. Rethinking construction: report of the construction task force on the scope for improving the quality and efficiency of UK construction. London: Department of the Environment, Transport and the Regions, (1998).

[26]Woo, J. H., Mark J. Clayton, Robert E. Johnson, Benito E. Flores, Christopher Ellis, Dynamic Knowledge Map: reusing experts' tacit knowledge in the AEC industry, Journal of Automation in Construction, 13 (2004) 203– 207

[27]Hevner, A.R., March, S.T., Park, J. and Ram, S. Design Science in Information Systems Research, MIS Quarterly 28(2004)1, 75–106