KNOWLEDGE MANAGEMENT AND QUALITY MANAGEMENT SYSTEMS

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ABSTRACT

Knowledge Management (KM) is the formal management of knowledge for facilitating creation, access, and reuse of knowledge, using people, processes and technology. KM does not deal with structured information, but with "living" information and experience that circulate within the company's everyday operations. KM takes advantage of an organization's most valuable asset – the collective expertise of its employees and business partners – by putting it to good use. In short, KM can be defined as a systematic and organized application of the sum of knowledge used and shared everyday within the organization. KM, therefore, provides for continuous improvement of the performance of the organization the same way that a quality management system does. ISO 9000 series and ISO 10014, together, provide a robust framework for performance improvements in the construction. In addition, like quality management, KM is more of a systematic approach involving people, culture and tools.

This paper looks at the correlation of KM and quality management systems. It stresses the significance of continuous improvement for construction organizations. Finally, it explores the ways that quality management systems can benefit from KM activities.

KEY WORDS

knowledge management, quality, systems.

INTRODUCTION

The various changes that have been taking place in the present productive world have demanded a greater productive efficiency and better product quality from the companies (including the construction field) as a means to keep their competitiveness and presence in their operation market.

Amidst all these changes, knowledge stands out as a propelling factor of a new economy, the knowledge-based economy (Nonaka and Takeuchi, 1997; Bettiol and Ribeiro, 2006,). In this new economy, the competitiveness of the construction organizations is directly tied to their ability to effectively create and share knowledge within the organization and with their business partners.

For construction organizations, KM is not new. To date, most companies embarked on knowledge management issues in search of improved efficiency of their processes. Thus, enabling construction organizations to gather, organize, share and reuse the collective experience and know-how of their employees is seen as important to competing in the current economy (Ribeiro, 2001).

Construction organizations can take advantage of KM to reach a sustained market position by a more efficient management of the activities of the business value chain, innovation processes, production and human resources. This explains the organization's growing emphasis on a better management of its knowledge. The main issue for the

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organization is how to use and share the knowledge created from beating its competitors (Walter et al., 2005).

KM is the formal management of knowledge for facilitating creation, access, and reuse of knowledge, using people, processes and technology. KM does not deal with structured information, but with "living" information and experience that circulates within the company everyday operations. KM takes advantage of an organization's most valuable asset – the collective expertise of its employees and business partners. In short, KM can be defined as a systematic and organized application of the sum of knowledge used and shared everyday within the organization.

ISO 9000 series and ISO 10014, together, provide a robust framework for performance improvements in the construction based on the eight quality management principles. ISO 9001 standard combines people, processes and organizational aspects of an organization to implement an effective quality management system. ISO 9004 entails continuous improvement in organization performance to satisfy all its stakeholders groups and to achieve an efficient ISO 9001 based quality management system.

The ISO 10014 standard complements ISO 9000 series by focusing on each quality management principle in turn and providing a list of actions that can be implemented to maximize the possibility of achieving the optimum performance of the organization.

KM, like quality management, is more of a systematic approach involving people, culture and tools aimed at fulfilling the organization's business objectives. KM, therefore, provides for continuous improvement of the performance of the organization. This is why the implementation of ISO 9001 management system should serve as a basis for integrating KM.

This paper looks at the correlation of KM and quality management systems from the analysis of KM elements: people, processes and technology. It stresses the significance of continuous improvement for construction organizations. Finally, it explores the ways that quality management systems can benefit from KM activities.

KNOWLEDGE AND KNOWLEDGE MANAGEMENT

Knowledge can be classified as explicit and tacit (Nonaka and Takeuchi, 1997). Explicit knowledge is that which is transmitted in formal language, through mathematic equations, and symbols. It can be expressed by means of documents, manuals, computer code, verbal language, etc. Once registered, this knowledge can be made available for access to other members of an organization. Tacit knowledge is that which is not externally expressed, made up of information, experience and personal insights from each member of an organization. Tacit knowledge is often hidden and cannot be represented easily, not even by electronic mechanisms (Märtensson, 2000).

Nonaka and Takeuchi (1997) define organizational knowledge as "the ability of an organization to create knowledge, spread it in the organization and incorporate it in products, services and systems". This knowledge can grow in two ways: when the organization makes better use of people's knowledge, and when more people know more about what is useful to the organization (Stewart, 1998), thus indicating that organizational knowledge occurs from individual knowledge.

However, individual knowledge is not simple to share. People are prone to retain knowledge. They often do not do it intentionally; they simply do not know how to externalize this knowledge or are not even motivated to show what they know. In addition to that, since this kind of knowledge belongs to the individual, he takes it away with him when leaving the organization. The organization needs to establish mechanisms so as to represent knowledge that people have and make it accessible to others as a means to spread the knowledge that is useful to the organization itself.

Nonaka and Takeuchi (1997) further argue that knowledge is essentially related to human action, and that both information and knowledge are specific to a certain context. Knowledge without context is futile and must have context if it is to be useful to an organization. Context is an important issue in a number of domains, and from an engineering point of view, context can be seen as the collection of relevant conditions and surrounding influences that make a situation unique and comprehensible (Naveiro and Brezillon, 2003).

KNOWLEDGE MANAGEMENT

Many organizations have tried and failed to implement KM (Obaide and Alshawi, 2005). These failures were related to the lack of an acceptance of a general methodology to guide the successful implementation of KM in organizations (Rubenstein-Montano et al., 2001; Obaide and Alshawi, 2005).

For Märtensson (2000), when implementing KM we must consider some critical elements such as: relate it to the organizational objectives; have the support of the top administration; relate it to creativity; develop an appropriate organizational culture which encourages knowledge sharing; create appropriate incentives for people to share and apply knowledge; allocate time for people's learning and establish systematics to measure results. Terra (2000) apud Santiago Jr (2005) add the need to consider information system along with the use of technologies to help the processes of capturing, spreading and storing knowledge in organizations.

Few organizations have systematically implemented systems to manage their knowledge (Ribeiro 2005, Love et al. 2005). On the other hand, KM plays a critical role in organizations that act in project-based environments (Liebowitz, 2005), as is the case of the AEC (Architecture, Engineering and Construction) companies.

Project involves the participation of different experts, with different skills and knowledge, frequently from different organizations, who meet for a certain time with the purpose of creating a product or service. Project knowledge resides in the group formed and the Project itself does not have any organization memory (Fong, 2005). The end of a project is, therefore, the end of collective learning. Besides that, knowledge and the lessons learned in previous projects are normally not systematically integrated in a company's organizational memory (Ribeiro, 2006).

Thus, KM system in construction is seen as a means to identify and explore the individual knowledge of people in the organization through individual experiences, lessons learned, and best practices (Ribeiro, 2006).

PEOPLE

In the Age of Knowledge, searching for organizational intelligence is anchored in the asset located in people, structures and the clients of an organization (Stewart, 1998). Human asset is formed with knowledge, experience and individual competences. Structural asset, comprised of systems, networks and software, is responsible for support so that the human asset may develop its activities. Furthermore, there is the client asset which considers the values of the relationship between the organization and those with whom it negotiates. The fact that a group of individuals does not suffice to build the human asset of an organization must be taken into account. The knowledge of each individual must be elicited. Thus we can see that the "intellectual asset is not created from different parts of the human, structural and client asset but from the exchange among them" (Stewart, 1998).

It is important to observe that individual learning does not guarantee organizational learning. But, without it, organizational knowledge does not occur. On the other hand, organizations can learn regardless of any specific individual, but not regardless of all of the individuals. The basis for these statements is in systemic thinking, according to which the characteristics of a system are found in the interrelations of its parties. This means that the learning of an organization can only be effective through effective learning interrelations among its members.

To make the process of knowledge use possible in the organization, the organization must identify the necessary competences. This can be done through Knowledge Maps. These maps can be used by the organization to help it identify its knowledge needs and the knowledge strategy to use so that the organization may fill in the gaps observed (Cavalcanti et al. 2001).

PROCESSES

The processes involved in knowledge management seek to create, register, spread and use knowledge in the organization. Creating or generating knowledge has to do with all the forms of knowledge creation, whether it is through the integration with the outside world or by means of the interaction among the members of the organization. Using documents and manuals helps transferring the organization's existing explicit knowledge to other people and helps them to re-experience the experience of others. This is the form of knowledge creation normally used by education and formal training. As for tacit knowledge, because it is in people's minds, its capture involves a more sophisticated process based on intensive personal contact. Transferring this kind of knowledge to other members of the organization is possible through face-to-face contact, informal conversations and even by the use of narratives (stories and statements).

Registers seek to identify and structure knowledge considered useful to the organization so that those who need it may have access to it, i.e., its purpose is to present knowledge in a format that may make it easier to be reused. Spreading and sharing knowledge is meant to transfer knowledge among the members of an organization. Use refers to members of the organization applying their knowledge.

Some authors (e.g. Mäntersson, 2000) add a fifth process to those abovementioned: measuring. Organizations invest in KM but measuring its impact on organizations is still a complex area (Mäntersson, 2000). Without measuring, managers cannot assess if KM is producing positive results and how the process can be enhanced.

TECHNOLOGY

Communication is an essential organizational activity. Under these circumstances, Information Technology (IT) appears to provide an infrastructure for the development of an organization's production and communication activities. IT plays an important role in KM processes and has been considered a fundamental enabler (Obaide and Alshawi, 2005).

When implementing IT a number of difficulties and obstacles must be overcome in order to have a more effective use of this technology. Nevertheless, the greatest difficulty in the virtualization of processes in the construction industry refers to the need of solving structural problems, such as the standardization of specifications, common terminologies and software interoperability (Jacoski and Lamberts, 2002).

On the other hand, KM cannot be implemented with IT only; other KM tools are needed. For Al-Ghassani at al (2005), KM tools have to do with KM techniques (non-IT tools) and KM technologies (IT tools), both required to support KM processes. KM Techniques are tools that do not require technology to support them and occur in different forms, such as: face-to-face interactions, recruitment and training, brainstorming, communities of practice (Al-Ghassani et al., 2005).

KM technologies depend heavily on the implementation of IT resources and consist of a combination of hardware and software technologies, such as: ontology, knowledge bases, intranets/extranets, among others (Al-Ghassani et al., 2005).

Ontology is used to represent knowledge. In the view of Computer Sciences, it is understood as a set of standardized concepts, terms and definitions accepted by a particular community. It is important to observe that it is not so much the vocabulary used that qualifies what is to be considered ontology, but the conceptualizations that the vocabulary terms plan to capture

(Chandrasekaran et al., 1999). For these authors, without ontology or conceptualization of domain knowledge, it is not possible to have a vocabulary that may represent it.

Besides being used to represent knowledge, ontology has been used to structure the basis of knowledge, and one of its main purposes refers to sharing and reusing the basis of knowledge (Oliveira, 1999). Knowledge bases are commonly used to capture explicit knowledge of an organization and can help them do their best in difficult situations enabling construction companies to retain the knowledge that could otherwise disappear in times of pressure and restraint (Ribeiro, 2006).

QUALITY MANAGEMENT SYSTEMS

Implementing a Quality System requires the organization to have specific documentation so that it meets the requirements stated in the norms. Also, it takes a lot of effort to standardize their processes.

ISO 9000 quality management standards are a generally accepted basis for business within the construction industry. ISO 9000 standards are both a way to spread and share good practices and a tool to communicate company performance using international references. An overwhelming majority of big organizations has implemented ISO 9001 quality management systems (Frost, 2005). ISO 9001: 2000 is a customer-oriented quality management standard and requires a documented quality management system.

While ISO 9001 is certification-driven and focuses on the client, ISO 2004 focuses on continuous improvement and considers the other stakeholders involved, besides clients: people in the organization, owners/investors, suppliers and partners, society in the shape of community, and those affected by the organization and its products.

The ISO 10014 standard complements the ISO 9000 series by focusing on each quality management principle: client-driven focus, leadership, people involvement, process approach, systemic management approach, continuous improvement, factual decision-making approach, mutual benefits when dealing with suppliers. The successful use of these eight principles of management in an organization “will result in benefits for all parties, such as improvement in financial return, value creation and increased stability” (NBR ISO 9004 2000).

Examples of documentation created in a Construction Organization when implementing its quality system are: Quality Manual, System Procedures (describing what to do), Work Instructions (information on how to do) and Registrations (documenting what has been done) (Cintra 2005). While the three first items have to do with guidelines to follow by the Quality System, registers are generated by activities, i.e., they are concerned with Quality Management.

Registrations can enhance knowledge about the process developed by the organization since they work as a process feedback. Identifying a non-conformity reveals the opportunity of improvement and induces the evolution of the system. A non-conformity must undergo critical analysis so as to assess its causes and consequences and define the corrective actions to take.

All the documentation described above is used by the organization to prove to its clients and other entities it is following the Quality System. This implies a great change in the organization’s culture, and takes training and education.

Although in order to improve the need for learning is clear, many companies are reluctant to use Total Quality Management (TQM) as part of its learning process to reduce quality failure in their projects (Love et al 2003 apud Love et al 2005). Organizations must be able to learn by detecting and correcting errors and, from past experiences, prevent these errors from happening again.

ISO 9000 and 10014 standards provide a robust framework to improve quality in the organization. Their recommendations can be grouped according to three aspects: organizational aspects of an organization, people and processes to be presented next.

ORGANIZATIONAL ASPECTS OF AN ORGANIZATION

The organization interested in implementing a quality management system must aim at continuous improvement in its performance by meeting the needs of the clients and concerned parties, not only in search of certification. Therefore adopting a quality management system should be a strategic decision to the organization.

ISO standards emphasize the need for leadership, commitment and active involvement of the top administration in several activities in order to achieve the established objectives. Among other recommendations, the norms suggest the top administration should: plan the future and the management of changes; create an atmosphere favoring awareness, motivation and involvement of people in the organization. For people to get involved the organization must help to create an open two-way communication of information and create means to encourage innovation; guarantee resource availability to execute processes; conduct the critical systematic analysis of the performance of the quality system, determine the necessary competences for the personnel in charge of those tasks that may affect the quality of the product, and provide training and other actions to meet the competence needs.

PEOPLE

An organization interested in implementing quality management systems needs to have competent personnel for the activities that affect the quality of the product. This competence must be based on appropriate education, training, skill and experience.

In order to plan for education and training the norms recommend the consideration of tacit and explicit knowledge along with planning and improvement tools, besides creativity and innovation. These plans must also include changes and organizational development and the use of learning from past experiences.

PROCESS

Processes must be documented to the necessary extent so as to support an effective and efficient system operation. Besides that, they must support training in the operation of processes and the sharing of knowledge and experience between work groups and teams.

The organization must identify the necessary processes for the quality management system and its application throughout the organization. These can be product accomplishment processes and product accomplishment supportive processes in order to achieve the desired objectives.

As an example of a support process the norms present information management. According to one of the quality principles “factual decision-making approach”, decisions must be based on the analysis of data obtained in measurements and collected information. Thus, norms establish that the organization must treat data as a fundamental resource to convert information into knowledge.

In order for data to be useful they must be transformed into registration. These must be established and maintained to provide evidence of conformity with requirements. They can be obtained from external and internal sources, learning from past experience, etc. Registrations also show the efficient operation of the quality management system. Compared to the criteria of acceptance they will allow for the identification of the necessary correction actions to eliminate the causes of non-conformity (so as to avoid their repetition), preventive measures (to eliminate the potential causes of non-conformity) or potential improvements in the efficiency and effectiveness of the process. Thus, the organization must determine, collect and analyze appropriate data to demonstrate precision and efficiency of the quality management system and to assess where continuous improvements to the efficiency of the quality management system can be made.

Another process to consider is concerned with communication. It must rely on appropriate tools for the necessary communication of the information in the quality management system.

ISO QUALITY MANAGEMENT STANDARDS AND KM

This study assumes that the concepts of knowledge management can indicate paths to be taken by quality management in addition to allowing for the organization of knowledge, since both systems involve the participation of people and are geared towards continuous improvement.

Table 1 shows the knowledge necessary for a quality management system according to the processes and elements that make up KM. When the organization decides to implement QMS they need to create specific documentation. The process of creation will occur from the internal and external interactions and must be supported by KM tools to capture explicit and tacit knowledge involved in this process.

Table 1 – Knowledge necessary for the QMS according to KM activities

Elements Processes	People	Process	Technology (KM tools)
Creating	Competence Training	Learning from Clients Information on Competitors Member of the Organization Past Experience Publishings	Capture of the explicit and tacit knowledge
Storing	Setting responsabilities	Organizational Memory	Representation of knowledge
Spreading	Encouraging sharing	Conditions that help spreading	Transfer of knowledge
Using	Motivation	Practices for use and reuse of knowledge	Systems Integration
Measuring	Indicators	Relation to organizational performance	Measuring tools
Organizational Aspects (all processes)	Culture Learning People Management Top Administration Support	Organization's strategy and objectives	Process Management Information Management

After capturing the necessary knowledge for the organization, the company should represent such knowledge so as to foster its technical memory. The responsibility for maintaining this memory must be attributed. As example of structure for the organization of knowledge in the quality system of a construction organization can be seen in Cintra (2005).

The knowledge registered needs to be made available to other members of the organization. To do so, the organization must provide the means that help sharing this knowledge among people in the organization.

Motivation programs must also be established encouraging use and reuse of knowledge registered in the organization. The need for interoperability among systems should be emphasized here so as to help this use.

After starting to work, the system needs assessment so as to feed its processes. Indicators are established in order to allow for the comparison between what was planned and what was done.

In the system operation, registrations are generated to attest what was done. And in this feedback process, registration related to past experiences start a new cycle and should be used to create new knowledge.

Finally, for an effective use of KM by companies, the organizational aspects discussed along this study must be observed, with special attention given to people management, by setting development and motivation programs.

IMPROVING THE ORGANIZATION QMS WITH KM

In today's economy, quality management is a core management system within organizations (Frost, 2006). ISO 9000:2000 series are both a way to spread and share good practices and a tool to communicate company performance. The process approach and the continual improvement are two most critical quality management principles and they are the cornerstones of the QMS. Therefore, when establishing a QMS, the value-adding organization's own processes should be taken as the starting point as it is required by ISO 9001:2000. A certified QMS will include procedures describing how processes are performed and managed and for preventing problems and achieving improvements. Continual improvement normally involves streamlining the process flow, identifying problems and its causes, searching for innovative solutions, finding new ways to resolve complaints and developing new responses to customer needs. These tasks demand knowledge and know-how. The new ISO 10014 standard provides clear guidelines on achieving financial and economic benefits via ISO 9001:2000-based QMS. ISO 10014 was designed to identify value adding processes and suggests tools to plan their implementation and measurement in financial terms. KM is clearly an interdisciplinary area, which is often cross-functional in practice.

Processes are increasingly being used to capture and store experience (Funk, 2001). Some processes have been refined and improved over long use and capture the experience gained by people handling them. They are an important source of lessons learned (successes and failures) and know-how. Besides, processes may capture lessons learned and best practices in a wide area of applications, e.g. product specifications, planning, budgeting, and inspection and if reused can be a key to an organisation's success. To carry out an activity within a process, people need specific skills and knowledge as well as concrete information as an input for the task at hand. Experience and lessons are expensive to gain and are often acquired over a long period of time, and so KM plays a key role for improving the QMS. Savings are considerable if lessons learned and best practices from prior activities can be captured, organised, shared and reused efficiently across the organisation. KM, therefore provides for QM the knowledge and know-how and tools needed for continual improvement and consequently for improved organizational performance.

CONCLUSIONS

Construction organizations have embraced KM in search of greater efficiency in their processes. Creating, storing, spreading and using the existing knowledge in the employee's experiences and know-how play an important role for the organization to compete in the new knowledge-based economy.

On the other hand, organizations are driven to seek product and service improvement as a means to keep their presence in their operation market.

An analysis on the elements that make up KM as well as an analysis on the ISO quality standards is presented in this paper. KM's objective, like that of QMS, is to improve the

performance of the organization and is concerned with people, process and technology. Thus, we presented in this paper the correlation between these systems.

Finally, we presented in this paper how applying KM can help construction organizations implement/maintain their quality systems.

FUTURE WORKS

The next step in this project will be checking the considerations presented here in a practical situation.

To do so, semi-structured interviews will be carried out with workers at construction companies, in Portugal and Brazil, who make use of quality management systems. The objective will be to associate the KM activities that are possible to use by construction organizations as a contribution to the improvement of their quality system.

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