3 Construction as a Knowledge-Based Industry

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3.1 Introduction

The emergence of the knowledge era as an integral part of the global economy is leading to dramatic changes in the business environment. Knowledge management (KM) and its manifestation in the expertise of people is now seen as the greatest value of creation for organisations. In a recent Competitiveness White Paper, *Our Competitive Future: Building the Knowledge Driven Economy*, a knowledge economy was defined as one in which the generation and the exploitation of knowledge have come to play a predominant part in the creation of wealth (DTI, 1998). Similarly, the OECD report *The Knowledge-Based Economy* suggested that what is created in a knowledge economy is a network society, where the opportunity and capability to access and join knowledge- and learning-intensive relations determine the socio-economic position of individuals and firms (OECD, 1996). The issues of knowledge production, transmission and transfer are important facets of the knowledge economy.

In a knowledge economy, it could be argued that different kinds of knowledge are evident. These include:

- *'Know-what'* – accumulation of facts that can be broken down into pieces.
- *'Know-why'* – scientific knowledge that underlies technological development, product and process advancements.
- *'Know-how'* – skills or capability to do something and the reason for the formation of industrial networks to enable firms to share and combine elements of know-how.
- *'Know-who'* – involves information about who knows what and who knows how to do what.

Other characteristics of a knowledge economy include an intensified knowledge codification, accelerated transmission of information and emergence of flexible organisations. Such organisations are characterised by multi-task responsibilities, teamwork, job rotation to achieve high product quality and some customisation, together with the speed and low unit cost of mass production. The implications are:

- An increased demand for knowledge, skills and learning; the formation of hierarchies of networks driven by the acceleration of the rate of change and rate of learning.
- Growth of learning organisations that search for linkages to promote interfirm interactive learning, and for partners and networks to provide complementary assets, forming innovation systems and business clusters; formation of complex chains of creation, production and distribution, and global competition.

This chapter discusses knowledge production, transmission and transfer in the context of the construction industry. Following this Introduction, Section 3.2 outlines key characteristics of the construction industry and its role in delivering knowledge-intensive products and services. It is argued that the construction industry, although known for its highly tangible products such as buildings and other structures, is increasingly now recognised as a provider of services, placing more emphasis on knowledge. Section 3.3 focuses on the knowledge production process, the interaction of tacit and explicit knowledge in the creation of new knowledge, and the type of knowledge to manage in construction processes, people and products. Issues relating to skills and competencies in supporting knowledge production are also discussed. Section 3.4 deals with mechanisms facilitating the transmission and transfer of knowledge. The importance of communicating and sharing knowledge within and across organisational boundaries to cope with the increase in collaborative working practices is highlighted. Section 3.5 discusses the need for creating and sustaining a knowledge culture to facilitate knowledge production, transmission and transfer. Section 3.6 presents a summary of key conclusions and recommendations.

3.2 The construction industry and knowledge-intensive products and services

Today's UK construction industry increasingly shares many of the characteristics of the knowledge economy. The industry employs in excess of 1.5 million people and contributes around 8% of GDP. It has the third largest construction output in Europe and is the fifth largest in the world. Exports are in the order of £10 billion, whilst domestically the construction industry is a major sector for delivery of key government programmes such as housing, hospitals and infrastructure. The industry is heterogeneous and diverse, consisting of different organisations, consultants, building materials and product producers, and professionals providing a range of services for clients, customers and the wider community. The industry is dominated by small and medium enterprises (SMEs), which make up over 90% of all organisations, with a relatively small number of large companies. UK consultants and contractors operate in almost every country throughout the

world. The knowledge group of occupations is not broadly homogeneous. Some categories of occupations participate more closely than others in 'scientific and technological' activities, i.e. they are more knowledge-intensive.

Too often, the industry is known for its products (e.g. buildings, roads, bridges, dams and monuments) and not seen as an industry that provides services to its clients and customers. This is despite the very high levels of 'service-input' needed in the formation of construction products. Knowledge-intensive organisations rely on professional knowledge or expertise relating to a specific technical or functional domain. The term knowledge-intensive, in a way, intimates economists' labelling of firms as capital-intensive or labour-intensive. To some extent, these 'labels' describe the relative importance of capital and labour as production inputs. In a capital-intensive firm, capital has more importance than labour; in a labour-intensive firm, labour has the greater importance. By analogy, labelling a firm as knowledge-intensive implies that knowledge has more importance than other inputs.

The knowledge economy is often considered to include 'research and development'-intensive industries and advanced services, whilst too often the so-called resource-based sectors are regarded as medium- or low-knowledge activities. This position is changing fast. Whilst the resource-based organisations do not undertake extensive research and development, they now have to adopt increasing amounts of advanced technology in order to maintain a competitive advantage in an increasingly global marketplace. This is increasingly achieved by focusing on new-added products and services, which has placed an increasing emphasis on skills and knowledge.

Research conducted by Windrum *et al.* (1997) and den Hertog and Bilderbeek (1998) identified design, architecture, surveying and other construction services as knowledge-intensive service sectors. An important feature that distinguishes knowledge-intensive sectors from manufacturing firms is the type of 'product' they supply and, following this, the role they play in regional and national innovation systems. Whereas manufactured products and processes contain a high degree of codified knowledge (they are a 'comodification' of knowledge), knowledge-intensive sectors are characterised by a high degree of tacit ('intangible') knowledge. Specialised expert knowledge and problem-solving know-how are the real products of knowledge-intensive services. Construction activities can be highly knowledge-intensive. Just as 70% of the production cost of a new car can be attributed to knowledge-based elements such as styling, design and software (Scottish Enterprise, 1998), the same can be said of the building of a new modern office complex. A new modern office complex has a high proportion of its development cost attributable to knowledge-based elements such as design, an assessment of cost alternatives of different components of the building, advice on contractual aspects, risks and buildability of the project, quality, health and safety issues on the project, to mention but a few.

Professional knowledge, i.e. knowledge produced by consultants while interacting with their clients' settings, is deeply embedded in a mutual socialisation process, where consultants and their clients design together their final output. This is often seen in the kinds of services provided by professional/consultancy firms of architects, quantity surveyors and engineers. For consultancy or professional firms, their main capital is intellectual assets, and most of their processes are geared towards the exploration, accumulation and exploitation of individual and firm expertise.

3.3 Knowledge production in construction

Organisational knowledge is a mixture of tacit and explicit knowledge. Tacit knowledge is stored in individuals' heads. It is a product of experiences, insights and intuition which could be technical (i.e. know-how of an expert) or cognitive (i.e. based on values, beliefs and perceptions). In the context of construction, examples of tacit knowledge include estimating and tendering skills acquired over time through hands-on experience of preparing bids, understanding the construction process, interaction with clients/customers and project team members in the construction supply chain, as well as understanding tender markets. This type of knowledge is experiential, judgmental, context-specific and therefore difficult to codify and share.

Explicit knowledge is stored as written documents or procedures. As this type of knowledge is codifiable, it is reusable in a consistent manner and therefore easier to share. Examples of explicit knowledge in construction include design codes of practice, performance specifications, drawings in paper-based or electronic format and construction techniques. Materials testing procedures, design sketches and images, 3-D models and textbooks are also examples of explicit knowledge.

3.3.1 Knowledge creation

According to Nonaka and Takeuchi's (1995) theory of knowledge creation, there are four distinct modes of interaction that result in the creation of knowledge (see the SECI model in Figure 3.1). Construction project knowledge is created through the actions of individuals, project teams and

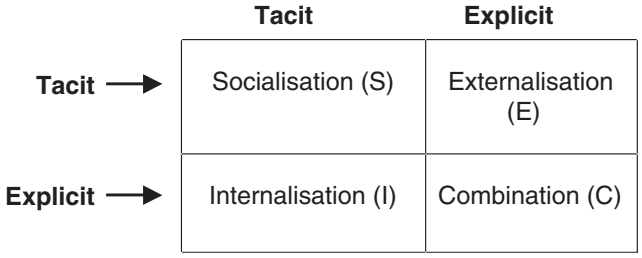

Figure 3.1 Knowledge creation theory (Nonaka and Takeuchi, 1995)

construction organisations, and the interactions of these different types of knowledge (explicit and tacit) from concept design to handing over of the completed project.

Tacit to tacit interaction takes place through the process of socialisation. An architect giving a verbal account or an explanation of a design concept to a client during a meeting is an example of this type of interaction. Apprentice carpenters, bricklayers, plumbers, etc. often work with their masters to learn craftsmanship not through formal instruction but by socialisation which involves observation, imitation and practice. The long tradition of apprenticeship schemes in the construction industry is responsible for producing various craftsmen who rely on their tacit knowledge to solve construction problems. Such experiential knowledge is reinforced and developed through shared experience by continuous interaction and learning from each other. Similarly, young engineers, architects and surveyors supplement their academic training through mentoring. The mentors are often senior management staff who can help individuals to learn, unlock their talents and develop their knowledge in the organisation.

Internalisation takes place when knowledge is transformed from explicit to tacit by individuals. For example, an architect reading a textbook on design theory, or using a manual on design standards, could interpret these explicit documents to create an internal mental model of a unique design satisfying the client's requirements and his/her taste and style. Externalisation is the reverse process where tacit knowledge is made explicit so that it can be shared. An architect engaged in a discussion with a contractor on site, which is subsequently followed by a written instruction made available to specialist subcontractors, engineers and quantity surveyors, is an example of an externalisation process. This process also takes place when an architect translates a design concept or mental model into sketches to explain to a client.

Explicit to explicit knowledge interaction takes place through a process called combination. Combination involves gathering, integrating, transferring, diffusing and editing knowledge (Nonaka and Toyoma, 2003). Individuals and project teams in construction create knowledge through integrating and processing various project documents (e.g. design brief, sketches, project programme, engineering and production drawings, performance specifications, conditions of contract, bills of quantities). Technologies such as e-mails, databases, CAD systems, document management systems and project extranets facilitate this mode of knowledge conversion.

Various other technologies and techniques are used to facilitate other knowledge conversion processes, such as face-to-face interactions, communities of practice, project review meetings, brainstorming sessions and 'toolbox talks' on site. Some of these are discussed in Chapter 6.

Much of the training and experience of construction professionals is based on a balance between codified (explicit) knowledge and tacit knowledge. Case study interviews with structural design firms show that about 80% of

knowledge used during concept design is tacit compared to about 20% of explicit knowledge, whilst the reverse is true at the detailed design stage – 20% tacit and 80% explicit (Al-Ghassani, 2003). It is the dynamic interactions between tacit and explicit knowledge that facilitates decision making in the implementation of construction projects. This is why construction project documents are understood and interpreted by those who have been through the same or similar type of training. For example, structural engineers can extract meanings from design codes or interpret construction drawings easily whilst accountants cannot. It was highlighted in the previous chapter that managers get two-thirds of their information from face-to-face or telephone conversations (tacit) and the remaining third from documents (explicit).

3.3.2 Implications for knowledge management

Decisions on what knowledge a construction organisation needs or the knowledge intensity depends on the context of the business environment, i.e. key knowledge about processes and people for the delivery of its products. These context-based factors address issues of what is produced (products – goods/services), how it is produced (processes) and by whom (people).

There are therefore three aspects of knowledge to manage in the construction context: (1) products or project types, (2) processes and (3) people (see Figure 3.2). The knowledge base of construction organisations is a function of the procedures put in place to capture knowledge about processes, products, as well as people, because knowledge primarily resides in people, not technology (Davenport, 2000). Technology supports connectivity; it is therefore an important enabler to support the KM process.

Product-based factors relate to the characteristics of the services or goods to be produced, whether standardised, mature or innovative (Hansen *et al.*, 1999). Construction project organisations are characterised by the types

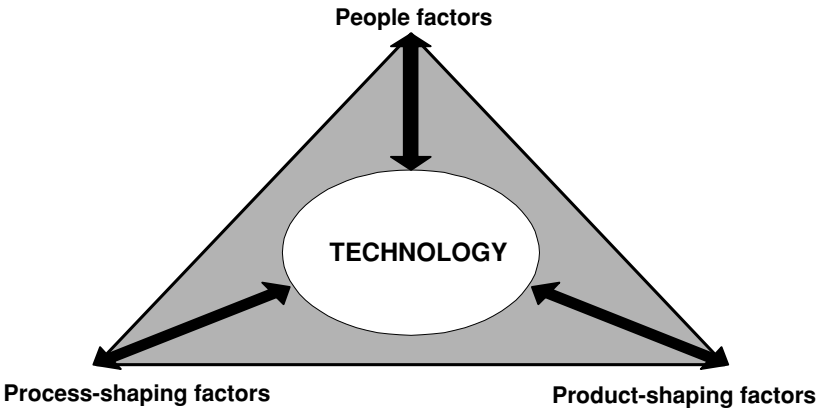

Figure 3.2 Context-based factors influencing a KM strategy. (Reproduced with permission from Robinson *et al.*, 2001)

of projects or the products they deliver. There is a range of 'component products' to produce different types of 'end products', from small and simple buildings to large and sophisticated structures such as the Millennium Bridge. Construction 'end products' are classified into three distinct types: standard construction, traditional construction and innovative construction (Bennett, 1991). Innovative projects are needed to satisfy the demands of clients with unusual needs, or where established answers are no longer appropriate as a result of market or technological changes (Bennett, 2000). Knowledge about clients, end-users and market characteristics is therefore important for construction organisations. Clients range from 'one-off' or occasional clients with very little knowledge of construction to major clients with repeat business and considerable knowledge of construction. End-users may have varying needs and aspirations too. The type of knowledge to be managed in construction is therefore influenced by a combination of client, end-user and market characteristics.

Process-based factors relate to the technical and management systems required for the delivery of products. The 'end products' required by clients are often different as are the (technical and management) processes used in the delivery of construction projects. This difference has profound implications for processes and the types of knowledge to be managed during design and construction. Technical processes range from highly knowledge-intensive approaches relying mainly on tacit knowledge, such as producing design sketches using pencil and paper, to automated processes relying on intelligent and knowledge-based systems (explicit knowledge) codified in plant, machinery or robots for on-site construction. The management processes depend on the type of product to be delivered. Standard construction products are more effectively managed by programmed organisations relying heavily on routine and standard procedures (codified knowledge) to manage the design and construction process. Traditional construction products require professional organisations relying on a mix of standard and flexible procedures (tacit and explicit knowledge) to manage the design and construction process, with specialist contractors who are able to interpret design information in order to manufacture and construct the products. Innovative construction requires highly flexible management procedures characterised by a higher utilisation of tacit knowledge to manage complex design and construction processes. New knowledge is developed through problem solving or creativity to find answers to fulfil unusual and demanding client requirements.

People-based factors relate to skills, problem-solving abilities and the characteristics of teams. Bennett (1991) argued that while appropriate project management structures are necessary to tackle the different types of products, they are not sufficient to ensure an efficient construction industry. Highly skilled individuals and competent teams (designers, suppliers and constructors) are vital for the construction process. Standard construction requires individuals with basic knowledge and skills.

However, problem-solving or creative people are needed for innovative projects that are often ill-defined and complex to implement. Individuals with tacit knowledge are central to the creativity required in the design and construction of innovative projects. Team stability also has a profound implication for knowledge creation and reuse. Egan (1998) noted that 'the repeated selection of new teams inhibits learning, innovation and the development of skilled and experienced teams'. This view is supported by Bennett (2000) who argued that the best result comes from the same people working together project after project.

3.3.3 Knowledge mapping

The starting point for structuring construction project knowledge is to develop a knowledge map for locating explicit knowledge, and for serving as pointers to holders of tacit knowledge. Figure 3.3 shows a knowledge map with multiple level of details. The items or elements on the knowledge map can be text, drawings, graphics, documents, directories, icons, symbols or models which can also serve as links to more detailed knowledge. For example, skills yellow pages are widely used to provide a directory of experts. This can help in finding the right person to approach for advice and best practice. A leading consulting organisation has skills yellow pages that put one in contact with not just another person but that individual's network (Sheehan, 2000). Such a knowledge mapping tool is very important but needs to be kept up to date to maintain its usefulness.

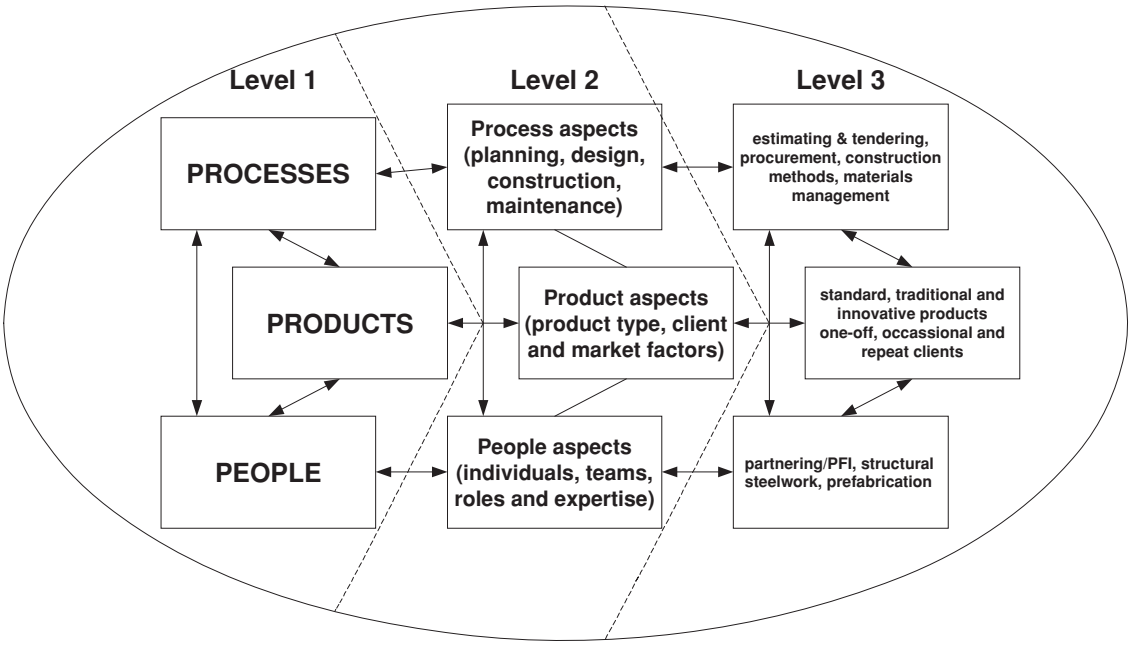

Figure 3.3 Knowledge map (Robinson *et al.*, 2002) (PFI, private finance initiative)

Table 3.1 Examples of process knowledge base

Sub-processes	Key knowledge issues
Procurement	Partnering, PFI, design and build, construction management, traditional contracting
Estimating and tendering	Profit margins, overheads, bidding success rate, bidding costs, regional factors, sub-contract quotations
Materials management	Structural steelwork, concrete
Construction methods	Prefabrication, on-site construction

Source: Robinson *et al.* (2002)

Table 3.1 illustrates a range of process knowledge areas that construction organisations may wish to explore. A similar profile could be developed for people and product knowledge.

The knowledge map serves as a continuously evolving project memory, forming a link between different knowledge sources, capturing and integrating new knowledge into the project knowledge base. It also enables construction project team members to learn from past and current projects through the navigation of information as well as the creation of new knowledge, by adding, refining and broadening the scope.

3.3.4 Skills and competencies in a knowledge economy

In order to truly embrace the ethos of the knowledge economy, the construction industry and its firms will need to address a host of challenges. The main challenges include having to cope with increasing competition, the construction market becoming more global, the changing levels and patterns of demands from clients, customers and the society, and dealing with the pace and implications of changes in information and communication technologies (ICT). These have important ramifications for organisations, some of which are structural as well as cultural. For many organisations, the knowledge economy involves rapid change, uncertainty and turbulence. Firms will need to continuously adapt their technical and management processes, seek and retain appropriate skills and competencies to deal with unusual product demands, and accommodate new technologies and grasp new opportunities.

In order to have a competitive industry, and one that is capable of improvement in a knowledge economy, it is essential that the industry has an efficient, motivated and competent workforce. In such an economy, employee mobility and loyalty are important issues for management. A future where 50% of school leavers are expected to proceed to higher education is one that is placing pressure on the industry's ability to recruit at operative and technical levels, and requires adjustments to recruitment at higher technical, managerial and professional levels. Competing in the labour

market of the future, construction will need to be seen as a cutting-edge knowledge-based industry – providing career opportunities, better working practices and innovation. In recent years, lack of requisite knowledge and of skilled labour within the industry has come to the forefront, with clear indicators that skills are failing to keep up with demand. *The State of the Construction Industry Report* (DTI, 2002) highlights that over the last few years, intake onto construction-related degree courses has declined considerably, affecting the capacity of the industry to deliver the government's programme of infrastructure renewal and improved value for money. Future skills requirement and any skills restructuring need to be devised to facilitate the meeting of wider social and political targets demanded by clients and government, and sought by the industry. These should include policies related to working conditions, workforce engagement (including diversity and equality), health and safety, career development and life-long learning.

The key skills requiring further training were identified in the Construction Research and Innovation Strategy Panel's recent reports, *Changing Skills Needs in the Construction Industry* (CRISP, 2001) and *Culture and People in Construction – A Research Strategy* (CRISP, 2002). These skills are inter/intra-team trust, interorganisational teamwork and co-operative working. The skills associated with exploiting information communication technologies for improved business needs are also vital. In construction, there is a slow but increasing take-up of e-business approaches and models by a few practices, suppliers and manufacturers.

It is estimated in the *Accelerating Change* report (Strategic Forum for Construction, 2002) that the construction industry will need to recruit the equivalent of 76 000 workers per annum based on modest growth estimates. Given changing clients' demands and the desire to apply new technology and processes, it is essential that the key culture and people issues in construction are addressed urgently. Engagement of the workforce is vital to establishing a culture of 'organisational learning' as this enables the workforce to continually learn and update its skills. This is needed for meeting the challenges of the knowledge economy and for improved competitiveness. In addition, both the reports *A Commitment to People – Our Biggest Asset* (Rethinking Construction, 2000) and *Respect for People – A Framework for Action* (Rethinking Construction, 2002) noted that construction organisations that fail to improve their attitude and performance towards respecting people will fail to recruit and retain the best talent and business partners.

3.4 Communicating and sharing knowledge

In the construction industry, as in other knowledge-based industries, knowledge can be viewed as a 'stock of expertise'. An organisation's stocks of expertise come from the flows in complex input–output systems. Knowledge

flows in through hiring, training and purchase of capital goods. Some knowledge gets 'manufactured internally', through research, invention and culture building. Knowledge flows out through staff departures, imitated routines and sales of capital goods.

The organisation of the supply chains is an important characteristic of construction organisations. These supply chains exhibit a specific division of labour and institutionalised roles, such as engineering companies and architects, building contractors, and the manufacturers and suppliers of building materials or parts.

3.4.1 Intra- and interorganisational knowledge sharing

In the UK construction industry, there is now a steady increase in collaborative working practices, such as partnering, alliances, joint ventures, framework agreements and private finance initiative (PFI) projects. In addition, projects are growing in complexity and cost, and clients' demands and expectations are also increasing more than ever before. This presents a situation where organisations have to collaborate and share knowledge, skills and expertise in order to meet the needs of clients. However, organisations need to be mindful of both the communicative behaviours and practices associated with knowledge exchange and the 'knowledge paradox'. Organisations will have to be open to, formal and informal, information and knowledge flows from both networks and markets. At the same time, they must protect and preserve their intellectual capital and knowledge base because it is upon this latter point that survival depends. Many construction organisations have started to develop extranets to facilitate collaborative working on specific projects. However, external knowledge sharing poses greater risks than internal sharing – raising complex issues such as confidentiality, reliability and copyright. Matusik and Hill (1998) argued that 'more permeable firm boundaries provide for easier access to external knowledge but, at the same time, allow for more rapid dissemination of a firm's unique stock of knowledge outside its boundaries'. They further argued that 'grafting knowledge from the outside environment is not easy, a firm needs mechanisms to bring public knowledge in, to transmit this knowledge within the firm and to fuse the new knowledge with existing stocks of knowledge'.

Many innovation processes in the management and procurement of construction activities are becoming increasingly interactive, requiring simultaneous networking across multiple communities of practice such as professional groups, functional groups and business units (Egbu *et al.*, 1999). This networking involves communication and negotiation among different social communities with distinctive norms, cultural values and interest in the innovation process (Egbu *et al.*, 2000). This therefore means that the knowledge needed for innovation and competitive advantage is distributed within organisations and across organisational boundaries. Heterogeneous

team organisations cut across these boundaries and are therefore important for realising the products of the knowledge economy. The movement of personnel could also be seen as a mechanism for distributing tacit knowledge and skills, or human capital, across space and time.

Construction professionals and organisations face economic imperatives when they conduct their knowledge work. More codification of knowledge, and more explicit repositories, enhances knowledge costs, efficiency of exploitation and transparency of sharing. However, Sternberg (1988) argued that much of the knowledge on which performance in real-world settings is based is tacit. Tacit knowledge, however, does not imply that such knowledge is completely inaccessible to conscious awareness, unspeakable or even unteachable; merely that it is not usually taught directly.

Explicit repositories of knowledge often hide the in-depth nature of knowledge work, which includes the articulation of collective tacit knowledge into a strategic collective expertise. It could be argued that the competitive advantage of professional firms in the construction industry lies in their ability to build communities of practice, relationships with their clients, and to increase their tacit and collective knowledge capital through intensive socialisation. Professional practices in construction may therefore take seriously their ability to shift from accumulation-driven KM towards more sense-making and tacit understanding-driven knowledge capital.

Network relationships and collaboration are key sources of knowledge building, language sharing and in the building of shared meaning. Organisations working together in networks such as supply chains are likely to spread and share best practices and the results of research and development. However, organisations would need to be mindful of adaptive efficiency and role boundary spanning when dealing with the different types of organisational co-operation and collaboration.

3.4.2 Communities of practice (CoPs)

An important concept in relation to building appropriate networks is that of a community of practice (CoP). Communities of practice (CoPs) are developed through the process of acting together, to create meaning through negotiation (Brown and Duguid, 1991; Lave and Wenger, 1991; Wenger, 1998). The negotiation of meaning has two complementary elements, 'participation' and 'reification'. From the perspective of a single CoP, 'participation' refers to the social interaction of members that keeps the CoP together, and 'reification' stands for the material manifestations of a diversity of cognitive activities by which members create meaning. An important requirement for sharing knowledge between people is therefore a presence of shared practice. Shared practices are vital for developing knowledge as they enable the flow of knowledge within the group.

The communication of knowledge in CoPs is possible and effective between people who, to some extent at least, share a system of meaning. In other words, they have an 'absorptive capacity' to understand one another.

The use of CoP is an effective mechanism for integrating strategic business units (SBUs) and functional areas such as human resources, planning, information technology, design, marketing and training. Since all professions and occupations are affected by a KM approach, it is essential that all professions, including support professions, move out of their 'functional silos'. Within a CoP, the issue of handling knowledge in heterogeneous and temporary groups is important. Such groups are characterised by performing tasks with a high degree of complexity and lack of formal structures that facilitate co-ordination and control. They often entail high-risk and high-stake outcomes and depend on an elaborated body of collective knowledge and diverse skills. Moreover, there is mutual dependency of the participating partners, which stems from a division of labour where each task is dependent on the other.

A recent survey of large construction organisations carried out at Loughborough University (Carrillo *et al.*, 2002) showed that CoPs are the most widely used technique for knowledge sharing. Large international construction organisations with a range of specialist skills tend to have the greatest need as well as resources to set up CoPs and to benefit significantly from them.

3.4.3 Networking

Networking is not only important for gaining information and knowledge; it is also necessary in order to overcome barriers that may prevent individuals or teams being able to understand each other's perspectives. Organisations rely on groups or networks of specialists because they can access a larger amount and more diverse, yet relevant, information and knowledge than individuals, and thus possess the potential for improved task performance. Over time a group or network may develop a collective understanding or shared mental model. The team can have a shared mental model of the task, knowledge about work, and a shared mental model of the team, and knowledge about group members. Experience of working with the same group allows individuals to develop an understanding of others' abilities, enabling them to develop strategies for solving problems. The strategies are not known solutions but are knowledge bases that are highly regarded for certain types of information. Previous interaction enables a shared mental model, which reduces the amount of 'small talk' required before they can communicate on the relevant issue. An understanding of the communication behaviours of others should help communicators calibrate their communication so that informative intention is understood. Communication behaviours within an organisation play a significant part in contributing to or detracting from an organisation's success. This again highlights the importance of absorptive capacity among those sharing and communicating professional knowledge.

The construction industry has also been made increasingly aware of knowledge sharing through networks. Examples of knowledge sharing

networks are the Construction Best Practice Programme (CBPP), Construction Productivity Network (CPN) and Movement for Innovation (M4I). The Co-operative Network for Building Researchers (CNBR) is also a useful network. Following the Egan (1998) recommendations, a number of benchmarking clubs have also been created in construction to facilitate learning and sharing best practice. This is consistent with what Bennett (2000) referred to as the 'third way' in construction, that is, the need to balance co-operation with competition.

3.4.4 Communication

Communication is a key requirement for building a project's, or an organisation's, knowledge base (Egbu *et al.*, 2000). More specifically, it involves interaction between specialists, moving information more freely between those with information/knowledge and those who may find the information useful. Building and maintaining networks is important if individuals and organisations are going to widen and possibly strengthen their decision-making potential. Maintaining communication can be used to prevent interaction deteriorating, improve interaction or as a routine mechanism for keeping knowledge exchange fluid. Being aware of strategies for maintaining communication and consciously using communication strategies to strengthen and build networks will be important for the strategic management of knowledge.

A business environment that is conducive to information and knowledge exchange would seem to be one that has a supportive culture, with participants who are actively engaging in individual and project objectives. The participants who are active within the project value their own and their colleagues' participation, and their knowledge. Participants must feel that they can express their true thoughts on the subject, and these must be valued. Wherever hierarchical structures, social power or competition are a dominant factor, individuals may be less willing to voice their true thoughts and opinions.

A problem with business communication is that people cannot be forced to provide or accept knowledge. Communication of ideas, information and suggestions in a competitive environment may not be forthcoming. If power, position or status is used to demand information, the requestor may obtain the information he or she wants without any positive intellectual contribution from the individual. Specialist information, which manifests in the person's mind, is exchanged, in most cases, when the person chooses to disclose it. When it is not known whether someone has specific information or knowledge, he/she cannot be forced into divulging it. Tacit knowledge resides in the individual person's mind and there is little chance of others knowing it unless the person chooses to disclose it.

Organisations and projects are complex, with complexity increasing with the number of multidisciplinary specialists involved. The project

environment brings with it considerable information processing needs. Individuals within organisations and projects will determine how much effort they are going to expend assisting the processing of information. Individuals may be selective with the amount of information disclosed, the person to whom they disclose it and the degree to which they attempt to get the other person to understand. An organisation or project environment that facilitates the release and exchange of information needs to support individuals, groups and networks, making strategic efforts to assist information and knowledge flow. Organisations need communication strategies to reduce barriers and support co-operation.

3.5 Creating and sustaining a knowledge culture

Managing knowledge assets is not easy. Creating and sustaining a knowledge culture where knowledge is valued and where knowledge creation, sharing and utilisation are a natural and an instinctive part of business processes is also not easy, but essential for meeting the challenges ahead.

The following issues are important in creating and sustaining a knowledge culture for the challenges associated with the knowledge economy:

- Support from top management and the presence of a strong 'knowledge champion'.
- Link to economic performance and strategy, underpinned by a coherent knowledge vision and leadership.
- Clear purpose and shared language and meaning of KM.
- 'Flexibility' in the lines of communications, allowing top-down, bottom-up and lateral communications within organisations. Multiple channels of knowledge transfers/dialogue with functional departments, interaction with clients/customers and suppliers.
- A risk-tolerant climate, where it is accepted that lessons could be learned through mistakes.
- A climate where people genuinely feel valued and people feel some form of 'ownership' or are involved with the KM initiatives in place.
- A climate where people feel secure in their jobs.
- Technical infrastructure (systems to obtain, organise, restructure, warehouse or memorise and distribute knowledge) such as intranet, internet, repositories, databases and video-conferencing.
- Organisational infrastructure (teams, relationships and networks) including face-to-face meetings, brainstorming sessions, apprenticeships, job rotation, coaching and mentoring, CoPs, quality circles, reports and project summaries, help desks and bulletin boards.
- A sharing culture where there is openness and willingness to share information, experience and knowledge across project teams and the organisation.

- Change in motivational practices (including performance management and team-based rewards).
- An environment that supports and promotes education and training.

For a corporate-wide programme, the involvement of the Chief Executive Officer or the Managing Director is important. At a regional and departmental level, the involvement of top management is also crucial. The strategy for planning the approach to managing knowledge assets for an organisation will usually be developed by a small team drawn from top or senior management, representing different aspects. Representation and buy-in from the wider organisation is important, so as to ease the implementation and rolling-out stages of the strategy. Similarly, having robust organisational infrastructure, flexible knowledge structures and positive motivational practices should promote knowledge sharing. Further discussions in creating a knowledge-sharing culture in construction project teams are provided in Chapter 12.

3.6 Conclusions

Conducting business in a knowledge economy brings opportunities and challenges. The opportunities include the possibility of increasing market share, improving productivity and profitability through innovation and the effective management of knowledge assets. The main challenges involve dealing with increased global competition; the changing levels and patterns of demands from clients, customers and the society; and the increasing pace and implications of change in information and communication technologies (ICT).

The construction industry is a knowledge-based industry. It is diverse, being made up of different organisations, consultants and professionals providing a range of services for clients, customers and the wider community. The activities of today's construction industry also demand an increased level of knowledge, skills and learning; and this relies on the formation of hierarchies of networks driven by the acceleration of the rate of change and rate of learning. The industry can be viewed as a 'stock of expertise'. These stocks of expertise come from the flows in complex input–output systems. Knowledge flows in through hiring, training, and purchase of capital goods, while some knowledge gets 'manufactured internally'. Knowledge flows out through staff departures and imitated routines.

Knowledge is the driving force of a knowledge-based industry. It is critical for effective action in the economy of the future and can bring critical competitive advantage. Knowledge leadership is vital for the industry. The question for leaders in the construction industry and for management is how to optimise within the old constructs that still exist. For example, if

the construction industry is to build and maintain capability in a knowledge economy, it has to change its adversarial culture to a sharing culture. Furthermore, it has to learn from each project and transfer knowledge from projects to organisational bases. The industry will also need to invest in long-term relationships.

For the construction industry to deal successfully with the challenges of the knowledge economy, it has to deal effectively with its skills shortage. Creating and sustaining a knowledge culture (where knowledge is valued and where knowledge creation, sharing and utilisation are natural and instinctive parts of business processes) is essential for meeting the challenges of the knowledge economy. This calls for effective vision, leadership, coherent strategies and structures, and respect for people.

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