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IMPORTANCE OF TACIT KNOWLEDGE TOWARDS COMPANY PERFORMANCE AND ITS RELEVANCE TO CONSTRUCTION

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ABSTRACT

Valuable human and knowledge resources will be wasted unless organisations make better use of these prime resources. Tacit knowledge in particular is still considered to be relatively unexplored and proper understanding and management of this resource is of immense importance for better organisational performance.

The research addresses the importance of people factor and tacit knowledge in construction and examines the contribution towards the company performance and achievement of competitive advantage through a thorough literature review. Principle insights of dominant views on organisational resources are discussed to highlight the strategic nature of tacit knowledge. Labour and knowledge intensive nature of the construction industry is revealed and finally the importance and the significant role of people factor and tacit knowledge in construction are highlighted. This provides the basis for more empirical research on finding importance of tacit knowledge towards organisational performance in the construction industry.

Keywords: construction worker, organisational performance, Tacit knowledge.

BACKGROUND

Within the last few decades, there has been an increasing interest in the tacit dimension of knowledge, which is perhaps hardest to manage, as it cannot be formally communicated and is often embedded within human beings. Thus, the issue of tacit knowledge has been dealt with within many disciplines and by many authors, yet still considered to be relatively unexplored and not fully understood (Zack 1999) compared to work on explicit knowledge (Leonard and Sensiper 1998; Holtshouse 1998). Nevertheless, tacit knowledge has become more relevant to sustaining business performance than traditional physical capital and considered as a very crucial factor affecting an organisation's ability to remain competitive (Amit & Schoemaker 1993; Grant 1996; Spender 1996; Teece 2000; Eisenhardt and Santos 2000). In this context, there is an emerging importance placed on tacit dimension of knowledge within the construction industry and its organisations to achieve best value due to industry's inherent nature.

The construction industry is considerably more fragmented than many other industries with a much greater concentration of small professional organisations (Tatum 1986; Carty 1995; Halpin and Woodhead 1998). The services offered by these professional organisations are characterised by being highly tacit knowledge intensive in nature (Løwendahl 2000), with a wide range of professionals involved, working as an inter-

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disciplinary team in delivering the construction products. In addition, the concept of the knowledge worker (Green et al 2004) has long been important within the construction industry, which is considered to be one of the labour intensive sectors of the economy compared to other industries.

This paper aims to highlight the importance and the relevance of tacit dimension of the knowledge in construction organisational performances through a critical and comprehensive literature review and a synthesis. Accordingly, the paper is organised into four broad sections: the first section explores the strategic importance of tacit knowledge, to highlight the vital role gained within organisations towards achieving competitive advantage. Within the second section, salient features of the construction industry are discussed and finally in sections three and four the importance and the relevance of people factor and tacit knowledge in construction are critically analysed respectively.

STRATEGIC NATURE OF TACIT KNOWLEDGE

The view that knowledge is a valuable organisational resource has become widely recognised and accepted in the business community. One consequence is the increase in organisations' efforts to deliberately manage knowledge in a systematic manner. Yet, an understanding of what constitute 'knowledge' is central to its effective management. Definitions of knowledge range from the practical to the conceptual to the philosophical and from narrow to broad in scope. Knowledge is built from data, which is first processed into information. There seems to be a large misconception in considering knowledge interchangeably with information. However, the various definitions of knowledge suggest that it is much more than information. As Grey (1996) contends knowledge is the full utilisation of information and data, coupled with the potential of people skills, competencies, ideas, intuition, commitment and motivation. According to Nonaka & Takeuchi (1995), knowledge could be defined as a dynamic human process of justifying personal belief towards the truth. Both these definitions further stresses the involvement of human beings and as Beveren (2002: 19); asserts "*Even though some argue knowledge can be acquired, stored and used outside of the human brain, knowledge cannot exist outside of the human brain and that only information and data can exist outside of the brain*". This further has fuelled the attempts to distinguish between knowledge and intellectual capital and too often the delineation between the two terms is unclear and seldom adequately addressed (Guthrie 2000). However, it is necessary to view knowledge on the basis of its final use and/or on the basis of the context of its use (Carrillo et al 2000). This underscores the fact that knowledge can be viewed as a component of a task performing system. That is, a state of that system which warrants task completion, and the future repetition of this task (ibid: 2). Highlighting the end use, Beckman (1997) defines knowledge as reasoning about information and data to actively enable performance, problem-solving, decision-making, learning and teaching. Thereby, information becomes knowledge when it enters the system and when it is validated (collectively or individually) as a valid, relevant and useful piece of knowledge to implement in the system (Blumentritt and Johnston 1999).

Despite various definitions and classifications of knowledge, work by Polanyi (1958), Nonaka and Takeuchi (1995), divided knowledge into tacit and explicit. Although knowledge could be classified into personal, shared and public; practical and theoretical; hard and soft; internal and external; foreground and background, the classification of tacit and explicit knowledge remains the most common and practical.

Tacit knowledge represents knowledge based on the experience of individuals, expressed in human actions in the form of evaluation, attitudes, points of view, commitments and motivation (Nonaka et al 2000). Since tacit knowledge is linked to the individual, it is very difficult, or even impossible, to articulate. Explicit knowledge, in contrast, is codifiable knowledge inherent in non-human storehouses including organisational manuals, documents and databases. Yet, it is difficult to find two entirely separated dichotomies of tacit and explicit knowledge, instead knowledge can fall within the spectrum of tacit knowledge to explicit knowledge. What ever the classification it takes, knowledge has become more relevant to sustaining business performance than capital, labour or land (Drucker 1992) and considered as a very crucial factor affecting an organisation's ability to remain competitive (Amit & Schoemaker 1993; Grant 1996; Kogut & Zander 1992; Krogh & Roos 1996; Peteraf 1993; Spender 1996) in today's fast changing and non-linear business environment. During the last decade, the centrality of knowledge and more generally of intangible resources, in the creation of value and competitive advantage has been subject of several reflections which can be set in different mainstreams as the Resource Based View (Amit & Schoemaker 1993; Barney 1991; Grant 1996), the Competence Based Competition (Leonard-Barton 1992; Nonaka and Takeuchi 1995; Prahalad and Hamel 1990; Rumelt 1994), Dynamic capabilities approach (Spender 1996; Teece et al 1997; Brown and Eisenhardt 1998) the Knowledge Based View (Grant 1996; Sveiby 2001). In all these mainstreams, capabilities gained through intangible resources, specifically knowledge, are seen to be at the basis of company's ability to achieve competitive advantage. Succeeding section outlines the principle insights of these different approaches to highlight the strategic nature of tacit knowledge.

Knowledge Based view of the organisation

Researchers investigating on the sources of company's sustained superior performance have primarily and typically anchored their work in the Resource Based View (RBV) of the organisation (Barney 1991; Wernerfelt 1995; Peteraf 1993). The RBV considers two assumptions in analysing sources of competitive advantage. First, it assumes that firms within an industry may be heterogeneous with respect to the resources they control. Second, these resources may not be perfectly mobile across firms, and thus heterogeneity can be long lasting. One of the principle insights of this view is that not all resources are of equal importance or possess the potential to be a source of superior performance through resource heterogeneity and immobility. As Barney (1991) contended it is the possession of key resources or strategic resources and its effective deployment in product-markets that render superior performance for organisations. To be a key resource or a strategic resource it should possess four attributes:

- It must be valuable: to exploit opportunities and/ or to neutralise threats in a firm's environment
- It must be rare: among a firm's current and potential competition
- It must be imperfectly imitable, and
- There can't be strategically equivalent substitutes for this resource that are valuable but either rare or imperfectly imitable.

These attributes of organisational resources can be thought of as empirical indicators of how heterogeneity and immobility a firm's resources are and thus how useful these are for generating superior performance through sustained competitive advantage. For

many authors (Amit & Schoemaker 1993; Grant 1996; Krogh & Roos 1996; Spender 1996; Teece 2000; Eisenhardt and Santos 2000) knowledge, which possesses all these characteristics of a strategic asset, is the best and the only resource for achieving sustainable competitive advantage as postulates in the Knowledge Based View (KBV) of the firm. This perspective considers knowledge as the most strategically significant resource of the firm (Grant 1996), and its proponents argue that heterogeneous knowledge bases and capabilities among firms are the main determinants of sustained competitive advantage and superior corporate performance (Decarolis and Deeds 1999; Winter and Szulanski 1999).

Yet, the increasing dynamism of the environment, with its frequent and rapid changes in technology, customer preferences, and competition, has led a number of researchers (e.g., Eisenhardt 1989; D'Aveni 1994) to question the sustainability of superior performance of any given strategic position, bundle of resources or set of moves. As Eisenhardt and Santos (2000) argued, in high-velocity environments, an extreme form of dynamic markets where even basic industry characteristics such as boundaries, competitors and customers are in flux, no specific advantages are sustainable. Therefore, the dynamic capabilities approach argues that competitive advantage is dependent on particular organisational and managerial processes, termed 'dynamic capabilities', which are defined as the firm's ability to integrate, build and reconfigure internal and external competencies to address rapidly changing environments (Teece et al 1997).

Based on this understanding of organisations and dynamic environment, Grant (1996) proposed a knowledge-based theory of strategy. As Grant (1996) asserts, the source of competitive advantage in dynamic environments is not knowledge that is proprietary to the organisation, because the value of such knowledge erodes quickly due to obsolescence and imitation. Rather, sustained competitive advantage is determined by non-proprietary knowledge in the form of tacit individual knowledge. Tacit knowledge can form the basis of competitive advantage because it is both unique and relatively immobile. The distinction between tacit and explicit knowledge has proven to be particularly important in this dominant view, which identifies tacit knowledge as the most significant strategic resource of firms. Yet, because that knowledge is possessed by individuals and not the organisation, a critical element of sustained competitive advantage is the ability to integrate the specialised and tacit knowledge of individuals. In addition, Grant (1996) makes the point, also emphasised by other scholars (Kogut and Zander 1996; Kogut 2000), that tacit knowledge can also be integrated externally through relational networks that span organisational boundaries, especially in high-velocity environments, where the speed and scope of knowledge integration are paramount for sustaining competitive advantage. Overall, Grant's approach extends the dynamic capabilities view of strategy (Teece et al 1997) and can be considered an outgrowth of resource based thinking. As such, this highlights the importance of tacit knowledge towards organisational performance when integrated and managed properly. The following section further outlines the significance of tacit knowledge by highlighting the reasons for its strategic nature.

Tacit Knowledge and its diffusion within the organisation

As Herrgard (2000) and Empson (1999, 2001) contended, organisations' knowledge resources can be described as an iceberg. The structured, explicit knowledge is the visible top of the iceberg, which is easy to find and recognise and therefore also easier to share. Beneath the surface, invisible and hard to express, is a momentous part of

the iceberg. This hidden part applies to tacit knowledge resources in organisations. Tacit knowledge is the unarticulated knowledge that resides in human beings, which is obtained by internal individual processes like experience, reflection, internalisation or individual talents (Herrgard 2000). Therefore it cannot be managed and taught in the same manner as explicit knowledge. An organisation's core competency is more than the explicit knowledge of 'know-what'; it requires the more tacit 'know-how' to put 'know-what' into practice (Brown & Duguid 1998). Even if coded knowledge is easier to diffuse, the role of tacit knowledge is often essential for being able to use coded knowledge.

The characteristic of tacit knowledge is the difficulty in coding it so as to be shared like explicit knowledge. Yet, literature reveals several different schools of thought regarding diffusion and codification of tacit knowledge. One believes that tacit knowledge can be and must be made explicit for sharing seems to be stronger than those who regard that tacit knowledge as always being tacit. One prominent example on the former argument is Nonaka & Takeuchi (1995) who created a model of knowledge creation in their SECI-model as given in Figure 1.

		Tacit	To	Explicit
From	Tacit	Socialisation		Externalisation
	Explicit	Internalisation		Combination

Figure 1: SECI Model of Knowledge Creation

The mode in focus is externalisation, where tacit knowledge is articulated to explicit knowledge through dialog and listening as indicated in the SECI-model. Converting the tacitness of one's knowing to make it explicit is not an easy task. Yet according to Polanyi (1958), who views tacit knowledge as achievable only through personal experience, diffusion seems to be impossible, where as others (Leonard & Sensiper 1998; Zack 1999; Holthouse 1998) consider sharing tacit knowledge as very difficult.

It is dubious whether externalisation is really necessary and what benefits can achieve by doing so. As stated previously, value, rareness, inimitability and non-substitutability are the indicators of resource heterogeneity and immobility to become strategic assets and capabilities generated from these strategic assets, which cannot easily be copied by the rivals ultimately become the path for gaining better performance. By articulating, diffusing tacit knowledge into documents, databases or other permanent medium, hence dilute the strategic nature by making it easier to acquire or imitate. To make all knowledge explicit and eliminate the tacit personal elements in it could even be destructive to all knowledge (Polanyi 1966). It is this difficulty of diffusing tacit knowledge to other forms of codified knowledge renders the strategic nature of the tacit over the explicit knowledge. In this context, tacit knowledge gains a prominent role within the construction industry and its organisations due to industry's inherent nature. Succeeding sections briefly explore

the nature of construction industry and important role of tacit knowledge within the construction domain.

AN OVERVIEW OF CONSTRUCTION

Construction is an industry which utilises a variety of separate firms in a temporary multidisciplinary organisation, to produce investment goods like buildings, roads, bridges etc, which are custom built to unique requirements. The industry is generally driven by single and unique projects, each creating and disbanding project teams made up of varying combinations of large and small firms from across the supply chain spectrum (Tatum 1986; Carty 1995; Halpin and Woodhead 1998). The short-term temporary project based nature is considered as an intrinsic characteristic of construction and industry is considerably more fragmented than many other industries with a much greater concentration of small firms (Green et al 2004). The scale of small firm activity in the UK construction industry is considerable, with, in 1999, 99% of UK construction firms having 1-59 staff (DETR 2000: Table 3.1) and by 2002 delivering some 62% of the industry's workload (DTI 2003: Table 3.3) and accounting for 122,220 small and medium construction firms in 2003 (Green et al 2004). Further, the number of professional service firms within the construction industry has risen from 48,202 in 1995 to 52,490 in 1998 (CIB W55-W56 2002) and the services offered by these professional service firms are characterised by being highly knowledge intensive in nature (Løwendahl 2000).

This in a way evident the shift towards the knowledge economy in the UK construction industry and there is significant agreement that the principle means by which this growing body of professional service firms creates value through the successful management of knowledge (Robinson et al 2001). The UK Government's Competitiveness White Paper, Building the Knowledge Driven Economy (DTI 1998), refers to the more effective use and exploitation of all types of knowledge, particularly in the traditional construction industry in order to give the UK a competitive edge. Moreover, there are a wide range of professionals involved in construction sector, working as an inter-disciplinary team in delivering the construction products. The UK construction industry employed 19,130 workers per one billion pound output (total of 1,599,000 workers) in 2003 (Green et al 2004), hence considered to be one of the labour intensive sectors of the economy. In this context, the construction industry is perceived as one of the labour and knowledge intensive value creating sectors of the economy. Next section explores the prominent role played by the people in the construction industry.

“PEOPLE” FACTOR IN CONSTRUCTION

Construction companies frequently claim that ‘people as their greatest asset’ (Carrillo et al 2000) in a situation where literature on human resource management repeatedly emphasises the need to treat people as a key resource. People are an organisation's most valuable asset and this is especially true in relatively low-tech, labour intensive industries such as construction (Green et al 2004). However, people also represent the most difficult resource for organisations to manage. As highlighted in the intrinsic characteristics of the industry, construction employs extremely diverse range of people from a wide range of occupational cultures and backgrounds, including people in unskilled, craft, managerial and professional positions, challenging to manage people effectively to ensure organisational success. The importance of the construction worker is highlighted by the fact that industry relies on skill and on the

capacity to bring different skills together effectively (Drucker & White 1996), thereby the concept of the knowledge worker has long been important to construction organisations (Green et al 2004). In recent years, with the growth of the service sector, this emphasis placed on the construction knowledge worker has gradually increased. Although, there is an emerging importance placed on the people factor in the construction industry, as one of labour intensive sectors of the economy, yet it is still considered to be an “under-charted territory” (Kululanga & McCaffer 2001: 346) within construction organisations.

The ignorance of the people factor within the construction context has contributed to a great extent for the under performance of the industry as lamented by many authors. As Egan (1998) asserted;

“...much of construction does not yet recognise that its people are its greatest asset and treat them as such. Too much talent is simply wasted, particularly through failure to recognise the significant contribution We understand the difficulties posed by the fragmented structure of the industry, but construction cannot afford not to get the best from the people” (para 17: 14).

As contended by Nesan & Holt (1999), the issue of the critical role that employees play in fostering an effective construction business (appropriately referred to as the “people” factor) has often been overlooked. According to Cooke-Davies (2001: 185), “*it is people who deliver the projects and not processes and systems*”, which gains increased validity in the context of construction, as a labour intensive industry. Hence it is argued (Love & Holt 2000; Dainty et al 2003) that there is a necessity for the construction industry to define more appropriate performance criteria for both project and organisational level by redefining “traditional” financial orientated success parameters to consider the knowledge, skills and behaviour inputs which contribute to superior performance. Further, managing construction knowledge worker with softer human resource policies based on empowerment and commitment is important, specifically when it comes to the professional service firms within the construction industry, who invest heavily in knowledge based services. Having discussed about the people factor within construction, succeeding section emphasise the importance of tacit knowledge in construction.

TACIT KNOWLEDGE IN CONSTRUCTION

Within construction, the type of knowledge varies enormously, yet gains increase concern on tacit knowledge as a labour intensive industry as discussed before. Specially, Engineers, Architects and other professionals within the construction industry are not in a position to ‘cut and paste’ best practice (Kamara et al 2002) from the past due to the unique and the complex nature of the construction projects. They have to draw on the past to find solutions for the future. Tacit knowledge evolves from these shared practices and experience which need to be managed for the project and the organisational success. According to Wetherill et al (2002), knowledge in construction domain can be classified into three categories as illustrated in Table 1, which further highlights the emphasis placed on knowledge worker and tacit knowledge.

Table 1: Classification of Knowledge in construction domain

Domain Knowledge	the information available to all companies and is partly stored in electronic data bases
Organisational Knowledge	company specific and intellectual capital of the firm which also comprises knowledge about the personal skills, project experiences of the employees
Project knowledge	which includes both project records and the recorded and unrecorded, memory of processes, problems and solutions

Wetherill et al's (2002) classification reflects the organisational hierarchy and when one moves from domain knowledge to project knowledge the concentration on knowledge too moves from explicit to tacit nature. By taking a different stance Stahle (1999) suggests organisations into three-dimensional system i.e. mechanistic, organic and dynamic nature, depending on the different challenges presented for management of knowledge. Mechanistic part deals more with explicit knowledge whilst organic nature helps the organisation to work flexibly with a people-centred orientation and involves the management of tacit knowledge. The dynamic nature facilitates continuous improvement and innovation. Wetherill et. al's classification reflects the organisational hierarchy and when one moves from domain knowledge to project knowledge the concentration on knowledge too moves from explicit to tacit nature, which further highlights the knowledge worker concept in construction. Stahle's suggestion indicates both the management and the production of the knowledge. In a similar sense Moodley et. al (2001) contends that the tacit knowledge is developed through the individual or project teams, while the explicit knowledge is created through process, procedures and other routines that can be codified.

Despite the type of knowledge to be managed in construction, review of current literature reveals numerous definitions and techniques of Knowledge Management (KM) due to wide range of interest, perspectives and issues represented by different authors. These fall mainly into the IT perspective (Explicit knowledge) where authors focus on IT tools to deliver KM solutions (Ruggles 1997; Bair and O'Connor 1998), the Human Resource (Tacit knowledge) perspective that relies on the people aspect to provide KM solutions (King 1999; Egbu et al 2001) and the integrated perspective which acknowledges that both the IT and HR perspectives complement each other (Scarborough et al 1999; Tiwana 2000). Nevertheless, KM is defined as 'process of creating, acquiring, capturing, sharing and using knowledge, wherever it resides, to enhance learning and performance in organisations' (Scarborough et al 1999), which emphasise both perspectives. Managing knowledge more effectively offers construction organisations a possible mechanism for improving their performance in times of greater competition (Carrillo 2004).

However, despite the interest and the effort put into KM by many leading companies, the discipline is still in its infancy in the construction industry and is at an embryonic stage in the UK construction (Robinson et al 2001; Carrillo 2004). As Rezgui (2001) cited, there are few key reasons that limit current approaches of KM in the construction industry. Among the key factors for these limitations are;

- Much construction knowledge, by necessity, resides in the minds of the individual working within the domain.
- The intent behind the decisions is often not recorded or documented.

- The individuals who have knowledge about the project are likely to leave for another project at the end of the construction stage; hence their input is not captured.

As such all these three limitations clearly indicate the direct correlation with the human factor in the construction industry and highlight the importance of tacit knowledge and the people-centred approach of the KM to overcome these limitations. This further stresses the importance of the concept of knowledge worker which has long been central to construction industry performance.

In this context, Management of Knowledge and Innovation Research Unit (Egbu et al 2003) has empirically established that problem solving, managing change and innovation as the main triggers of the knowledge production in construction organisations and even out of these three categories, majority of the triggers were associated with problem solving aspects of the professionals. Also in this survey the majority of respondents have noted that they rely on their colleagues as a primary knowledge source and in addition, 'the construction project team' has been cited as the second mostly used knowledge source. Yet another survey (Carrillo et al 2002) of 170 UK construction organisations, indicated that communities of practice as the most widely used technique for KM particularly in large construction organisations. Further, Robinson et al (2001), in a study of the state of KM within the UK construction sector, discovered that over 70% organisations intended to have a KM strategy in place by the end of 2002. The main three reasons for this were:

- The need to encourage continuous improvement (92.5%);
- To share valuable tacit knowledge (88.7%);
- To disseminate best practices (86.8%);

All these empirical studies highlight the importance of the people factor and their tacit knowledge than the explicit knowledge in the construction context. Skills, experience and talent of construction workers, as tacit knowledge is considered to be very valuable towards organisational performance due to intrinsic characteristics of the industry. Thus, through proper integration and management of tacit knowledge in construction, the performance of the industry as a whole could be enhanced.

CONCLUSION

Knowledge plays a key role in today's fast changing business environment and contributes largely towards sustained business performance. Yet, tacit knowledge based on skills, experience and talent of people is considered to be relatively unexplored and underutilised when compared with other resources. This paper has revealed the importance of tacit knowledge towards organisational performance and achievement of competitive advantage and has further highlighted relevance of tacit knowledge in the construction industry by considering its intrinsic characteristics. This provides the basis for more empirical research on finding importance of tacit knowledge towards organisational performance in the construction industry.

REFERENCES

- Amit, R and Schoemaker, P J H (1993) Strategic assets and organizational rent. *Strategic management journal*, **14** (1), 33-46.
- Bair, J H and O'Connor, E (1998) The state of the product in knowledge management. *Journal of Knowledge Management*, **2**(2), 20-7.

- Barney, J B (1991) Firm resources and sustained competitive advantage. *Journal of Management*, **17**, 99-120.
- Beckman, T (1997) *A methodology for knowledge management*, International association of science and technology for development AI and soft computing conference. Canada.
- Beveren, J V (2002) A model of knowledge that refocuses knowledge management. *The Journal of Knowledge Management*, **6**(1), 18-22.
- Blumentritt, R and Johnston, R (1999) Towards a Strategy for Knowledge Management. *Technology Analysis and Strategic Management*, **11** (3), 287-300.
- Brown, S L and Eisenhardt, K (1998) *Competing on the Edge - Strategy as Structured Chaos*. Boston: Harvard Business School Press, MA
- Brown, J S and Duguid, P (1998) Organizing knowledge. *Californian Management Review*, **40** (3), 90-111.
- Carrillo, P M Anumba, C J and Kamara, J M (2000) Knowledge management for construction: key IT and contextual issues. In: Gudnason, G (ed.) *Proceedings of the Inter. Conf. on Construction IT*, 28-30 June, Reykjavik, Iceland, Icelandic Building Research Institute, 155-165
- Carrillo, P.M Robinson, H S Al-Ghassani, A M and Anumba, C J (2002) *Survey of Knowledge Management in Construction*. KnowBiz Project Technical Report, Department of Civil and Building Engineering, Loughborough University, UK.
- Carrillo, P. (2004) Managing knowledge: lessons from the oil and gas sector. *Construction Management and Economics*, **22**, 631-642.
- Carty, G (1995) Construction. *Journal of Construction Engineering and Management*, **121** (3), 319-28.
- CIB W55-W56, (2002) *Construction industry comparative analysis*. June, Project group
- Cooke-Davies, T (2001) The real success factors on projects. *International Journal of Project Management*, **20**(3), 185-190.
- Dainty, A R J Cheng, M and Moore, D R (2003) Redefining performance for construction project managers: an empirical evaluation. *Construction Management and Economics*, **21**, 209-218.
- D'Aveni, R A (1994) *Hypercompetition: Managing the Dynamics of Strategic Manoeuvring*. New York: The Free Press.
- Decarolis, D M and Deeds, D L (1999) The Impact of Stocks and Flows of Organizational Knowledge on Firm Performance: An Empirical Investigation of the Biotechnology Industry. *Strategic Management Journal*, **20**, 953-968.
- Department of the Environment, Transport and the Regions (DETR) (2000) *Construction Statistics Annual: 2000 Edition*. London: DETR
- Department of Trade and Industry (DTI) (2003) *Construction Statistic Annual: 2003 Edition*. London
- Department of Trade and Industry (1998) *Competitiveness White Paper: Building the Knowledge Driven Economy*. available at <http://www.dti.gov.uk/comp/competitive/>
- Drucker, J and White, G (1996) *Managing people in construction*. Institute for personnel and development, London
- Drucker, P (1992) *Managing for the Future: The 1990s and beyond*. New York: Truman Talley Books, NY.

- Egan, J (1998) *Rethinking construction: report of the construction task force on the scope for improving the quality and efficiency of UK construction*. London, DETR.
- Egbu, C O Botterill, K and Bates, M (2001) A conceptual framework for studying knowledge management in project-based environments, *In: Proceedings of the First International Conference on Postgraduate Research in the Built Environment*, University of Salford, UK, 15–16 March, 186–95
- Egbu, C et al (2003) *Knowledge production, resources and capabilities in the construction industry. Work package 1-final report*, Knowledge management for sustainable construction competitiveness project, Available from: www.knowledgemanagement.uk.net
- Eisenhardt, K (1989) Making Fast Strategic Decisions in High-Velocity Environments. *Academy of Management Journal*, **32** (3), 543-576.
- Eisenhardt, K M and Santos, F M (2000) Knowledge based view. *In: Pettigrew, A, Thomas, H and Whittington, R (Eds) Handbook of strategy and management*. London: Sage publications.
- Empson, L (1999) The challenge of managing knowledge. *Financial times: Mastering strategy*, 4th October.
- Empson, L (2001) Introduction: Human Relations. *Special Issue on Knowledge Management in Professional Service Firms*, **54**(7), 811–17.
- Grant, R M (1996) Toward a knowledge-based theory of the firm. *Strategic Management Journal*, **17** (Winter special issue), 109-122.
- Green, S Newcombe, R Fernie, S and Weller, S (2004) *Learning across business sector: Knowledge sharing between aerospace and construction*. UK: University of Reading.
- Grey, D (1996) What is knowledge [online]. *The knowledge management forum*, Available From : http://www.km-forum.org/what_is.htm
- Guthrie, J (2000) Intellectual capital review: measurement, reporting and management. *The journal of Intellectual Capital*, **1** (1).
- Halpin, D and Woodhead, R (1998) *Construction Management*. 2nd edition, New York: Wiley
- Herrgard, T H (2000) Difficulties in the diffusion of tacit knowledge in organizations. *Journal of Intellectual Capital*, **1**(4), 357-365.
- Holthouse, D (1998) Knowledge research issues. *California Management Review*, **40** (3), 277-80.
- Kamara, M J Anumba, J C Carrillo, P and Bouchlaghem, N (2003) Conceptual framework for live capture and reuse of project knowledge. *Construction informatics Digital library*, available at <http://itc.scix.net/data/works/att/w78-2003-178.content.pdf>
- King, W R (1999) Integrating knowledge management into IS strategy. *Information Systems Management*, fall, 70–2.
- Kogut, B (2000) The Network as Knowledge: Generative Rules and the Emergence of Structure. *Strategic Management Journal*, **21**, 405-425
- Kogut, B and Zander, U (1992) Knowledge of the firm, combinative capabilities and the replication of technology. *Organization Science*, **3** (3), 383-397.
- Krogh, G and Roos, J (1996) *Managing knowledge, Perspectives on cooperation and competition*. London: Sage publication.

- Kululanga, G K and McCaffer, R (2001) Measuring knowledge management for construction organisations. *Engineering, construction and architectural management*, **5**(6), 346-354.
- Leonard-Barton, D (1992) Core Capabilities and Core Rigidities: A Paradox in Managing New Product Development. *Strategic Management Journal*, **1**, 111-125.
- Leonard, D and Sensiper, S (1998) The role of tacit knowledge in group innovation. *California Management Review*, **40** (3), 112-32.
- Love, P E D and Holt, G D (2000) Construction business performance measurement: the SPM alternative. *Business process management journal*, **6** (5), 408-416.
- Løwendahl, B R (2000) *Strategic management of professional service firms*, 2nd, Denmark: Handeshøjskolens Forlag
- Moodley, K Preece, C and Kyprianou, R (2001) An examination of knowledge management implementation within civil engineering consulting organisations, *In: Akintoye, A (Ed.), 17th Annual ARCOM conference*, 5-7th September, University of Salford, Association of Researchers in Construction Management.
- Nesan, L J and Holt, G D (1999) *Empowerment in Construction Organisations: The Way Forward for Performance Improvement*. Somerset: Research Studies Press.
- Nonaka, I and Takeuchi, H (1995) *The knowledge creating company: How Japanese companies create the dynamics of innovation*. New York: Oxford university press,.
- Nonaka, I Konno, N and Toyama, R (2000) Emergence of Ba. *In Nonaka, I and Nishiguchi, T (Eds), Knowledge emergence: Social, technical and evolutionary dimensions of knowledge creation*. Oxford: Oxford University press.
- Peteraf, M A (1993) The corner stones of competitive advantage: A resource based view. *Strategic Management Journal*, **14**, 179-191
- Polanyi, M (1958) *Personal Knowledge Towards a Post-critical Philosophy*. London: Routledge and Kegan Paul Ltd
- Polanyi, M (1966) *The Tacit Dimension*. London: Routledge & Kegan Paul Ltd
- Pralahad, C K and Hamel, G (1990) The Core Competence of the Organization. *Harvard Business Review* (May-June), 79-90.
- Rezgui, Y (2001) Review of Information and Knowledge Management Practices State of the Art in the Construction Industry. *The Knowledge Engineering Review Journal*, **16** (2).
- Robinson et al (2001) Linking knowledge management strategy to business performance in construction organisations, *In: Akintoye, A (Ed.), 17th Annual ARCOM conference*, 5-7th September, University of Salford, Association of Researchers in Construction Management.
- Ruggles, R (1997) *Knowledge Management Tools*. Butterworth-Heinemann, Boston, MA.
- Rumelt, R P (1994) Forward in competence based competition. *In: Hame, G. and Heene, A., (Eds), The strategic management series*, Chichester: John Wiley & Sons.
- Scarborough, H Swan, J and Preston, J (1999) *Issues in People Management: Knowledge Management: A Literature Review*. Institute of Personnel and Development, Wiltshire: The Cromwell Press.
- Spender, J C (1996) Making knowledge the basis of a dynamic theory of the firm. *Strategic Management Journal*, **17**, special winter issue, 45-62.
- Stahle, P (1999) New challenges for knowledge management, *In Reeves, J. (Ed.), Liberating knowledge*. London: Caspian Publishing, 36-42.

- Tatum, C B (1986) Organising to increase innovation in construction firms. *Journal of Construction Engineering and Management*, **115** (4), 602–17.
- Teece, D J (2000) *Managing intellectual capital*. Oxford: Oxford University press.
- Teece, D J Pisano, G and Shuen, A (1997) Dynamic Capabilities and Strategic Management. *Strategic Management Journal*, **18** (7), 509-533.
- Tiwana, A (2000) *The Knowledge Management Toolkit*. New Jersey: Prentice Hall.
- Wernerfelt, B (1995) the resource based view of the firm: ten years after. *strategic Management journal*, **16**, 171-174.
- Wetherill, M Rezgui, Y Lima, C and Zarli, A (2002) Knowledge management for the construction industry: The E-CONGS project. *ITcon*, **7**, 183-195.
- Winter, S G and Szulanski, G (1999) *Replication as Strategy*. Working Paper - Presented at the 1999 Academy of Management Conference.
- Zack, M (1999) Developing a knowledge strategy. *California management review*, **41**(3), 125-145.