

# AN INVESTIGATION OF PROBLEMATIC ISSUES ASSOCIATED WITH SITE MANAGEMENT - THE CASE STUDY OF GREAT MAN-MADE RIVER PROJECTS IN LIBYA

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Construction site management (CSM) mainly involves a combination of numerous activities, which turn basic resources into a finished product. It directly influences security, material supply, resource utilisation, health and safety, planning, cost and all construction processes during the production stage. Thus, CSM can greatly influence aspects of sustainable development relating to construction, and is therefore paramount to project success. Practically, it is not a simple procedure to manage a site successfully. Construction work has become a complex set of processes, and there are numerous management challenges which are continually occurring on construction sites. The aim of this research is to investigate the problems which constrain optimal CSM, and to identify the approaches which have been taken to solve these problems. As part of the research methodology, an in-depth literature review was carried out on CSM in order to define and identify CSM problems and possible resolutions. This resulted in several CSM problems being identified as the most significant and regularly occurring when managing a construction site. In order to investigate CSM problems practically, five construction sites suggested by organisations which have worked on behalf of Great Man-made River Water Utilization Authority (GMRWUA) in Libya were used for multiple-case studies. Structured interviews with a Senior Project Manager, a Construction Manager, and a Contract Manager were carried out to gather data from the case study. Additionally, a questionnaire survey involving Construction Site Managers and Site Engineers was also administered. The main findings of the paper are the identified ranking of importance of CSM problems in terms of their effect on managing construction sites, in addition to their frequency of occurrence. Moreover, problem solving approaches to be undertaken by the CSM team were identified in GMRWUA projects to assist in mitigating CSM problems in the future.

**Key words:** Case studies, Construction Site Management (CSM), Current problem-solving approaches, Problems of CSM, GMRWUA.

## INTRODUCTION

In construction management, the main objectives are to complete a construction project with the required quality (CIRIA 2001), prevent 're-invention' of the wheel' (Holroyd 1999), improve project performance (Robinson *et al* 2001) and with less time (Hassan 2005). Wideman (1986), Newcombe *et al* (1993) and Fapohunda (2009) argue that CSM is the act executing the majority of these objectives and the entire construction process from inception to completion on a site. It can therefore be seen that a construction site manager carries out the single most arduous, demanding, and responsible function of the construction process (Wakefield 1978), and faces several engineering challenges and management problems that occur on the site (Anumba and Mohamed 2006). There is, consequently, a need to look deeply at problematic issues associated with site management. For that reason, this research seeks to investigate

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the problems which are faced by construction site managers and to expand knowledge of the current problems-solving approaches.

The paper starts with reviewing the CSM definition and problems, and is followed by a brief description of the adopted research methods. Five case projects within the case study are used to investigate the CSM problems from a practical perspective and to identify problem-solving approaches which have been adopted. The frequency of CSM problems and the ranking of their importance, in terms of their effect on managing a site, are also presented (with respect to the ten problems that are considered as the most significant occurring in managing a construction site).

## CONSTRUCTION SITE MANAGEMENT

Recognition of the site management should be a priority for attention by all contractors, since on site profit and reputations can be built or damaged. Monies may be made or lost, and there is considerable scope for improving efficiency, productivity and quality (Harlow 1985; Fellows *et al* 2002). Site management involves the combination of a large number of activities including, site investigation as pre-construction work, and CSM practices during the construction process (Anumba and Mohamed 2006). This research focuses on CSM practices, and these have been divided by into six sub-processes: planning, monitoring and control; management, supervision and administration; delivery and materials' handling; commercial management; production on and off-site; legal and health and safety (Construction IT 1996; Illingworth 2000; Mohamed and Anumba 2004). From the sites considered in the study, all can be described as having problems in at least one of these processes.

### Construction Site Management Problems

Mohamed and Anumba (2004) and Alzohbi (2008) believe that numerous problems and engineering challenges occur when managing these site processes. There is an urgent need to investigate the problems that are faced by the construction site manager to identify constraints and optimal solutions. Through the review of literature DeCuyper (1993), Wilde (1997), Holroyd (1999), Li and Love (2000), Doran (2004) and Toor and Ogunlana (2008), it was discovered that the most recognised problems, which affect CSM have been categorized into two types; external constraints and internal constraints.

#### *The External Constraints*

External constraints are those that are external to a site manager's own organisation, and may arise before the work commences or during the site work. Such constraints relate to complications in technical studies, design issues, poor information transfer and inadequate co-ordination of site management activities (DeCuyper 1993).

1) *Design*: Wilde (1997) believes that the design and drawings are often the source of site problems. Abadi (2005) stresses that basic information concerning construction operations is required before the start of work on site. Moreover, it is not always evident that the systematic update of drawings takes place when modifications occur,

which inevitably leads to delay in the execution of work, unforeseen costs, and conflicts.

2) *Technical Studies*: Technical studies are often given too little time and consideration, which may impact on construction processes, estimated budgets and productivity (DeCuyper 1993, Spilsbury 2008). Poor technical studies can often lead to unforeseen work causing unjustified costs.

3) *Co-ordination of Site Management*: Construction may be considered as the result of the interaction of a group of actors, and there is an unavoidable need for co-ordination between these actors. Barton (1976) and Dorn (2004) believe that co-ordination on the construction site is the most difficult task facing site management.

4) *Information Transfer*: Kimmance (2002) supports Morrison & Morrison (1993) who stated that the majority of information transfer problems on the site arise from one or both of the following problems: the problems that occur because all drawings are not systematically updated when modifications are introduced; and problems that are covered up on site by staff without informing the site manager.

#### *The Internal Constraints*

The internal constraints are those which are internal to the site manager's organisation, and involve a large number of elements. DeCuyper (1993), Holroyd (1999) and Doran (2004) view the following internal constants as the most influential internal constraints for the site management and organisation.

5) *Estimating Requirements*: incorrect evaluating causes many problems to occur during site work. These include: labour shortages, failure to obtain needed equipment on time, defective and damaged materials (Mohamed and Anumba 2004).

6) *Quality Control*: Doran (2004) confirms that insufficient inspection and test plans, which should be prepared from the technical specifications, working drawings and method statements, could be major reasons behind the problem of quality control.

7) *Planning*: Poor planning is the most significant factor influencing management of the construction site (Mustapha and Naoum 1998). De Cuyper (1993) reported that the majority of site problems arise from; a lack of planning, no time scheduling being used, no evaluation of the efficacy of site work, and misunderstanding of the client's requirements at an early stage of a project.

8) *Materials Supply and Storage On Site*: Ibn-Homaid (2002) believes that "*material management is the most common and frequent cause of delays in projects*". Guthrie *et al* (1998) and Holroyd (1999) believe that a non-compliance with International Material Storage and Supply standard causes mainstream problems.

9) *Health and Safety*: Griffith and Watson (2004) see legislation relating to health and safety on site as one of the most problematic issues facing construction site managers. Cheng and Li (2004) argue that the lack of using and complying with the standards and regulations of health and safety causes serious accidents on sites.

10) *Multicultural Projects*: construction site managers who carry out work beyond national borders often face special problems, such as operating within local regulations and social customs, dealing with multiethnic work teams, and the import of materials (Burgess and Enshassi 1990).

## RESEARCH METHOD

Fellows and Liu (2008) and Love *et al* (2002) define triangulation as the use of qualitative and quantitative techniques together in the study of a topic. A combination of qualitative and quantitative research methods were used to gain insights and results in order to draw conclusions from the research.

### Data Collection Process

#### *Literature Review*

Literature was drawn from peer-reviewed books, journals, papers and research reports. This survey aimed to report recent research in this area in order to understand a site manager's role, identify theoretical problems in managing construction sites and resolutions undertaken by site managers.

#### *Case Study Technique*

The Great Man-Made River Project (GMRP) was chosen as a case study for the research and is one of the largest civil engineering projects in the world, in addition to being the largest for the transportation of water from the Sahara Desert (Loucks, 2004). Five construction sites identified by international organisations, which have worked on behalf of the Great Man-made River Water Utilization Authority (GMRWUA)-central zone in Sirte City, were used as shown in Table 1. Through the case study protocol, structured interviews were also selected as a data collection technique.

#### *Questionnaire Survey*

A postal questionnaire survey was administered to a sample of site managers who are working on construction projects in the GMRWUA. Questions were formulated to identify the frequency of the problems occurring in managing construction sites, and to rank the importance of the site problems in terms of their effect on managing the construction site.

## ANALYSIS AND DISCUSSION

Structured interviews were formulated for the Site Manager, Construction Manager, and Chief Resident Manager in each organisation involved in the case study (see Table1).

The interviews were aimed at investigating the problematic issues of CSM and the problem-solving approaches that are used in the GMRWUA in Libya. Table 1 indicates details of respondents highlighting nationality, experience and current role.

**Table 1:** Project personnel involved in the interviews

<i>No</i>	<i>Number of Company</i>	<i>Nationality</i>	<i>Years of Experience</i>	<i>Current Role</i>
1	Organisation A	German	15 Years	Construction Manager
		Austrian	21 Years	Site Manager
2	Organisation B	English	43 Years	Chief Resident Engineer
		English	36 Years	Site Manager
3	Organisation C	Cypriot	26 Years	Site Manager
4	Organisation D	Bosnian	28 Years	Construction Manager
		Bosnian	16 Years	Site Manager
5	Organisation E	Egyptian	25 Years	Construction Manager
		Egyptian	25 Years	Site Manager

#### *Key problems of the construction sites*

Table 2 summarises the problems identified from projects representing the case study, in relation to the ten construction site management problems outlined in the literature and deemed to have the greatest influence on effective management of construction processes. Table 2 indicates the perceived problems and solving approaches from the case study sites.

Organisations (A), (B), (C) and (E) experienced planning problems as both the original problem (X), and resulting from other problems (o), from a lack of estimating requirements, and in particular poor material supply. In organisation (D), although the planning process was affected by several issues, it was not the origin of the problem. Essentially, this was caused by the CSM team not understanding the client's requirements clearly before commencement of work on site.

While organisations (A), (B), (C) and (D) suffered from material supply problems owing to the majority of materials being from overseas, organization (E) did not. The majority of materials used by organization (E) were imported from its home (Egypt), Libya's neighbour, which does not suffer restrictions through complex customs procedures, and also because of the well-known professional suppliers in the organisation's home country. This confirms that poor materials supply arrangements cause the majority of materials problems on the site (Holroyd 1999).

Although organisation (E) had experienced problems from the complexity of design specifications, the only other organisation that had suffered major design problems was organisation (C). This resulted from the design being carried out by another consultant and without involvement of the site manager. This goes with the advice of Bresnen *et al* (1987), DeCuyper (1993) and Abadi (2005), who stress the importance of engaging the site manager in the early stage of design.



Case problems/construction Approaches to site processes	Design	Technical Studies	Coordination of the site management	Information Transfer	Estimating of Requirement	Quality Control	Planning	Material supply	Health and Safety	Multicultural Projects	Approach to Problem Solving
<b>Case 1 (Org A)</b> -Information Transfer -Poor Planning -Poor Material Supply (MS) -Difference of Language -Shortage Qualified Labours				X			O X O O	X		X	*Informal site meeting & discussions * Using E-mail to transfer drawings & information. * Understand the client requirements. * Choosing professional suppliers. * Understanding in depth the Local Regulation and Policies. * Training the local labours.
<b>Case 2 (Org B)</b> -Poor Planning - Lack Quality Control & MS - Poor co-ordination - Language problems - religion attitude - Poor local and health and safety regulations			X			X	X O O	X		X	* Trying to plan day-to-day work on the site * Taking a more practical approach to quality control * Reporting senior manager & client * Trying to manage a schedule for Local labour. * Adopting the UK health and safety Standards. *The use of manuals and guidance.
<b>Case 3 (Org C)</b> -Poor Planning -Shortage Qualified Labours. -Poor Design & Info Transfer - Poor Communication. -Poor Material Supply	X			X	X		X O O			X	* Developing knowledge and experience from previous projects. * Discussion with the designer and Suggest solutions. * Employing local coordinator. * Finding suitable alternatives of suppliers. *Using E-mail to transfer drawings
<b>Case 4 (Org D)</b> -Poor Technical Studies -Poor Material Supply Poor Quality Control	O	X	O		O	O	O O O	O X			*Informal site meeting & discussions * Reporting senior manager & client * Developing knowledge and experience from previous projects. * Adjusting project activities according to new situations.
<b>Case 5 (Org E)</b> -Inaccurate Planning. - Complexity of designs. -Poor health and safety. - Poor co-ordination.	X		X				X O O O		X		*The site managers draws his Previous experience. *Technical problems are discussed and examined on and off site. *Referring the problems to company's engineering division

Note: X is Origin of problem; O is Sub-processes is affected. **Table No (2):** The Summary of the Problems and Solving Approaches identified from the case studies.

Owing to the differences in language, religion, culture and regulations (Multicultural Projects), organisations (A), (B), and (C) experienced communication problems in dealing with multicultural teams and staff, local authorities, and local regulations. This also tends to impact on project planning, as witnessed in organisation (B). Organisation (E) has been not affected by multicultural problems because of its Arabic origin and having the same language, religion, culture and often the same regulations to that of the client. In spite of the difference in language, culture and regulations, organization (D) has not been affected by the multicultural problems. The reason being, that the CSM team obtained intensive cross-cultural training before entering Libya to work on the project. This is further supported by Burgess and Enshassi (1990) who observed that “*there is a pressing need to recognize and consider cross-cultural training as an integral part of construction management if organizations are to remain competitive and successful*”.

Problems with technical studies were experienced by organisation (D) on an infrequent basis. However, this problem was seen to affect the majority of other construction processes, such as planning, design, estimating requirements, material supply and quality control. This proves that “*too little attention and time is given to the technical studies, although they are of primary importance for reaching a high productivity and high quality*”. (DeCuyper 1993).

Generally, other problems, such as poor health and safety, lack of quality control, poor co-ordination of the site activities and lack of the estimating requirements, have normally happened with organizations at the commencement of work.

#### *The Problems-Solving Approaches*

Table 2 also summarises the problem-solving approaches used by organisations, although these were seen to differ from one case to another. Organizations (C) and (D), with extensive knowledge of Libyan culture, followed informal approaches that were heavily reliant on previous experience, informal site team meetings, discussions between the site team and experts in order to solve problems, and reports to senior management and the client.

Such procedures were reflective of culture (the tribal nature in Libya); where in the tribe system any dispute or internal problem can be resolved by meeting, discussion and the transfer of decision-making to the tribe’s sheikh.

Organisation (B) followed a practical and more structured approach to the control of quality, planning day-to-day work on the site, monitoring project activities and health and safety procedures. Organisation (A) and (C), however, followed both informal and structured approaches.

#### **Data Analysis of Questionnaires**

Questionnaires were used to identify the frequency of the site management problems occurring on construction sites, and to rank the importance of the site problems in terms of their effect on managing projects. A total of 37 questionnaires were

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administered with a response rate of 33 returns representing 90% of respondents. The results and statistics were documented using four main descriptive statistics, these being: Frequencies (Percentage), Total Score, Mean Score and Importance Index. The ranking of the questions is based on the mean score with the higher importance index. Nine different organisations, which work on behalf of GMRWUA, were involved in the questionnaire survey, as illustrated in the Table 3.

**Table 3:** Organisations and sites involved in the questionnaire survey

<i>Organisation</i>	<i>Nationality</i>	<i>Type</i>	<i>The type of the site</i>
<i>1</i>	German	Private	Construction Buildings Irrigation Works
<i>2</i>	English	Private	Supervision of the Construction Pump Stations Works
<i>3</i>	Cypriot	Private	Pipe Line & Pump Stations Works
<i>4</i>	Bosnian	Private	Pipe Line & Pump Stations Works
<i>5</i>	Egyptian	Private	Pipe Line & Pump Stations Works Irrigation Works
<i>6</i>	French	Private	Construction Buildings Pump Stations Works
<i>7</i>	South Korean	Private	Construction Buildings Irrigation Works
<i>8</i>	Tunisian	Private	Construction Buildings
<i>9</i>	German	Private	Construction Buildings Pump Stations Works

Table 3 shows that three basic types of construction sites were involved in the questionnaire survey. Different types of sites were selected based on the belief that although there are general problems that occur in the majority of sites, each site has its own specific problems. The majority of the respondents (80%) had wide experience of working in the Libyan construction sector, which added to the in-depth findings of the research.

#### *The Frequency of the CSM Problems*

In order to find out the occurrence frequency of site management problems, the respondents were asked to rank the frequency of the ten problems which occurred while managing construction sites. The results are shown in Table 4. The ranking of the frequency of CSM problems is based on the mean score and the higher importance index.

**Table 4:** Frequency of the site management problems

<b>The Problems of CSM</b>	<b>Total score (Ts)</b>	<b>Mean Score (Ms)</b>	<b>Importance Index (Ii)</b>	<b>Rank</b>
FP1= Design	295	2.95	0.7375	<b>2</b>
FP2= Technical Studies	230	2.3	0.575	<b>6</b>
FP3= Co-ordination of the Site	245	2.45	0.612	<b>5</b>
FP4= Information Transfer	250	2.5	0.625	<b>4</b>
FP5= Estimating Requirements	200	2	0.5	<b>9</b>
FP6= Quality Control	170	1.7	0.425	<b>10</b>
FP7= Planning	280	2.8	0.7	<b>3</b>
FP8= Material Supply	460	4.6	1.15	<b>1</b>
FP9= Health and Safety	230	2.3	0.575	<b>7</b>
FP10= Multicultural Projects	220	2.2	0.55	<b>8</b>

Table 4 shows that the highest ranked CSM problem is Material Supply (mean score (Ms) =4.6, Importance Index (Ii) =1.15), followed by Design, Planning, Information Transfer, Co-ordination of the Site, Technical Studies, Health and Safety, Multicultural Projects, and Estimating Requirements. The least frequent problem was Quality Control.

*The Importance of CSM Problems:*

With the purpose of investigating the importance of the CSM problems, in terms of their effect on managing the construction site, respondents were asked to rank (1 = least important and 10 = most important) the importance of the ten problems according to their experience. The statistics were computed to generate the total score, mean score and importance index and are summarised in Table 5. The ranking of the importance of the CSM problems is based on the mean score and higher importance index. Table 5 shows that the most important problems of CSM in terms of their effect on managing a construction site are: Design, Material Supply, Technical Studies, Information Transfer, Estimating Requirements, Quality Control, Co-ordination of the Site, Health and Safety. The least important problem is Multicultural Projects.

**Table 5:** Importance of the site management problems

<b>The Problems of CSM</b>	<b>Total score (Ts)</b>	<b>Mean Score (Ms)</b>	<b>Importance Index (Ii)</b>	<b>Rank</b>
IP1= Design	801	8.01	0.801	<b>2</b>
IP2= Technical Studies	726	7.26	0.726	<b>4</b>
IP3= Co-ordination of the site	382	3.82	0.382	<b>8</b>
IP4= Information Transfer	616	6.16	0.616	<b>5</b>
IP5= Estimating Requirements	495	4.95	0.495	<b>6</b>
IP6= Quality Control	459	4.59	0.459	<b>7</b>
IP7= Planning	874	8.74	0.874	<b>1</b>
IP8= Material supply	727	7.27	0.727	<b>3</b>
IP9= Health and Safety	319	3.19	0.319	<b>9</b>
IP10= Multicultural Projects	314	3.14	0.314	<b>10</b>

## MAIN FINDINGS AND CONCLUSION

The main findings from the data were concluded as follows:

- The most significant problems faced the site managers in the GMRWUA projects were consistent with the problems identified by *DeCuyper (1993)*. These problems are classified as External Constraints and Internal Constraints.
- The most frequent problems in managing construction sites were: material supply followed by planning, information transfer, co-ordination on site, technical studies, health and safety, multicultural projects, estimating requirements and quality control.
- The ranking of the most important problems on construction sites, in terms of their effect on managing construction work were problems of planning followed by design, material supply, technical studies, information transfer, estimating requirements, quality control, co-ordination on the site, health and safety and finally the problem of multicultural projects.
- The ranking of the importance of construction site management problems is not always based on the frequency of occurrence on site. For example, although the problem of the technical studies occurred infrequently, it was also seen to affect the majority of construction processes on the site.
- Although the problem of multicultural projects has a negative effect on site management effectiveness, in contrast to Burgess and Enshassi (1990), this problem is considered as the least important problem of site management in terms of their effect on managing construction work. However, the importance of cross-cultural training is an essential requirement for effectively managing overseas projects successfully.
- The problem-solving approaches used in GMRWUA projects can be classified into two main categories:
  - Informal methods - these encompass previous experience, discussion or informal meetings and reference to experts.
  - Structured methods - these encompass practical approaches to control quality, day-to-day planning and health and safety procedures. (Anumba and Mohamed 2006)

This research has highlighted the major problems which have occurred within the GMRWUA. Even though the ten major problems in CSM are common problems in many countries, there are numerous other problems that can occur in the CSM. Therefore, in order to obtain a broader and clearer picture of the problems in terms of managing construction sites, large sample sizes will be required to produce more reliable findings and validation of data.

## REFERENCES

Abadi, M (2005) *Issues and Challenges in Communication within Design Teams in the Construction Industry*, Unpublished PhD Thesis, School of Mechanical, Aerospace and Civil Engineering (MACE), University of Manchester.

- Alzohbi, M G (2008) *An Investigation of Problematic Issues Associated with Site Management – The Case Study of Great Man-made River Projects in Libya*, Unpublished MSc Thesis, Faculty of Development and Society, Sheffield Hallam University.
- Anumba, C J and Mohamed, S F (2006) Potential for improving site management practices through knowledge management. *Construction Innovation Journal*, **6**, 232-246.
- Barton, P K (1976) *The Co-ordination of Mechanical and Electrical Services Sub-contractors within the Building Process*. Salford: University of Salford.
- Bresnen, M, Bryman, A and Beardsworth, T K (1987) Effective Construction Site Management. In: P. Harlow (ed.) *Technical Information Service*. **85**, 1-6. Berkshire: The Chartered Institute of Building (CIOB).
- Burgess, R and Enshassi, A (1990) Training for Construction Site Managers Involved with Multicultural Work Teams. *Project Management*, **8**(2), 95-101.
- Cheng, E W and Li H (2004) Construction safety management: an exploratory study from China. *Construction Innovation*, **4**, 229-241.
- CIRIA (2001) *Faster Construction on Site by Selection of Methods and Material*. CIRIA Report C560. London: CIRIA.
- Construction IT (1996) *Benchmarking best practices construction site processes*. Construct I.T. Centre of Excellence, University of Salford.
- DeCuyper, K (1993) Site Organisation and Management. In: ENBRI (ed.) *R&D for the Construction Site Process*. Luxembourg: ENBRI.
- Doran, D (2004) Quality Management. In: D. Doran (ed.) *Site Engineer Manual*. Chapter 1, Glasgow: Whittles Publishing.
- Fapohunda, J (2009) *Operational Framework for Optimal Utilisation of Construction Resources during the Production Process*, Unpublished PhD Thesis, Faculty of Development and Society, Sheffield Hallam University.
- Fellows, R and Liu, A (2008) *Research Methods for Construction*. Oxford: Blackwell.
- Fellows, R, Langford, D, Newcombe, R and Urry, S (2002) *Construction Management in Practice*. 2<sup>nd</sup> ed. Oxford: Blackwell Science Ltd.
- Griffith, A and Watson, P (2004) *Construction Management: Principles and Practice*. Basingstoke: Palgrave Macmillan.
- Guthrie, P, Woolveridge, C, Coventry, S and Wilson, S (1998) *Managing material and components on site*. London: CIRIA.
- Harlow, P A (1985) The Practice of Site Management. *The Chartered Institute of Building*, **3**, 7-9.
- Hassan, P F, Griffith, A and Stephenson, P (2005) An empirical study of the training needs of site managers within the UK construction industry. In Khosrowshahi, F (Ed.), *21st Annual ARCOM Conference*, 7-9 September 2005, SOAS, University of London. Association of Researchers in Construction Management, Vol. 1, pp. 95-104.
- Holroyd, T (1999) *Site Management for Engineers*. London: Thomas Telford.
- Ibn-Homaid, N T (2002) A comparative evaluation of construction and manufacturing materials management. *International Journal of Project Management*, **20**(1), 263-270.
- Illingworth, J R (2000) *Construction Methods and Planning*. 2<sup>nd</sup> ed. London: E&F Spon.



- Li, H and Love P (2000) Genetic search for solving construction site-level unequal-area facility layout problems. *Automation in Construction*, **9**(2), 217-226.
- Kimmance, A G (2002) *An Integrated Product and Process Information Modelling System for On-Site Construction*, Unpublished PhD Thesis, Department of Civil and Building Engineering (MACE), Loughborough University
- Love P, Holt G and Li H (2002) Triangulation in construction management research. *Engineering Construction and Architectural Management*; **9**, 294-303.
- Loucks, D P (2004): The Great Man Made River in Libya: Does it make Sense? The Third Annual D. R. F. Harleman Honorary Lecture in Environmental Fluid Mechanics, 5 November 2004, Pennsylvania, the Pennsylvania State University.
- Mohamed, S F and Anumba, C J (2004) Towards a framework for integrating knowledge management processes into site management practices, *Proceedings, 20th ARCOM Annual Conference*, 1–3 September, Heriot-Watt University, 45–54.
- Morrison, A and Morrison, D (1993) *Looking around: Pupils book*. Heinemann.
- Mustapha, F and Naoum, S (1998) Factors influencing the effectiveness of construction site managers. *International Journal of Project Management*, **16**(1), 1-8.
- Newcombe, R, Langford, D and Fellows R (1993) *Construction Management: Organisation Systems*. London: B. T. Batsford.
- Robinson, H S, Carrillo, P M, Anumba, C J and Al-Ghassani, A M (2001) Knowledge management: towards an integrated strategy for construction project organizations, *Proceedings, 4<sup>th</sup> European Project Management Conference (PMI)*, 6–7 June 2001, Café Royal London. Project Management Institution.
- Spilsbury, R (2008) *At the Building Site: Technology at Work*. Capstone Global Library
- Toor, S R and Ogunlana, S O (2008) Problems causing delays in major construction projects in Thailand. *Construction Management and Economics*, **26**(4), 395-408.
- Wideman, R M (1986) The PMBOK report: PMI Body of Knowledge Standard. *Project Management Journal*, **17**(3), 15-24.
- Wild, J (1997) *Site Management of Building Services Contractors*. Oxford: E&FN Spon.