ARCOM

Performance & Productivity Research

Chairman: Professor Paul Olomolaiye

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Dr Andrew Dainty

ARCOM DOCTORAL RESEARCH WORKSHOP

Performance and Productivity Research

School of Engineering and Built Environment, University of Wolverhampton

Friday 8th June 2001, 11.00-16.00.

Chairman: Professor Paul Olomolaiye, University of Wolverhampton
Organisers: Dr Andy Dainty, Coventry University and Dr Mohan Manavazhi, University of Wolverhampton

10.30 – 11.00	Coffee	
11.00 – 11.05	Welcome and introduction to the day	Andrew Dainty, *Coventry*
11.05 – 11.15	Introduction to Performance and Productivity Research	Paul Olomolaiye, *Wolverhampton*
11.15 – 11.35	*CONSTRUCTION TRAINING AND LABOUR PRODUCTIVITY*	Paul Chan, *Heriot-Watt*
11.35 – 11.45	Discussion and questions	
11.45 – 12.05	*PERFORMANCEIMPROVEMENT THROUGH ACTION RESEARCH: A LEAN CONSTRUCTION APPROACH*	Naomi Garnett, *Reading*
12.05 – 12.15	Discussion and questions	
12.15 – 12.35	*THE APPLICATION OF BENCHMARKING TO IMPROVE PRODUCTIVITY IN THE INDIAN CONSTRUCTION INDUSTRY*	Nisarg Hirani, *Abertay*
12.35 – 12.45	Discussion and questions	
12.45 – 13.45	Lunch	
13.45 – 14.05	*KNOWLEDGE MANAGEMENT FOR IMPROVED PRODUCTIVITY AND PERFORMANCE*	Ahmed Al-Ghassani, *Lough*
14.05 – 14.15	Discussion and questions	
14.15 – 14.35	*KEY PERFORMANCE INDICATORS*	Salma Y. M. Mahmoud, *Newcastle*
14.35 – 14.45	Discussion and questions	
14.45 – 15.05	*A COMPARATIVE STUDY OF CONTRACTOR PERFORMANCE IN JAPAN, US AND THE UK*	Hong Xiao, Wolverhampton
15.05 – 15.15	Discussion and questions	
15.15 – 15.30	Summary and conclusions	Paul Olomolaiye, *Wolverhampton*
15.30 – 16.00	Tea and Close	

CONSTRUCTION TRAINING AND LABOUR PRODUCTIVITY

Paul Chan

Department of Building Engineering and Surveying, Heriot-Watt University, Edinburgh, United Kingdom, Postcode EH14 4AS. (E-mail: p.w.c.chan@hw.ac.uk)

BACKGROUND INFORMATION

Productivity is widely known as a relationship between the inputs and the outputs, often crudely expressed as the outputs divided by the inputs. Indeed, productivity is an extremely vital performance measurement tool within the construction industry, as well as the economy on a whole. According to Lowe (1987), "the importance of productivity growth to an individual enterprise, an industry, or an economy is something on which most economists would agree." Arditi and Mochtar (2000) reaffirms that "the output of the construction industry constitutes one-half of the gross capital and 3 – 8% of the gross domestic product (GDP) in most countries, productivity improvement in the construction industry may have a significant impact on improving GDP." Notwithstanding its importance, several governmental and institutional reports over the last fifty years such as Banwell (1964), Latham (1994) and more recently Egan (1998), amongst others, have criticised on the sub-optimal performance of the British construction industry. As a result, this period saw a great interest within the area of construction productivity by many researchers, many of whom were concerned with the factors affecting productivity in the British construction industry. Yet, despite the many recommendations put forward by these researchers, the problem still persists. A review of past literature indicated that this was probably due to the fact that a great emphasis of past research is placed on the conversion process in an input-output framework rather than the input, labour. Furthermore, past research seldom discusses the issue of workmen's abilities when analysing labour productivity.

There is also a deficiency in construction skills training investment within the construction industry. Prior research highlighted the various shortcomings of the training provision within the industry. For example, Callender (1992) analysed the inadequacy of the National Vocational Qualifications (NVQs) system. Clarke and Wall (1998) and the Construction Industry Board (CIB) (1998) also attributed reasons such as the traditional skill boundaries and the ineffectiveness of the professional institutions, as well as, the Construction Industry Training Board (CITB) to be the causal factors of this deficiency. Whilst these tend to focus on the supply side of training, other researchers and practitioners attempted to suggest reasons for the poor demand for training by construction firms, e.g. the high costs of training, the shift towards self-employment and the inability to attract new blood into the industry [e.g. Hoare (1997), Winch (1998)]. Underlying these reasons, Chan *et. al.* (2001) suggested that training participation is low as employers simply do not recognise its benefits.

At first sight, there seems to be parallels between the level of training investment and organisational performance, yet construction researchers rarely link the two together. It is, therefore, the intention of this proposed research to investigate the relationship between training and performance. The following sections present the main aims and objectives, a brief overview of the methodology to be adopted and a report on current progress.

HYPOTHESES OF THIS RESEARCH

The following are the main hypotheses of this research:

Proposition 1: It is believed that the British construction industry perceives the training of construction operatives to be a significant factor of construction labour productivity.

Proposition 2: It is believed that an increase in training participation would lead to an improvement in construction labour productivity.

Proposition 3: It is believed that cultural differences are essential in explaining differences in productivity levels.

AIMS AND OBJECTIVES

This section briefly presents the possible outcomes – broadly categorised as *academic* and *industrial* outcomes. From an academic perspective, the proposed research aims to show that training is a strong causal factor of construction labour productivity, thus extending existing models of labour productivity. To the industry, it is the intention of to show that a greater interest and an increase in training participation would bring about benefits to the industry, in terms of time, cost or quality. This would then hopefully improve the skills training crisis in Britain.

PROPOSED METHODOLOGY

The proposed methodology is of a mixed methodology, i.e. comprising both quantitative and qualitative methods. Such a combination of both strains of methodology, commonly known as a triangulation of methods, is increasingly finding favour within construction research [Fellows and Liu (1997), Newman and Benz (1998)]. The philosophy of such combination is summed up in table 1 below.

Quantitative	***Qualitative***	***Qualitative - Quantitative***
Theory testing	Theory building	Wholistic
Deductive	Inductive	Closes the gap
Begins with theory	Ends with theory	Completes the cycle

Table 1. Interactive continuum of the two research paradigms
[Source: adapted from Newman and Benz (1998)]

There will be two stages in this methodology, starting with a qualitative approach towards the research question. This would involve interviewing construction companies to tap into the insights of the industry, to establish the industry's perceptions towards productivity improvements.

The second stage would involve principally quantitative studies, i.e. statistical analysis of data collected from e.g. financial reports, site visits etc., in an attempt to correlate those factors determined in stage one. In addition, information gathered throughout the two stages would also be consolidated and presented as case studies in the final report to be disseminated to the industrial partners.

CURRENT PROGRESS

At present, the researcher is into the eighth month of the Ph.D. programme. Up to the present moment, the literature search had been conducted. Approximately 140 academic research papers were retrieved in the broad areas of construction training, productivity and site management. In addition, the researcher had put together two conference papers. The first one, published in the conference proceedings of the first International Postgraduate Research Conference held in the University of Salford in March 2001, based on the review of the construction training in Britain over the last two decades. The second one, largely based on the current progress, had been sent for refereeing to the 17th ARCOM (Association of Researchers in Construction Management) Conference to be held in the University of Salford in September 2001. The researcher is also currently in contact with construction companies and professional institutions to gather a group of industrial partners for collaboration with this research project.

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PERFORMANCE IMPROVEMENT THROUGH ACTION RESEARCH; A LEAN CONSTRUCTION APPROACH

Naomi Garnett

Dept of Construction Management & Engineering, University of Reading, UK

INTRODUCTION

This paper provides a synopsis of an investigative piece of research to learn more about the impact of implementing the principles of Lean Thinking (Womack et al 1996) in construction for performance improvement. The work centred on an operational ie project level application of the first two principles of Lean Thinking (value and value streams) to create an operational framework which when combined with a waste management system provide the basis for a model of lean construction.

Significantly the work was undertaken within a dominant interpretive epistemological foundation with emphasis being placed on the context within which the implementation was made. Some aspects of the change work were positivist eg the process analysis of waste data. The implementation took the form of two action research cycles on two separate projects linked by the development of the lean construction model from one intervention to the other. The researcher was a facilitator in the change process and actively involved in observing and recording data for subsequent analysis. The results are both numeric and theoretical fulfilling the action research ethos of improving practice and generating theory.

Methodology

Research Focus

The researcher was asked by a major construction client to work with one of its existing project teams to target a cost per square foot reduction through the use of lean construction techniques. The consultancy offered the opportunity to effect change a project environment and potentially to learn about the nature of lean construction. The research aim is:
To investigate the impact of applying lean thinking principles during the design and construction of a building.

In developing the theoretical basis of the work, an extensive review of the lean manufacturing and lean construction literature was carried out. A further two related areas were identified: construction waste and the use of systems and process theory in construction. Three key issues emerged from this review.

Firstly that research in Lean Construction related to the application of lean production ideas to the construction site. Garnett at al (1998) recognised that the wider principles of lean thinking (Womack et al 1996) were not included in this definition of Lean Construction. DETR (1998) suggested that applying these ideas at a strategic level would lead to a product/customer facing industry where alliances, of a number of sorts, form to deliver product streams to customers over a long period of time. At an operational level, this would require changes to current project organisation practices. This is a critical problem for lean construction implementation and led to the research question:
Is a new operational framework (project organisation structure) a key element of the implementation of lean construction within a construction project?

A second issue that arises from the literature is the prevailing positivist epistemological basis of lean construction implementation. This suggests that implementing lean construction is not dependent upon the people or the context within which it takes place. Given the nature of construction ie (technologically complex, high levels of uncertainty, high levels of interdependency, temporary teams), it could be more appropriate to investigate other epistemological approaches. This led to the formulation of the research question:
Does the implementation of lean construction require strategies and methodologies based on the principles of social constructivism?

Finally the process literature also shows a positivist bias in the way generic process maps are often used to frame a construction project. This assumes that the processes for a specific project are pre-determined. An alternative approach is to suggest that these processes do not exist until created by the project team and that the process map simply provides a pictorial record of the consensus view about how the work will be undertaken. The third and epistemologically commensurate research question is therefore:
Is the creation of project specific processes by the project team an important factor?

Research Strategy
An action research approach was selected which allows the development of theory through practical application. The researcher worked along side the project team to develop a model for implementing lean construction (Objective 1) based upon the operational application of lean thinking principles. This led to the development of an operational framework for the project which adopted a systems approach identifying key systems eg structural frame and bringing together at an early stage the team which would design, supply and construct these key systems. The teams would identify a waste free plan for their work through the use of process mapping and analysis. The implementation plan (Objective 2) for this model would be underpinned by the need to develop a consensus view of the work in hand. The model would be further developed after this first implementation and subsequently used on a second project (Objective 3) where there would be a more extensive use and a wider selection of data gathered for analysis. The results would contribute both to improving the lean construction model for further implementation (Objective 4) and to developing aspects of lean construction theory (Objective 5). Finally the success of the work would be evaluated (Objective 6) in terms of the impact of applying lean construction on a building project.

Data Collection
The fieldwork data is generated using the principles of ethnographic casework and includes both "hard" data (construction times, process data, workshop reports) and "soft" data (interviews, daily diaries, site logs). There were two case studies. The first, a pilot study, involved a very limited change intervention with a project team. It was the repeat of an existing office design but targeted with reducing the cost per square metre significantly. The lean construction model and the theoretical work were further developed through the more extensive second study. This was the construction of a grocery retail store in Haslemere, Surrey.

Analysis Strategy
The data analysis has two parts; quantitative and qualitative. The quantitative analysis is based upon the principles of lean construction and includes identifying and quantifying waste at a number of levels within the project in order to improve project performance in terms of time and cost. The qualitative analysis follows a precedent set by Cherns and Bryant (1984). A number of propositions were identified from the qualitative data of the pilot study linked to the key issues of the literature review. For the case study a form of content analysis was used supported by the qualitative analysis software tool WINMAX to cope with the larger quantities of data. The data is coded using a template (King 1998) established during the pilot study. From this coded data, themes are identified which draw together related elements of coded data. Through further data reviewing and by relating to existing theory, potential theoretical findings are proposed. In this manner, inductive theory is generated completing the second strand of the action research philosophy.

Summary of results
The results of the pilot study were used to develop the lean construction model and to develop theoretical findings relating to the research questions. The results from the case study build on this work and are the major contribution of the work. The results consist of a consultancy report to the client, the theoretical developments from the qualitative analysis and the process analysis results from the quantitative analysis concerned with process waste. Tentative conclusions are drawn in four areas based on all these results. This work is not yet complete.

Project performance
The original aim of the research was to evaluate the impact of implementing lean construction. A key place to look for impact is on the project performance. The project finished on time at 22 weeks (a 15% reduction against similar client's projects). It had a cost overrun of 6%. There is how ever no case to be made that achieving these performance indicators was directly attributable to the implementation of the lean construction model. The most that can be said is that is did not seem to hinder the performance of the project and the project team members who took part in implementing the model reported positive benefits in better integration of work plans and communication.

Operational framework
The original premise was that implementing lean construction at the operational level would lead to the development of a new approach for organising and defining construction projects. This framework was a two dimensional matrix based upon key systems and value adding processes. A key aspect was the vertical integration within the construct process of each key system which provides an alternative to the conventional fast track view of pushing design and construction together horizontally.

The research focused on planning and executing the construct process for three key systems but in the existing construction environment. The framework was reviewed in the context of its usefulness to remove waste. The research showed that this operational framework is useful because it streamlines construction organisation identifying the project team members at an early stage and involving them in planning and executing the work. This reduces layers of management. The research also identified a number of elements which if in place would further reduce waste. The research question might be reframed as "Operational frameworks, which draw upon the principles of lean to change the

way in which construction work is organised, are limited. It is proposed that the operational framework lies at the centre of the successful implementation of lean construction. It should consist of: The complete product design; a project organisation based upon key systems; delivery teams and incentivised contracts; an integrated planned construct and waste measurement process and a site logistics plan".

Epistemology and lean construction

Social constructivism, because it is founded on the notion of "a shared view", could significantly improve construction efficiency by reducing the waste generated at operational and process level. This was a conclusion of the qualitative analysis. Throughout the project, the team dynamics continually change and develop as different suppliers are procured. They never perform. The reason for this is the way in which individuals' views (and suppliers' programmes) have to be rationalised to fit the operational plan. This generates waste. Alternatively a social constructivist framing of lean construction leads to an integrated team approach which develops a consensus view of the work to be done from the outset. Linking planning and acting in this way is key to removing operational and process waste. The participation of each individual member of the project team in this model is important and the research identified four factors at Haslemere which inhibited this: Company role and level of responsibility; Lack of individual knowledge; Existing HR practises; Inter company relationships. A theoretical inference might be that "A participative approach to implementing lean construction increases the opportunity to remove waste by generating a consensus view of the project which links planning and acting and generates value through an effective delivery process".

Waste

Waste was identified at three levels: strategic, operational and process within the case study. Strategic relates to the business environment; Operational waste relates to the organisation of the construction project and is characterised by waste at process interfaces (possibly between 36 and 45%); Process waste is defined as that waste within site processes (between 0 and 22%). It was not possible to identify the relationship between these levels of waste in this work. At Haslemere there was no vertical integration in the process framework and therefore no relationship between time and cost data on processes.

A revised waste management plan for the construct process was devised which includes the delivery teams planning and removing waste prior to work on site and subsequently capturing actual process data to compare and analyse against the planned process data. This identifies and tackles both operational and process level waste.

Theoretically it was key to understand that the important part of the process mapping and analysis work is the team-work that takes place to gain a consensus view of the work which can be recorded in the process map. The original research question could be theorised as "Mapping construction processes as part of project planning in a participative team environment benefits construction projects by building consensus, improving knowledge and supporting communication within the project team. It supports the removal of waste through establishing a consistent measurement tool relevant to the project and to which individuals can become committed thereby increasing the likelihood of success".

Conclusion

The research described is still incomplete. The amended lean construction model has still to be completed. The discussion about the credibility and transferability of these ideas to other construction environments is also incomplete. It has shown however current research in lean construction could benefit from a wider definition than the application of lean production in construction. Applying the more generic principles of lean thinking at operational (project) level supports the existing work by providing the environment within which the existing ideas can make an impact. It is however appropriate that research and practice move forward together since operational and strategic change are inherently more risky and it is key that the development over times allows time for both reflection and practice. In this context action research is a powerful tool since it provides for this dual aim and ensures that consideration is given to the people and context within which lean construction is developed.

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THE APPLICATION OF BENCHMARKING TO IMPROVE PRODUCTIVITY IN THE INDIAN CONSTRUCTION INDUSTRY

Nisarg Hirani

School of Science and Engineering, University of Abertay Dundee, Dundee DD1 1HG

INTRODUCTION

The construction industry is one of the largest employers world-wide, yet growth in the industry compared to other industries is much lower. This has caused profits to shrink and led to reduced work and fierce competition. This combined with high labour rates has forced European contractors to compare productivity with each other through benchmarking. In contrast, the availability of cheap labour in India caused industry to continue with old methods till the last decade. However, with Indian markets being liberalised and being exposed to international competition, local companies are being forced to seek ways and means to enhance productivity. (Garnet and Pickrell 2000, Hirani 1999, Mohamed 1996)

This research aims to develop a framework that will aid Indian construction industry in benchmarking productivity. The first step toward this is to understand the perception of the Indian construction industry towards benchmarking and productivity improvement.

METHODOLOGY

To conduct the research Oppenheim's (1992) 14-step model was consider appropriate. The literature review demonstrated a lack of information in the Indian industry therefore the grounded theory approach was selected. Grounded theory (Straus and Corbin 1994, 1990, Glasser and Straus 1967) approach raised a need for more interactive methodology than the linear model by Oppenhaim. A new methodology was developed which is shown in fig 1. (Milliman and Glinow 1998, Eisenhardt 1989, Blackwood 1988)

After a comprehensive literature review, a questionnaire survey combined with interviews were considered to be the most appropriate method for investigating the Indian construction industry's approach towards benchmarking and productivity improvement.

The questionnaire was divided in two sections. Section A was to collect demographic data while Section B dealt with the perception of construction industry toward benchmarking and productivity improvement. While conducting a cross-country survey in India it was decided to measure productivity on some of the project surveyed to get additional information. Four parameters to measure productivity were selected on the basis of literature review, predictability, human input, equipment and quality. All four were measured using various questions in each category. The survey was first piloted in Scotland to validate the questionnaire before using that in India. An application was developed in Microsoft access to code and arrange the data collected.

DATA COLLECTION

A total of 100 interviews were carried out across India in six major cities Ahmedabad, Baroda, Delhi, Calcutta, Mumbai and Banglore. Apart from these six major cities, some interviews were also carried out in Allahbad, Bhavanagar, Jamnagar, Kochi, Pune and Valsad. The survey included Contractors, Consultants, Project manager, Designers / Architects, Major clients and Research institutes. The companies surveyed had between 10 to 1000 employees and constructed projects ranging from small residential to mega infrastructure.

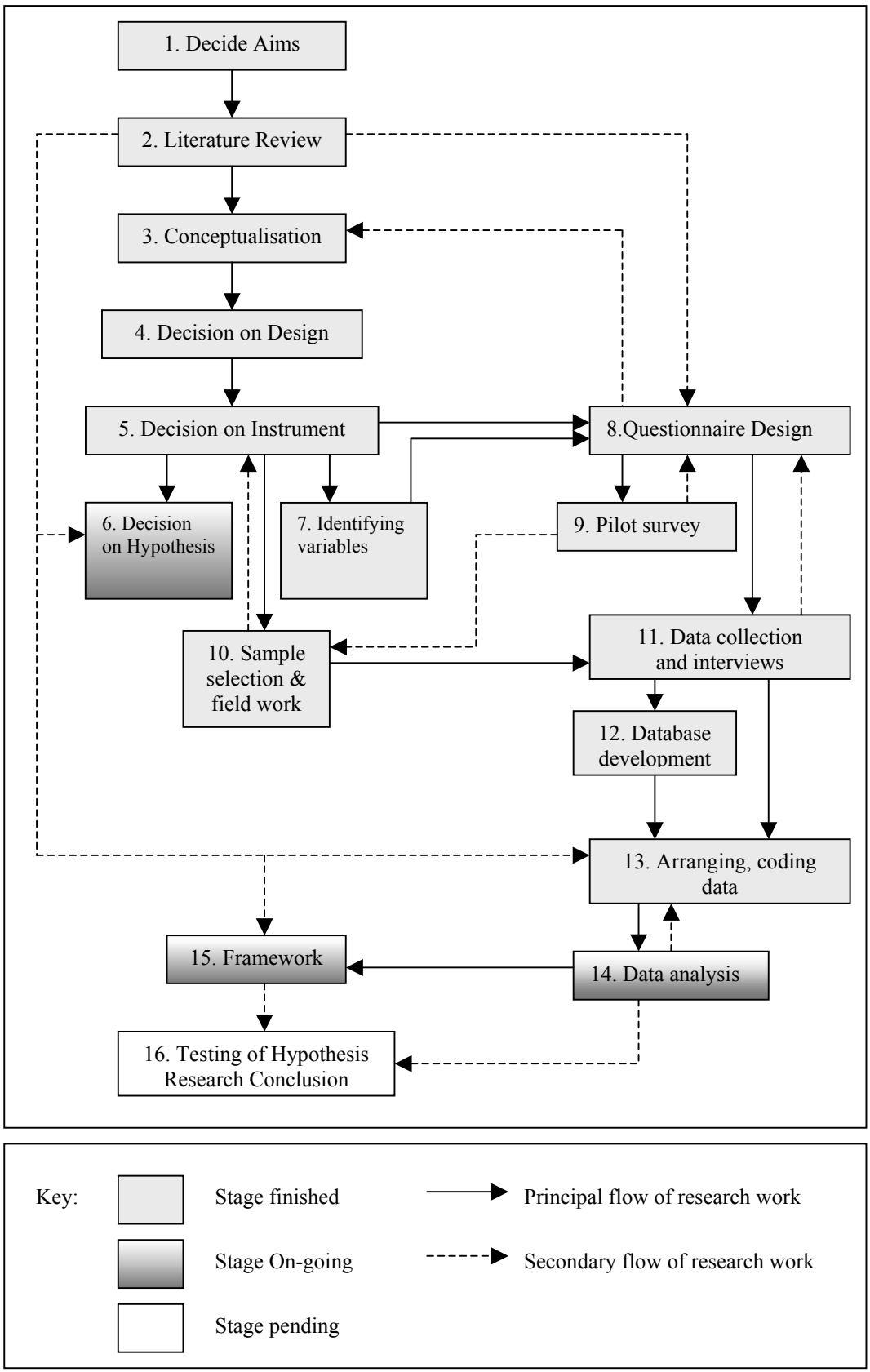

Figure 1. Research Methodology

All the interviews started with a presentation on Benchmarking in construction industry. These presentations were multiple level presentations each of which were tailor made to suit the individual requirements, spanning from a brief presentation covering basic definition and type of benchmarking to detailed presentation including comparison parameters and benchmarking partners, reasons and benefits, benchmarking process and examples of other industry and construction industry benefiting from benchmarking.

In the first part demographic data relating to number of projects done in last five years and completion status of those projects and experience in years and areas of work for the company were also collected. In the second part interviews were conducted by using quantitative question and non-structured informal interviews to determine the perception on construction industry towards benchmarking and productivity improvement.

Data collection was mainly in form of notes and recordings of the interview. After interview all the conversation was critically analysed in the light of literature review. It was then transferred in the form of answers for the questionnaire. All the information gained during survey was embedded in the interview taken after that. As the survey progressed certain questions were modified, added or deleted.

DATA ANALYSIS

The primary analysis and initial conclusion presented here is based on first 70 samples out of 100 as the process of data coding and analysis is continuing. Once coding of all data is completed it would then be analysed using Minitab.

Among 28 questions that were designed for total survey the first four questions were to understand the awareness about benchmarking. In the survey 47% of people surveyed were not aware of the term benchmarking and among 53% of the people who were exposed to the concept of benchmarking only 24% have actually used benchmarking in an informal way.

All the results presented hereafter are divided into two parts A and B, where A stands for the respondents who were not aware about benchmarking before this survey (47% of total) and B stands for the results of the respondent who were aware about benchmarking (remaining 53%). The responses in part A are based on respondents understanding and exposure they had on benchmarking mostly derived from presentations that were made to them before the interview. Analysis of some of the important questions is summarised bellow.

After finishing the first four questions on awareness all the people surveyed were requested to indicate the type of benchmarking they would prefer to implement in their organisations. The results of that are summarised in Table 1.

Table 1

Comparison Parameter	Benchmarking Partner							
	Internal		**Competitor**		**Functional**		**Generic**	
	A	**B**	**A**	**B**	**A**	**B**	**A**	**B**
Performance	67 %	73 %	30 %	43 %	63 %	40 %	0 %	0 %
Process	4 %	7 %	63 %	70 %	52 %	53 %	0 %	3 %
Strategic	0 %	13 %	52 %	57 %	85 %	83 %	22 %	20 %

As data sharing is the primary requirement for benchmarking all the interviewee were asked about the kind of data they would not like to share with benchmarking partners. 65% of the total respondents were ready to share any information. This could be subdivided into two parts as described earlier, 52% of respondents not aware about benchmarking while 77% of respondents aware about benchmarking were ready to share all information.

In the second phase, which followed the discussions on benchmarking, all people surveyed were asked about the type of productivity measurement and improvement programme they have in their organisations. They were also asked to list the areas they have implemented initiatives to improve productivity in last 1 to 3 or 4 to 9 years. In cases where they do not have a productivity improvement programme they were asked for reasons for not having one. This data is not yet available.

They were also asked to rank three statements on the scale of 1 to 5 where 1 stands for disagree and 5 stands for strongly agree. This was done to understand their readiness towards accepting benchmarking as a tool to improve productivity. Results are summarised in table 2.

Table 2.

Rank(% of total)	**1**		**2**		**3**		**4**		**5**	
Statements	**A**	**B**	**A**	**B**	**A**	**B**	**A**	**B**	**A**	**B**
Benchmarking as concept that can improve productivity	0	0	0	0	4	0	15	10	81	90
If a proper measurement system is develop it is possible to measure, monitor and document productivity	0	0	4	0	4	0	22	17	70	83
It is desirable to share data with competitors for benchmarking	0	0	7	3	19	7	30	23	44	67

This question is analysed only to give an indication, once all the data is coded it would be analysed using statistical tools like likert scales, chi square etc.

PRILIMANARY CONCLUSION

Continual professional development programme for industry is required as results clearly indicates the lack of awareness and knowledge of benchmarking in Indian construction industry as almost half of people surveyed were not aware about benchmarking and none have actually used benchmarking formally to improve productivity.

An interesting pattern could be observed in table 2, as the answers by both the types of respondents indicate the similar preferences. Both the types of respondents chose performance for internal benchmarking, as this is the easiest step to start, share data and to obtain relatively quick results. Process shows the highest response in competitor benchmarking, this could be helpful in bridging the gap between both the companies though there might be problem of sharing sensitive information between competitors. For functional benchmarking strategy was selected.

Similar conclusion were drawn from the analysis about the extent of data sharing, 77% of the people aware about benchmarking were ready to share information. Only 52% of the people who did not know about benchmarking were ready to share information even thought 63% of the preferred to use competitive benchmarking. This shows reluctance in almost 1/3 of the people surveyed in sharing data even though it could help organisation in improving. This could be attributed to fierce competition and lack of confidence in the system.

Analysis of table 2 shows that both the types of respondents agrees to concepts of benchmarking to improve productivity and measure, monitor and documents the productivity. Views on data sharing is different for both types, a higher number of people who know about benchmarking were ready to share the data than people who were new to the concept of benchmarking. This again shows that if they are trained for benchmarking they might change decision on data sharing.

Overall preliminary conclusion can be made that construction industry in India is still new to the concept of benchmarking though most of them agrees that it could be useful to improve productivity. As suggested earlier a continual professional development programme is required along with benchmarking clubs that could initiate benchmarking at an industry level. Once given confidence in the system they should be able to share data. An example of Construction Best Practice Programme, Construction Productivity Network, major contractors group could help in developing the benchmarking club. A framework is required for benchmarking which should include the education on benchmarking in its first step. The framework must include the preferences on type of benchmarking and sensitivity of data sharing.

EXPECTED OUTCOME

It is intended that the results of this project will give a clear idea about perception of the Indian construction industry towards benchmarking. Once the information gained from the interviews is critically analysed and merged with the statistical analysis, it will be possible to develop a framework for benchmarking for Indian construction industry. The questionnaire has evoked a good response from the industry. A group of contractors in Ahmedabad showed willingness to form a benchmarking club in collaboration of Ahmedabad Management Association. This will be used to check the robustness of the framework.

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KNOWLEDGE MANAGEMENT FOR IMPROVED PRODUCTIVITY AND PERFORMANCE

Ahmed M Al-Ghassani

Loughborough University, Department of Civil and Building Engineering

Introduction
Knowledge relates to information and data. It is defined as information with context (sometimes described as actionable information), whereas information is the processed data (data with meaning) and data are discrete facts about events.

Knowledge gives one the power to act and to make decisions that produce value to the individual and organisation. It can be tacit or explicit. Tacit knowledge is stored in the individual's brain as mental models, experiences and skills, whereas explicit knowledge is encoded in organisational procedures, formal models, rules, documents, products, services, facilities, systems and processes. Explicit knowledge can therefore be easily communicated while tacit knowledge is difficult to communicate.

Knowledge management is a systematic process of gathering, codifying and storing, sharing, and using the different types of knowledge. In construction it aims to manage the knowledge (lessons learned, best practices, etc) that is gained from individual projects, during their lifecycle, to make it more widely available through the organisation. Knowledge management is also defined as delivering the right knowledge to the right people at the right time and in the right format. Knowledge management helps to improve performance and increase productivity within organisations by:

- avoiding work duplication;
- preventing the repetition of mistakes;
- aiding problem solving;
- supporting decision-making;
- retaining tacit knowledge;
- facilitating staff training;
- managing and improving work practices and processes;
- generating competitive advantage so as to lead market (due to increased chances of innovation);
- improving business performance.

The role of IT in supporting the knowledge management process
To be successful, a knowledge management system should carefully address three issues: organisational culture, people, and technology. Technology forms one third of the time, effort, and money that is required to develop a knowledge management system. Technology is a key enabler to knowledge management and software vendors play an important part in providing new tools that support the knowledge management process. These vendors claim that their products are the complete and ultimate solutions to knowledge management problems.

Research Objectives
This research explores the role of IT in supporting knowledge management in construction organisations. The principal objective is to investigate the input of the existing IT tools and products to knowledge management and to examine the requirements for better IT support for knowledge management.

Methodology
The literature on knowledge management software was first reviewed. Major vendors and users of knowledge management software were then interrogated for a closer investigation of what current knowledge management software can offer. This was carried out by means of two survey questionnaires; one targeted at leading knowledge management software vendors, and the other targeted at knowledge management software users in construction organisations. The research is also linked to two on-going government-funded knowledge management projects namely the CLEVER (Cross-sectoral Learning in the Virtual Enterprise) project and the KnowBiz (Knowledge Management for Improved Business Performance) project. The two projects involve a number of industrial collaborators. Semi-structured interviews with these collaborators provide important input to the projects.

Findings
Existing knowledge management software products were found to address only some elements of the knowledge management process. This introduces a gap between the claims of knowledge management software vendors and what

users experience. Organisations that have used knowledge management software found that these products were not delivering what was expected due to several reasons.

Current software tools assume that organisations already have a clear understanding of their knowledge management problems and its processes. However, an organisation first needs to understand its knowledge problem within a business context; it then needs to identify some generic knowledge management processes to follow. More importantly, there should be measures to help in assessing the effect of the implemented processes on the organisation's business performance. Within the tools investigated, no tool was found to address these issues. Hence, three rapid prototypes are being developed to help in addressing these issues. These are: the "Problem Definer"; the "CLEVER Adviser"; and the "IMPaKT Assessor". Each of these is described in turn below.

The Problem Definer or the Problem Definition Template (PDT) has been developed within the CLEVER project and was then encapsulated in a prototype software system. The prototype was developed using Microsoft Access. The PDT consists of a set of questions that link the knowledge management problem to the organisation's business goals. It covers several knowledge management issues: type of knowledge that needs to be managed (including the business drivers for knowledge management), its characteristics, sources and users, and the current processes of managing knowledge. The output is a report containing a clarified knowledge management problem and a distilled set of knowledge management issues from the overall problem. This provides an appropriate platform for the development of knowledge management strategies in any business organisation. Figure 1 shows a sample screen from the PDT.

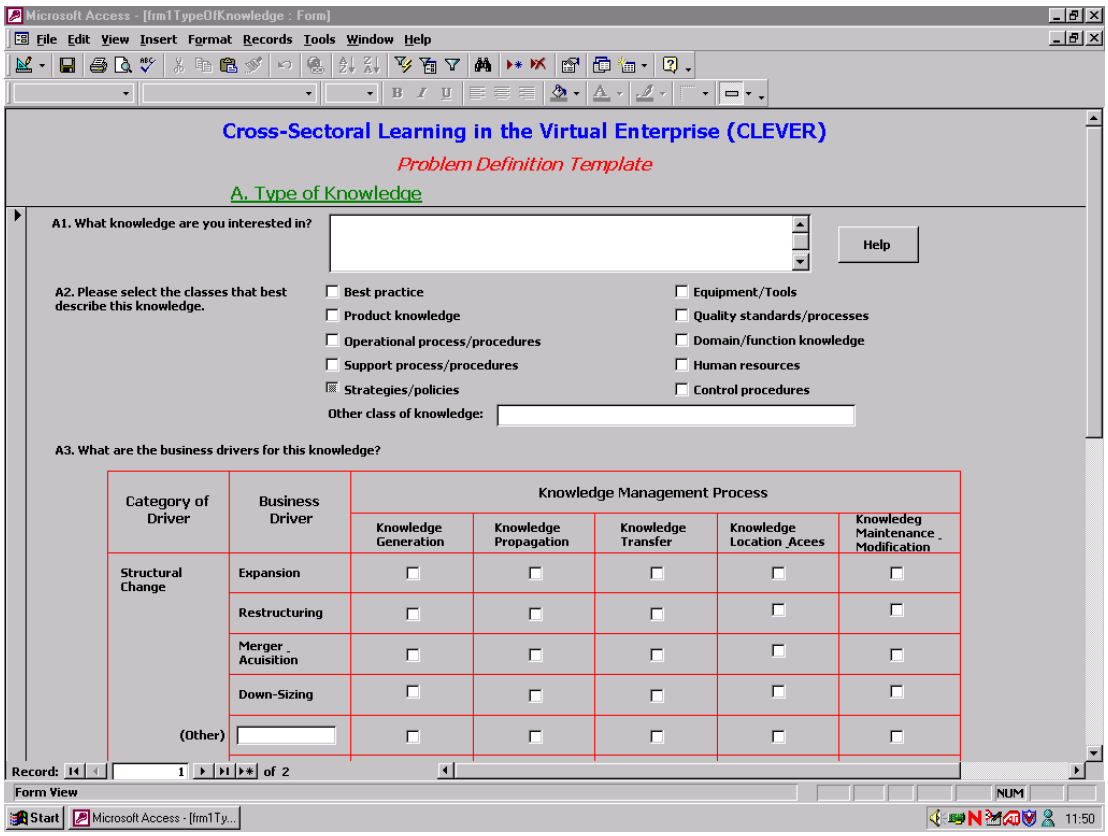
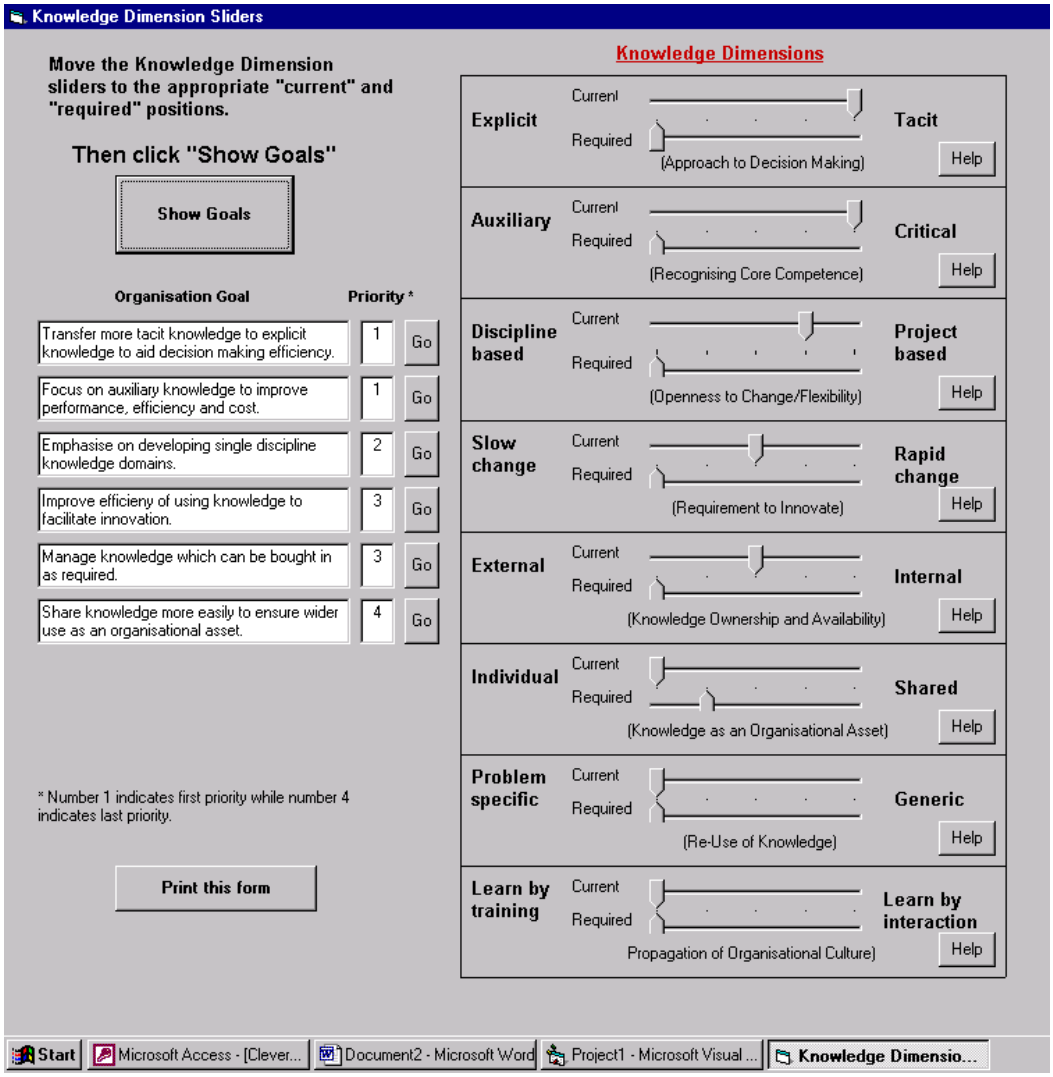


Figure 1: The Problem Definition Template (PDT).

The CLEVER Adviser was also developed within the CLEVER project. It was developed using Visual Basic programming language. The prototype investigates eight knowledge dimensions (Figure 2). These dimensions cover the characteristics of knowledge, its location, and how it is acquired. The prototype is able of presenting the organisation's goals with their priorities where for every goal the relevant knowledge dimension can be investigated against the other dimensions to produce the knowledge migration paths and to recommend generic processes for knowledge management.



The IMPaKT (Improving Management Performance through Knowledge Transformation) Assessor is being developed within the KnowBiz project. It aims to deliver a prototype system that evaluates and assesses the likely impact of using knowledge management to enhance organisational performance. Key measures including financial, non-financial, and Key Performance Indicators (KPIs) will be used as a basis for assessing performance. Business performance measurement models such as the Excellence Model and the Balance Scorecard will form an integral part of the system.

KEY PERFORMANCE INDICATORS

Salma Y. M. Mahmoud

University of Newcastle-upon-Tyne

INTRODUCTION

The central part of the proposed research deals with the use of Key Performance Indicators (KPIs) as tools that aim to effectively and continuously help the construction industry improve its performance.

BACKGROUND

The construction industry is believed to be under-achieving with low profitability and too little investment in capital. The thing that makes many of its clients dissatisfied with its overall performance. As described by Sir John Egan, the UK construction industry is at its best is excellent. It is believed to be capable of delivering projects that match any other construction industry worldwide. However, there are some concerns raised indicating that the industry is not performing to the best of its abilities. These concerns mainly focus on areas regarding the industry profitability margins, its ability to keep abreast of innovation in processes and technology, its clients' satisfaction, and the fragmentation of the construction procurement process. As a result, the industry is seen to be in need of re-orienting itself in response to these criticisms. To encourage the necessary changes, Egan has set targets and has also recommended developing and implementing regular performance tracking and monitoring programs using reliable performance metrics that can gauge performance in relation to improvement programs. This led to the development of the Construction Best Practice Program (CBPP) KPIs.

RESEARCH OBJECTIVES

Although this work is in its very early stages, it is anticipated that it will cover some or all of the following objectives:

1- Investigating the development of Key Performance Indicators (as applied to the UK construction industry).
2- Examining whether the way in which KPIs are displayed, defined and calculated might affect their perceived importance, understandability, relevance to the needs of the industry and comparability as viewed by the different parties involved in the construction project (i.e. client, consultant, contractor)
3- Survey the current use being made of KPIs.
4- Test the effectiveness of other performance measurement systems and identify any gaps where KPIs have failed to address (measure) important performance dimensions.
5- Use KPIs to identify the trends of the industry performance over time
6- Test the effectiveness of the different performance measurement packages applied to the construction industry, in different countries.

PROPOSED METHODOLOGY OF THE STUDY

The suggested research objectives and subsequent questions, listed at the beginning of this document, require the use of different data sources and research methods. Thus the research is expected to employ various different methods particular to each facet of the research problem.

The research is expected to be done in several stages determined by the achievement of the predefined objectives. As seen at this very early stage, it is expected that the possibilities for this work include the following methodologies;

- The literature review as the first part. Hence an exploratory study represents a main source to get the secondary data. The literature review is considered necessary to review prior studies in the development of performance measurement systems in different sectors and industries and to reflect some of the suggested models developed.
- A second source for the secondary data was the published documents prepared by some government bodies like the Construction Best Practice Program (CBPP), Department of the Environment, Transport and the Regions (DETR), Movement for Innovation(M^4I) etc. and this will mainly help in providing detailed background about the development of the construction KPIs.
- A significant portion of what is known on the topic will be obtained by interviewing some of the members of the KPIs working group.
- Semi Structured interviews are also suggested to be used for the purpose of conduction a causal study. Hypothesis are to be developed relating some of the dependent variables to some suggested independent variables. Consequently, developing a theory by interviewing people who are attempting to use these systems.
- Case studies are also thought of as one of the methods that can be used for in depth analysis of organizations attempting to use KPIs.

WORK ACHIEVED TO DATE

1- Literature review was the initial stage to start with and the focus was on references offering insight about performance in the construction industry, measurement and measurement metrics and techniques in different sectors and industries. It was mainly aimed at having a broad idea about the industry performance and deficiencies and gaps that researchers are trying to emphasize. Special attention has been paid to performance measurement metrics and their development in the construction industry a well as other industries.

2- Getting in contact with some of the persons involved in the development of the construction KPIs, it was possible to have a background about KPIs and to develop an idea about the curves, the data used and the steps and procedures followed to draw them. Furthermore, some concerns about their definitions and use in the construction industry were raised and possible limitation for their usefulness and conceivable problems with their definitions were preliminary highlighted.

3- Visiting some of the organizations which are trying to adopt the construction KPIs for their performance measurement was thought to be useful as well. An organization applying KPIs was visited and the main exercise was to depict the way they compile the available data and manipulate it to calculate the 10 headline indicators. The aim was to examine how different organizations could possibly have different interpretations for the same indicators and to see how diversely their calculation methodologies may vary.

A COMPARATIVE STUDY OF CONTRACTOR PERFORMANCE IN JAPAN, US AND THE UK

Hong Xiao

Built Environment Research Unit, School of Engineering and the Built Environment, University of Wolverhampton, Wolverhampton, WV1 1SB, UK

INTRODUCTION

With the globalisation of world economy, contractors have to compete with their foreign counterparts in their domestic as well as international markets. In order to improve competitiveness and achieve best practice, it is necessary for contractors to benchmark their performance and practice internationally. The Japanese and US construction industries are internationally renowned as world leaders (Levy, 1990; Flanagan, 1994). Moreover, their distinctive features in working practice may provide exciting opportunities for technology transfer and performance improvement and thus provide useful performance benchmarks for contractors. Notwithstanding this, when at its best, UK construction has been shown to be excellent, and capable of matching any other construction industry in the world (Centre for Strategic Studies in Construction, 1988; Egan, 1998; Flanagan, *et* al, 1998). This research aims to evaluate and compare contractor performance and practice among contractors from Japan, the UK and the US. From such evaluation, performance-enhancing models of best practice are to be derived.

An overview of the research methodology

Comparing contractor performance is a fastidious and onerous process; a fact compounded when international comparisons are attempted (Proverbs, 1998). When comparing contractor performance and practices internationally, the key issues are to maintain comparability and representativeness of data. To achieve this, a new research approach has been developed.

Previously, methods for conducting international construction comparisons have been categorised as pricing studies, macroeconomic studies and case studies (Edkins and Winch, 1999). Each method has its own advantages and limitations in terms of their comparability, their representativeness, and/or their resource requirements. Pricing studies are relatively easy to apply and results can be systematically analysed and interpreted. Comparability is maintained but at the expense of representativeness, or vice versa. The method relies on building prices or other (e.g. productivity) figures, which make the results highly sensitive to factors such as economic cycles, exchange rates and project characteristics.

Macroeconomic studies utilise available data, and thus are cost effective. However, they only reflect the situation on a macro level, so results have little practical value to individual contractors and as such have not been widely applied.

Case studies can be used to compare all aspects of construction projects and to demonstrate international differences between countries and why these differences exist. However, it is very difficult (if not impossible) to find matching cases in different countries because of the uniqueness of construction products and the uncertainties around the construction process. Data comparability is suspect and data collection is also extremely expensive and time-consuming.

As used by Proverbs (1996a, and 1996b) and by OECD/ Eurostat (Edkins and Winch, 1999; Vermande and Van Mulligen, 1999), this research uses an appropriate hypothetical project as the basis for a semi-structured questionnaire survey for accruing the data required to allow robust statistical analyses to be applied. Measures of contractor performance include construction cost, construction time, construction quality and sustainable development, and the questionnaire is designed around these themes. Respondents (project managers of general contractors in the three countries) are invited to answer questions related to the hypothetical project and to draw upon their previous project experience. Hard factors (such as the estimated unit price and the construction duration of the hypothetical project) and soft factors (such as their attitude to partnership and the extent to which feedback is sought from clients) are included in order to present a complete picture of contractor performance and practice. Relative figures in the form of percentages and ratios are used as much as possible to maintain the comparability of data.

The approach used here differs from pricing studies and that by Proverbs in that exact details of the hypothetical project are left to the respondents to decide, allowing them to draw upon their previous project experience and facilitate the inclusion of certain national vernacular characteristics into the design. This is considered essential in order not to

impose irregular/abnormal specification details onto the respondents, as this would no doubt induce a degree of bias into the response. Unlike case studies, the new approach uses a hypothetical project for generating comparable data and removes the need to identify matching or concurrent cases. That is, the appropriate characteristics of pricing studies (i.e. comparable data derived from a hypothetical project) and case studies (i.e. drawing on the respondents' previous project experience) are utilised, while disadvantages of both methods (i.e. unrepresentativeness in pricing studies and incomparability in case studies) are eliminated.

Data collection

In order to collect the necessary data, a semi-structured questionnaire survey was conducted simultaneously in Japan, the UK and the US. Previously established contacts with researchers, contractor organisations, professional bodies and contractors in the three countries were exploited. The semi-structured questionnaire was considered fairly complicated, demanding approximately two hours or more to complete, and a low response rate was somewhat anticipated.

In Japan, translated versions of the questionnaires were distributed to ninety-seven contractors through the Building Contractors Society (BCS). In the US, contractors were contacted by means of a large contracting body, The Associated General Contractors of America (AGC). Approximately 1500 informal enquiries were made seeking cooperation and participation in the survey. Questionnaires were sent to those who showed an interest. In the UK, companies listed in the *Kompass* Directory (Reed Business Information, 1999) and members of the CIOB (Chartered Institute of Building, 1999/2000) were contacted by telephone for cooperation in the survey. Detailed information about the survey is shown in Table 1.

Based on feedback received from the survey participants, the hypothetical project was considered suitably international in design and relevant to the three countries, while the information provided was sufficient to allow respondents to complete the questionnaire. That is, this new research approach was considered suitable for comparing contractor performance internationally.

Table 1 Questionnaire survey

	Distributed	Received		Held back for validation		Used in analyses	
	No.	No.	%	No.	%	No.	%
Japan	97	22	22.7	0	0	22	100
UK	417	34	8.2	2	5.9	32	94.1
US	113	38	33.6	6	15.8	32	84.2
Total	627	94	15.0	8	8.5	86	91.5

Performance comparison and some preliminary findings

Six variables were used to evaluate and compare contractor performance, namely (i) unit price, (ii) construction duration, (iii) defects, (iv) client satisfaction on cost, (v) client satisfaction on time, and (vi) client satisfaction on quality. Figure 1 shows a summary of relative contractor performance in the three countries. Here, the most efficient levels of performance for each of the six measures is standardised of ten, while other levels of performance are converted proportionally on a scale of 0-10.

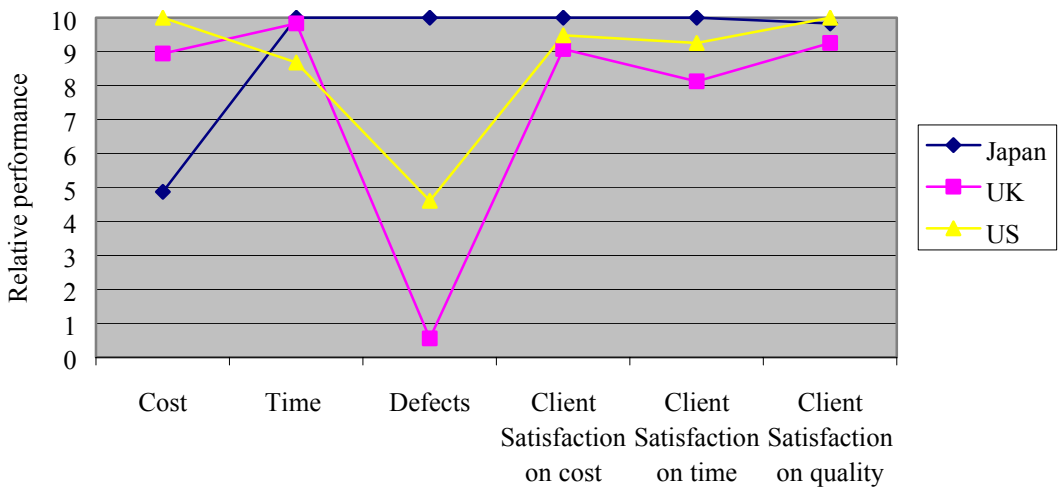


Figure 1 Comparison of relative contractor performance

Figure 1 shows that US contractors achieve superior performance in cost, while Japanese contractors are superior in regard to the number of defects (i.e. quality) and in respect to two measures of client satisfaction (cost and time).

From the above preliminary statistical analysis, significant differences in Japanese, UK and US contractor performance have been revealed. However, similar performance levels for construction time and construction quality have also been found.

Further research is required to reveal root causes behind these performance diversities. This would provide opportunity for contractors in different countries to learn from each other and improve their competitiveness respectively.

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