A STUDY OF PROJECT PLANNING ON LIBYAN CONSTRUCTION PROJECTS

Ali E Abubaker[1], David Greenwood and Allan Osborne

[1] *School of the Built Environment, Northumbria University, Ellison Place, Newcastle-upon-Tyne, NE1 8ST, UK.*

Construction projects are regularly faced by scheduling problems causing the projects to finish beyond their predetermined due date; this is a global phenomenon. The main purpose of this study is to consider the problems associated with project planning generally, with specific reference to construction projects in Libya. This study is unique in two respects. First, despite the recent high volume of infrastructure work in the country, there have been few investigations into construction delays in Libya. Secondly, earlier studies have considered the causes or the effects of project delays, whereas the present aim is to evaluate the potential of applying a planning and scheduling technique that is entirely novel in the Libyan context. The paper reports the results of Phase I of this research.

Keywords: delays, innovation, Libya, project planning, scheduling tools.

INTRODUCTION

Flanagan and Norman (1993) note that, in terms of scope, cost, time and quality, the construction industry, perhaps more than most, is particularly at risk. They add that this risk is often not dealt with adequately, resulting in poor performance with increased costs and time delays. Indeed, many construction projects are faced by scheduling problems causing the projects to finish beyond their predetermined due date. As a result, there are usually provisions for delay damages in the contract terms, which in turn is a major problem for project managers and practitioners (see, for example, Flanagan and Norman, 1993; Thompson and Perry, 1992). Ballard (2000) points out that it is necessary to quantify and understand the benefits of greater plan reliability for safety, quality, time and cost.

The work reported in this paper is part of a PhD study, whose aims are to (i) consider the problems associated with project planning generally; (ii) to contextualise these with specific reference to construction projects in Libya; and (ii) evaluate the potential of applying the 'Last Planner' approach on Libyan construction projects.

In order to accomplish this, six objectives were set for the research work. These were as follows:

1. Review the literature to discover a) the factors that contribute to project delays, and b) any literature that specifically highlights the failure of 'traditional' planning to deliver;

[1] ali.abubaker@unn.ac.uk

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2. Investigate the way planning is carried out in Libya (e.g. whether it is predominantly 'traditional') and what techniques it uses (e.g. whether it employs critical-path analysis, software tools, etc.);
3. Through literature review, investigate innovative techniques (in particular the 'Last Planner' approach to project planning) with particular reference to how they differ from the 'traditional' planning approach;
4. Investigate the 'Last Planner' approach to project planning and adapt a model suitable for construction projects in Libya;
5. Implement this model on a number of in-situ 'trials' on Libyan projects; and
6. Consider the results against typical performance and critically evaluate the contribution that the new techniques might make to project planning in Libya.

After a literature search, as outlined in objective 1, a first phase of data gathering took place (see objective 2, above) and these results are reported in the present paper.

BACKGROUND

A number of scheduling tools have been developed or proposed for construction management. Some have been adapted from other industries; an example being the Bar Chart model originally developed for industrial processes (Halpin and Woodhead, 1976). More sophisticated techniques have followed, many of them based on the Critical Path Method (CPM), and more recently, these have been supported by computer software packages. It is now relatively common for clients on many mid-size and large projects that contractors provide project plans using one of these planning and scheduling techniques (see Scott *et al.*, 2004). Some of the modelling techniques are of general purpose and use. The most commonly available and implemented techniques are activity-oriented models. CPM and PERT are typical examples of those techniques. These techniques are basically designed to act as planning, scheduling and monitoring (controlling) techniques. Other techniques are of special purposes and relevant only to certain types of construction projects. For example, the Line of Balance (LOB) technique is a tool used specially for scheduling repetitive projects. Some operations research techniques (mathematical programming, queuing models, and simulation) have been applied to the construction industry, but are, in general, of limited application in construction management, although simulation has potential to be applied to various areas in construction.

Project planning in the Libyan construction industry

Despite the recent high volume of infrastructure work in that country, there have been few investigations into construction delays in Libya; an exception being the work of Greenwood *et al.* (2001) who examined the role of the client in project overruns. Preliminary research, reported below, found that Libyan planners were familiar with most of the techniques described above. The aim of the present work is to evaluate the potential of applying an entirely novel scheduling technique to construction projects in Libya.

Shortcomings of 'Traditional' planning techniques

Against the context of continuing failures to complete on time, it may be useful to consider the efficacy of the various techniques that have become 'traditional' in the construction industry.

Bar Charts

The Bar (Gantt) Chart was originally developed for industrial production management and has been since widely used in construction management. The Bar Chart has been an accepted method for portraying a project plan and work progress since its original development early last century (Halpin and Woodhead 1976). The Bar Chart is more understandable than tables containing numerical data (El-dosouky, 1993). The visual clarity of the Bar Chart makes it a very valuable medium for displaying job schedule information. It is immediately intelligible to people who have no knowledge of network diagrams. It provides an easy and convenient way to monitor job progress, schedule equipment and crews, and record project advancement.

However, Bar Charts have well recognized and serious shortcomings when used for the original development of project management information. The Bar Chart does not show clearly the sequential relationships between project activities. Moreover, it does not convey to managers and workers what consideration must be given to the prerequisite activities. It is useful as a complement of other techniques for the reason of intelligibility and as a rough preliminary plan (Chrzanowski and Johnson 1986; Stradal and Cacha 1982). Clough (1979) concluded that the usual Bar Chart is not an adequate planning and scheduling tool because it does not portray a detailed, integrated and complete plan of the operations.

Networks

A variety of different types of 'critical path network' exist and these can be grouped under the general heading Critical Path Method (CPM). CPM can be a powerful tool for planning and management of projects. The various forms of CPM are essentially diagrammatic representations of a project that depict the sequence and interrelations of all the component parts of the project.

The logical analysis and manipulation of this network determines the best overall program of operation. The model is based on estimating the optimum time required for each work item and making the most economical use of available resources. It may be as detailed as desired to suit the anticipated conditions and hazards. During execution of the project, it permits systematic reviewing of current situations as they arise. So, allowance can be made for the effects of uncertainties in the original planning. It enables, also, for re-evaluation of future uncertainties to be made, and remedial measures for those operations that require correction or acceleration (Halpin and Woodhead 1976).

The CPM diagram can be represented by arrow networks, precedence networks and time-scaled diagrams. For more details about constructing CPM networks and uses, refer to Antill and Woodhead (1984). There are criticisms regarding the appropriateness of CPM. The technique is used on projects that are logically deterministic and consist of activities with estimated parameters.

The major disadvantage is that for complex projects, a CPM schedule becomes extremely detailed. The problem is magnified in projects consisting of repetitive activities such as in vertical (high-rise) construction and horizontal (roadway) construction. Since the same activities are repeated, the resultant CPM schedule is cluttered with the repetition of information (Chrzanowski and Johnson 1986). Naaman (1974) added that CPM does not permit the presence of loops or feedback used in repetitive processes.

Cole (1991) reported that the effectiveness of CPM in the detailed planning and controlling of repetitive building work is questionable. He concluded that, in summary, the model – CPM - does not reflect site conditions accurately and a contractor, when using the technique, should make allowances for this during the planning process. A practically-orientated critique of CPM and similar methods was made by Johansen (1995), who observed major differences between what he called the 'textbook' (or 'hard') approaches to planning, and what was actually done on site.

Program Evaluation and Review Technique (PERT)
PERT, unlike CPM, uses three time estimates for each activity. The first value represents an optimistic or minimum time (a). The second is a most likely or modal time (m). The last is a pessimistic or maximum time (b). Therefore, PERT is a probabilistic scheduling technique. The three times estimates are then used to compute the expected time (te), where te = (a+4m+b)/6. Then, 'te' is used as the best available time approximation for the activity in question.

Although PERT permits calculation of the probability of completing the project at specified times, it is based on the assumption that the critical path is longer than any other path in the network. Thus, unreliable results are obtained if the network contains several critical or nearly critical paths. Because PERT and CPM are similar, PERT suffers from the shortcomings associated with CPM technique.

Last Planner System

The Last Planner System (Ballard and Howell 1997) has been in use for about 15 years since its development in 1992. It has been successfully used in a series of projects ranging from oil refineries to commercial building construction (Ballard, 2000).

Lim *et al.* (2006) noted that studies on the Last Planner System to-date have been conducted mainly by the Lean Construction Institute (LCI), which has been involved with the system for a number of years, but at present, several countries are pursuing studies on the system.

In an experiment based in the UK, Johansen *et al.* (2004) recorded that: 'the researchers and the project team were of the opinion that the project had benefited substantially from using the Last Planner System methodology, and that without its use the construction project might have suffered a larger time overrun.'

One limitation of the Critical Path Method technique in production control is the difficulty in sufficiently reflecting the site conditions, which change practically every day. In contrast, the Last Planner System technique addresses such limitation by managing the daily work assignments (Howell and Ballard, 1994).

RESEARCH METHODOLOGY

The aims and objectives of the overall project of which this work forms part, were outlined above. After a literature search, a first phase of data gathering has already been completed and took the following form.

First, discussions were carried out with the heads of planning and project management of six large Libyan construction companies about their methods and approaches to planning and control of projects. This was in order to gain further access to individual planners within the companies. Following this, 60 questionnaires were circulated to project-based planners within these six companies.

In the questionnaire, respondents were first asked about their company and their position within it. All the companies were contracting organisations. Their names and those of the respondents remained confidential. Twenty-eight of the respondents held the title 'planning engineer', whilst 25 had the title 'project manager'.

They were then asked how they set completion targets for their project durations, namely, (i) who it was that set the overall contract duration (client, contractor or consultant) and (ii) whether the subsequent schedule was developed top down (starting with an overall period and analysing it into individual activities), bottom-up (starting with individual activities and combining them to match or produce an overall contract period).

The participants were then asked what planning techniques they used, and whether they used any scheduling software to support this, and additionally, where they had acquired the knowledge and experience of these techniques.

To assess the incidence of project delays, participants were then asked to give the planned and actual durations of their previous 10 (or more, if they wished) projects. One hundred and twenty such projects were reported.

Respondents were asked how (if at all) they allowed in their plans for the risk of these delay factors. Again, a prompt list was provided, which included: a fixed overall constringency allowance; a fixed allowance on each activity; a fixed allowance on certain specific durations; and not at all.

The next step was to discover, if such allowance took place, whether it was based on experience, discussion or computer simulation (and if the last, what form of software). Firms were also asked whether they undertook any post-project reviews of planning process and techniques, and, if so, what modifications were made as a result.

RESULTS OF THE RESEARCH TO-DATE

From the 60 questionnaires circulated amongst project-based planners within the six targeted companies 53 usable responses were collected. Their responses produced the following information.

Creating the schedule
Respondents were asked how they set completion targets for their project durations. The results reveal that in almost every case the overall duration was set by the client. The majority of planners (32) then built up their programmes from individual activities and then compared the result with an overall contract period; others (14) did the reverse, and started with an overall period, which they then analysed into individual activities. In five cases the decision was made by a committee and in two, a consultant was used.

Planning/scheduling techniques such as Bar Charts (31), CPM (14), and PERT (8) were generally used. The majority of participants (34) used electronic support tools (such as Microsoft Project™) with 19 of the respondents reporting that they used no such software support.

The majority (20) developed their planning knowledge in college with further on-the-job experience and 18 had relied on consultant training; twelve had picked up the techniques whilst working for other companies and three had been mentored by a colleague.

Project delays
Of the 120 projects reported by respondents, a clear majority (83, i.e. 69%) suffered some delay, and only 37 (31%) finished within time. Where delays had occurred (see above) respondents were asked about the most common causes. A prompt list, derived from the literature was given (for a summary of this directed towards the North African context, see, Greenwood, *et al.*, 2001) and this included weather,

resources, site conditions, subcontractor-problems and client changes. Table 1, below, gives a detailed view of these results.

Table 1: Causes of delay

1	Insufficient data collection and survey before design	Design
2	Delays in producing design documents	Design
3	Misunderstanding of owner's requirements by design engineer	Design
4	Changes in material types and specifications during construction	Materials
5	Late procurement of materials	Materials
6	Shortage of construction materials in market	Materials
7	Delay in material delivery	Materials
8	Unavailability of incentives for contractor for finishing ahead of schedule	Owner
9	Delay in payments by owner	Owner
10	Change orders by owner during construction	Owner
11	Slowness in decision making process by owner	Owner
12	Poor communication/coordination between consultant and other parties	Consultant
13	Delay in approving major changes in the scope of work by consultant	Consultant
14	Conflicts between consultant and design engineer	Consultant
15	Ineffective planning and scheduling of project by contractor	Contractor
16	Delays in sub-contractors work	Contractor
17	Poor qualification of the contractor's technical staff	Contractor
18	Difficulties in financing project by contractor	Contractor
19	Incorrect construction methods implemented by contractor	Contractor
20	Conflicts in sub-contractors schedule in execution of project	Contractor
21	Legal disputes b/w various parts project	Project
22	Type of construction contract (Turnkey, construction only)	Project
23	Original contract duration is too short	Project
24	Ineffective delay penalties	Project
25	Type of project bidding and award (lowest bidder)	Project
26	Shortage of equipment	Equipment
27	Low level of equipment-operator's skill	Equipment
28	Equipment breakdowns	Equipment
29	Unqualified workforce	Operatives
30	Low productivity level of operatives	Operatives
31	Shortage of operatives	Operatives
32	Nationality of operatives	Operatives
33	Effect of social and cultural factors	External
34	Differing site (ground) conditions	External
35	Accident during construction	External

By summarising and grouping these delays, it was possible to see a pattern of five major grouped causes.

The commonest group was that of delays due to resources; this included delays in payment for the project, lack of appropriate technology and information, and shortages of labour. Client changes represented the next most common grouped cause, followed by site conditions, and finally subcontractors (this final category, of course, could be treated either as a form of resource delay). Figure 1, below, shows this simplified grouping of the project delays encountered by respondents.

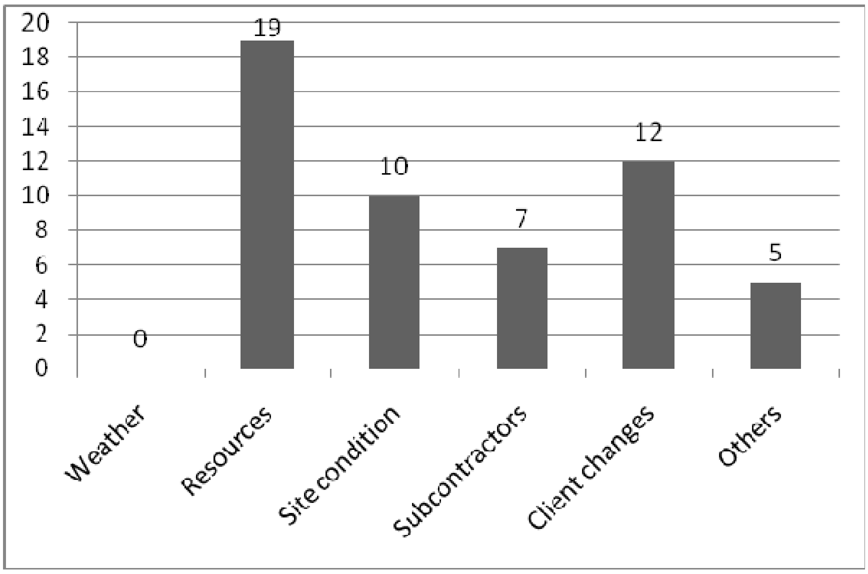

Figure 1: Causes of project delays

Planning for risks
The majority of planners surveyed (23) catered for risks by using a fixed allowance on each activity; others (15) started with an overall period used a fixed overall contingency allowance. In nine cases they fixed allowance on certain specific durations, and in six, not at all.

Such allowances were generally the result of discussion (34), rather than simply based on experience (19); none used computer simulation to assist in this. The majority of planners (28) undertook post-project reviews generally, but small projects were sometimes missed out; others (13) claimed that they always undertook post-project reviews. In eight cases the post-project review was made sometimes and in four, never used.

DISCUSSION OF THE RESULTS

It can be argued that the results of Phase I of the study paint a picture of construction planning in Libya that is not dissimilar from conditions elsewhere. There are, of course, local peculiarities and conditions that must be contextualised. However, in terms of the way that planners go about their task, these results seem remarkably familiar. Delays are frequent, and caused by some familiar factors. Interestingly, amongst the most commonly-cited causes are Resources and Subcontractors (which themselves could be considered as a resource). This hints at a confirmation of the comments earlier in this paper about the unsuitability of traditional planning methods (which are obviously used by Libyan planners) in dealing with the actual availability of resources in the field as opposed to those considered to be available in the schedule.

In general, the findings of Phase I of the work present a potentially favourable situation for the implementation and testing of a new approach to planning and production control, such as that offered by Last Planner. There have been a number of such trials in different countries around the world upon which to draw when designing this next phase of the work.

Access has been gained to a number of contractors who have shown willingness, in some cases, eagerness to cooperate.

- There are three objectives (described above) that relate to Phase II of the work: these are to:
- Investigate the 'Last Planner' approach to project planning and adapt a model suitable for construction projects in Libya;
- Implement this model on a number of in-situ 'trials' on Libyan projects; and
- Consider the results against typical performance and critically evaluate the contribution that the new techniques might make to project planning in Libya.

This will involve the experimental use of the Last Planner System on a number of projects. It is intended to study eight projects that are as similar as possible in scope and content. It is not intended that every project will be observed to completion and so an appropriate section of each of the eight projects will be identified for study. Four of these will constitute a 'control group' and work on them will simply involve collection of data on their time performance.

For the remaining four – the experimental group – the researcher will first present the Last Planner System (in the form of a seminar) to their assembled project managers / site planners (further investigation will first be necessary to establish precisely who the researcher should be working with on each project). These individuals will then be allowed to disperse to reflect upon what they have been presented with, and after a period of time, will reassemble as a focus group to be 'asked' their opinions on the new technique. They will then be asked to apply the technique and monitor results using documentation provided by the researcher.

Following this, these projects will be tracked, partly by the researcher, and partly through reports from the identified site-based respondent on each. Early follow-up visits by the researcher will ensure that the individuals are applying the system in an appropriate way. On completion of the trial period, results will be analyzed and compared and further evidence will be obtained by interview and by email correspondence with the researcher.

CONCLUSIONS AND FURTHER WORK

The research should provide a number of potential benefits to both existing knowledge and current practice. The main theoretical contribution of the proposed research lies in the investigation of the problems in the planning of construction projects and the possibility of alleviating those problems by using the very latest techniques in planning and scheduling theory. The research concentrates on novel approaches to planning and, in particular, the Last Planner approach. If this model proves to be appropriate to the context, it should contribute significantly to the effectiveness of project planning in Libya and could open new doors for further research direction in the industry.

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