AN INVESTIGATION TO IDENTIFY THE ROLE OF PRE-CONSTRUCTION SITE INVESTIGATIVE INFORMATION USED BY SMALL MEDIUM SIZED ENTERPRISES (SME)

Hannah L Wood and Philip Ashton

Built Environment Division, School Environment and Technology, University of Brighton, Brighton, BN2 4GJ, UK

Risk and uncertainty are an inherent part of any construction project and may be a major factor contributing to the success of the project. Whilst Site Investigation (SI) information is considered a pre-requisite of any construction project, questions remain regarding the effective use of such data and how this affects the project complexity at the pre-construction stage by SME’s on Design-and-Build (D&B) projects (Ashton 2003). This research programme is part of a global research project aimed at establishing the consequences and link between pre-construction information and project complexity. This paper provides the initial findings from a pilot survey aimed at establishing the current use and role of site investigative data having been awarded a standard D&B JCT 1998 contract. Previous research (Ashton 2003) established that inadequate and subjective methods were used to determine the extent and appropriateness of investigative work and that a significant problem resulted from a lack of understanding regarding complexity, risk and uncertainty associated with pre-construction planning. It also considers those factors that SME’s considered critical to the efficient use and comprehension of the pre-construction SI information and suggests ways in which the role of this information could be used to enhance D&B projects. This work has provided a series of recommendations and identified the need for a standardized recording mechanism to capture and present SI information to SME’s, in order that this data can be used more effectively.

Keywords: site investigation information, risk, project planning, SME.

INTRODUCTION

Since the introduction of the Civil Engineering Code of practice No. 1 in 1950, a site investigation in one form or another has been a pre-requisite for all but the simplest of projects (Ashton 2003). However, questions still remain regarding the effective use of such data at the pre-construction stage by SME’s on Design and Build projects. Previous research has identified that an appropriate site investigation is not always carried out (Weltman and Head 1983). The Building Research Establishment and the British Standards Institution are expert organizations that produce guidance relating to SI’s, however, despite the wealth of knowledge provided by these organizations Ashton (1996) identified a significant problem with the adequacy of site and ground investigative procedures. In response to this, research was carried out to develop a system, to be used by construction practitioners, to identify where shortfalls in available SI information occur; thereby providing opportunities to objectively establish whether or not to procure further SI work, in order to reduce risk associated
with uncertain site conditions. One of the most important achievements of this research was the ability to deliver a concise appraisal of an organization’s exposure to risk associated with uncertain site conditions.

As a result of this previous research a number of recommendations for further work were made, the most significant of these was to develop the principles used within the research and apply them to super-structure related problems thereby creating a system that incorporates the whole of a project. This research is taking that recommendation forward by investigating all types of pre-construction documentation and the effects on project complexity and risk.

The aim of this paper is to establish the current use and role of site investigation data having been awarded a standard Design and Build contract. This has been achieved by undertaking a review of the literature surrounding the topic and by carrying out a small sample questionnaire survey of small to medium sized contractors who carry out design and build projects in the UK.

RISK AND UNCERTAINTY

It is accepted throughout the industry that risk and uncertainty are an inherent part of any construction project; Latham (1994) states, “No construction project is risk free. Risk can be managed, minimized, shared, transferred or accepted. It cannot be ignored”. However, although a number of risk assessment methods are available, Mulholland and Christian (1999) suggest that there is a lack of an accepted method of risk assessment and management among professionals in the construction industry compared with the financial and health professions. They go on further to state that the construction industry also does not seem to recognize, nor accept, that risk should be addressed formally and given more serious attention.

The key factors relating to measuring the success of a project are the time, the cost and the quality of the finished project. The 2005 Construction Statistics from the Department of Trade and Industry (DTI) state that only 48% of projects were on target or better relating to cost and only 46% of projects were on target or better relating to time. This shows that over half the projects undertaken in the UK do not reach expectations in relation to time and cost. A 1992 worldwide survey reported that the majority of construction projects fail to achieve the objectives of the schedule (Cooper 1994). On many of these, a schedule overrun did not seem probable at the beginning of the project. Schedule targets are more often missed because of events, such as design problems and industrial disputes that were predictable but their likelihood and effects are difficult to predict with any precision because no two construction projects are the same. Approximately 80% of projects have high uncertainty at the beginning of construction (Mulholland and Christian 1999).

Kumar Dey (2001) suggests that the main barriers for project success are the changes in the project environment. The problem multiplies with the size of the project as uncertainties in project outcome increase with size. Large scale construction projects are exposed to uncertain environments because of such factors as planning and design complexity, presence of various interest groups (project owner, owners project group, consultants, constructors, vendors etc.), resources (materials, equipment, funds, etc.) availability, climatic environment and statutory regulations. Although risk and uncertainty affect all projects, size can be a major cause of risk. Other risk factors include the complexity of the project, the speed of its construction, the location of the project and its degree of unfamiliarity.
The role of pre-construction site investigative information

The high level of project failure in terms of time and cost may be due to the risk, uncertainty and complexity associated with the projects and the poor level of understanding of these factors. It is accepted that risk and uncertainty are a part of any construction project, no matter what the size, however it is evident from the high incidences of project failure in terms of time and cost that risk and uncertainty are not being properly identified and managed.

It is a common statement that the construction process is one of the most complex and risky businesses undertaken, Baccarini (1996) states that the construction process may be considered the most complex undertaking in any industry, however the construction industry has developed great difficulty in coping with the increasing complexity of major construction projects. This is supported by Mills (2001) who describes the construction industry as one of the most dynamic, risky and challenging businesses and goes on to say however the industry has a very poor reputation for managing risk, with many major projects failing to meet deadlines and cost targets. Mulholland and Christian (1999) support this further adding construction projects are initiated in complex and dynamic environments resulting in circumstances of high uncertainty and risk, which are compounded by demanding time constraints.

Mills (2001) found that the greatest degree of uncertainty is encountered early in the life of a new project. Decisions taken during the earliest stages of a project can have a very large impact on its final cost and duration. This highlights the issue that the planning at the earliest stages of the project must be well executed in order to be able to identify and manage the risks, uncertainty and complexity of the project.

Among the managerial functions in construction, planning is considered as the most important function that brings success for any given process (but only if it is done well and at the right time) (Gidado 1996). In the course of time, the management of risk has become a key element for the completion of projects within time schedule and planned budget. It is now a common opinion that controllable and uncontrollable risks can only be responded by utilising risk management process over the entire project, i.e. prior to the tender process and subsequently, by controlling and updating the system periodically during the application of the pre determined plan (Oztas and Ökmen 2005).

The elements of a construction project are uncertain. Managers can not know for sure what the future holds in store for them e.g. weather, availability and costs of labour or materials, interpretation of pertinent ordinances and contract documents and may not be sure of the past or present e.g. geology of site location (Lifson and Shaifer, 1982). However, with proper planning at an early stage, much of the uncertainty can be identified and managed provided that the correct information is available. Risk management is not about predicting the future. It is about understanding a project and making a better decision regarding the management of that project, tomorrow (Smith, 1999).

SITE INVESTIGATION

The need for a site investigation for all but the simplest of projects can be recognized by understanding the role and benefits of conducting a thorough site investigation. The site investigation has an impact on all aspects of a project including the project risk, completion time, cost and quality. The construction process involves an array of complex systems and subsystems from which a building rises. A thorough site investigation has been regarded by Hayes et al. (1987) as key to improving the
success of a project. The entire project design and philosophy may be based upon the information gathered at this early stage.

The design of a structure which is economical and safe to construct, is durable and has low maintenance costs, depends upon an adequate understanding of the nature of the ground. This understanding comes from an appreciation of the distribution of the materials in the ground, and their properties and behaviour under various influences and constraints during the construction and lifetime of the structure. An adequate and properly structured site investigation is therefore an essential part of any civil engineering or building project (AGS 2004).

Site investigations consist of a number of stages of work. The Association of Geotechnical and Geoenvironmental Specialists (2004) suggest that the process should be carried out in four stages, which may run consecutively or have long periods between them. The four phases they describe are as follows:

- Phase One: Information gathering, Desk Study;
- Phase Two: Limited intrusive ground investigation;
- Phase Three: Detailed ground investigation
- Phase Four: Collection of information and appraisal continuing into the construction works.

Ground investigation is carried out to obtain information about the nature and condition of the ground. This information is needed by the designer to produce an efficient and economic design for those parts of the permanent works which interact with the ground. Ground investigation affects the safety of both site operations and of the completed works (Clayton and Uff, 1986).

The Site Investigation Steering Group (1993) have produced a number of guides relating to site investigation. They state that there are hazards associated with the ground, and unless these hazards are adequately understood, they may jeopardize a project and its environment. The ground itself is a vital element of all structures which rest on or in the ground. There is no other element of a structure about which less is known, but the properties and behaviour of the ground must be known to achieve a safe and economical structure.

When considering if it is necessary to carry out a site investigation, there is an overwhelming argument that you pay for a site investigation whether you have one or not, and you are likely to pay considerably more if you don’t. The following facts, taken from research over the past twenty years showing little or no improvement in the situation support this argument:

- 37% of 5000 Industrial Building projects suffered delays due to ground related problems (NEDO 1983).
- 50% of 8000 Commercial buildings were found to have suffered unforeseen ground conditions (NEDO 1988).
- Geotechnical inadequacies were considered the major concern and reason for 210 premature failures costing an estimated £260 million (NAO 1989).
- 90% of risk to projects originated from unforeseen ground conditions which could have been avoided by adequate and full site investigation (Alhalby and White 1994).
• 80% of contractors taken from a university of Brighton questionnaire survey had sought redress in one form or another for difficulties faced as a direct consequence of an inadequate SI (Ashton 1996).

• From the analysis of over thirty six case studies it is suggested that there is an alarming and substantial lack of funding and resources allocated to carrying out an effective site appraisal and at the timewhen it is most needed (Ashton 2003).

It is not, however, adequate to carry out the most basic site investigation costing the least amount. A site investigation must be designed to an appropriate standard for the project. The Site Investigation Steering Group (1993) advise that many investigations bought cheaply fail to present an accurate account of the ground or groundwater conditions; it is therefore not surprising that the ground works designed for the site are often not suited to the actual ground conditions. In such circumstances the costs of remedying wrongly designed works or mobilizing alternative construction methods are usually far in excess of the cost of the original site investigation.

Even with unrestricted access and unlimited funds there will always remain some uncertainty and risk. However, what is certain is that insufficient, inadequate or inappropriate site investigation will greatly increase the uncertainty and the risks of incurring significant cost and or time overruns. In the worst case the unsuitability of the ground for the proposed development might only become evident after the construction has started (AGS 2004).

THE ROLE OF SITE INVESTIGATION IN PRE-CONSTRUCTION PLANNING

The importance of carrying out a thorough site investigation and has already been identified, however, it is not adequate to simply have the site investigation carried out if the information is then not used appropriately or not properly understood. In order to establish if and how site investigative information is being used at the pre-construction stage; a questionnaire survey has been carried out with the intention of providing results for an initial appraisal.

Methodology and questionnaire design

For this initial part of the research, a questionnaire survey was selected as the appropriate methodology; this was due to the number of benefits this method presents. Questionnaire surveys are cost effective, especially in this case where a sample covering a large geographic area (the whole of the UK) was required, making other forms of methodology such as face-to-face interviews impractical. Another reason that questionnaires were selected is that bias is reduced, there is uniform question presentation and no middle man bias, the researchers own opinions will not influence the respondent to answer questions in a certain manner (Walonick 2004). Further reasons that led to the choice of questionnaires as the research method include that analysis can be fairly simple, questionnaires are familiar to most people and questionnaires are less intrusive than telephone or face-to-face interviews leaving the respondent to complete the questionnaire on their own timescale.

It was decided that the criteria for the selection of companies would be that they must carry out design and build contracts, be an SME and operate within the UK construction industry. Design and build was chosen as the form of building contract in accordance with earlier research work, by selecting design and build, it is established that the constructor is the owner of the SI information (Ashton 2003).
SME’s were selected as it was felt that the greatest wealth of information would be obtained from this group due to the fact that in the UK over 99% of companies fall into this category (DTI 2004). A small enterprise is one which employs less than 50 people and has a turnover of less than €10 million and a medium enterprise is one which employs between 50 and 249 people and has a turnover of less than €50 million (European Commission 2003). To find companies who met these criteria, an internet search engine was used and a random sample was taken. The randomly selected companies were then issued with the questionnaire along with the covering letter describing the nature of the research and ensuring confidentiality in relation to company names and sensitive information. Thirty five questionnaires were issued. A simple statistical analysis of the questionnaires was carried out to determine the results of the study.

The questionnaire incorporates a mixture of open and closed ended questions as well as including opinion gauging questions using a Likert scale, this mixture of question type is used to gain the most useful data. Both types of questions have advantages and disadvantages, open questions give the respondent the opportunity to express their views but can be more difficult to analyse and interpret, where closed questions present the opposite, being simpler to analyse but may not let the respondent fully express their views (Oppenheim 1996). Respondents were also encouraged to add their own comments if they felt they could be useful to the research, this addresses addresses to some degree the criticism that questionnaires are unable to retain the flavour of a response in the same way that an interview can.

In order to maximize response rates the questionnaire was designed to be short and concise, it was felt that questionnaires that stretch over a number of pages can be off putting to potential respondents. The questionnaire includes fourteen questions which can be broken down into five sections.

Section one asks about the company, establishing what type of projects they undertake, for example residential, retail etc; the average project value that they work on and; the area of the UK in which they work. These questions are included to provided a comparison if needed between different types and sizes of project and different areas of the UK to determine if these factors have any influence on the data.

Section two of the questionnaire is designed to determine if a site investigation is being carried out for every project that the company undertakes and if not why not. These questions are essential to the research as it has previously been established that appropriate site investigation has not been carried out. Asking why a site investigation has not been carried out may establish a situation where site investigations are not required and clarify what factors determine further investigation.

Section three investigates who carries out the site investigation, what stage it is undertaken and how it is presented. It is important to determine what stage the site investigation is carried out as this will be essential information later in the research when establishing what information is required at the pre construction stage.

Section four ascertains how the site investigation information is used, if at all, and how easy the information is to be interpreted. The previous questions in the survey establish if and when a site investigation is carried out, this section determines who it is used by and what it is needed for. It is important to establish this as it indicates what role site investigation plays within a project and how easy the information is to interpret by the different parties involved in the project.
The final section gives respondents the opportunity to add any further information that they feel would be useful to the research. By giving respondents this opportunity valuable information can be gathered that may have been omitted from the questionnaire.

RESULTS AND DISCUSSION

With the pilot survey response rate of 34%, all respondents established that they always have a site investigation carried out for new build sites (one respondent noted that site investigation is not required for their refurbishment projects) and that they feel that the information is used properly. The respondents all considered that the site investigation they carried out was adequate, however the scope of this study has not been able to establish if this is in fact true. Further research investigating the history of the contracts undertaken by each company and assessing it in terms of completion time, budget overrun and quality to establish if in fact the project was successful and if any problems occurred as a direct result of poor or inadequate information relating to the ground working phase could be used to verify if the site investigation was adequate. However this would be difficult to undertake due to the extent of the research needed and the sensitive information relating to project failure that would be required.

The question “who carries out the site investigation” was asked to establish if many of these sized companies had the expertise to carry out a site investigation in house or if they required additional, more specialist contractors to carry out the work. 83% (10 respondents) of respondents indicated that they have an outside contractor conduct the site investigation, indicating that the site investigation stage is too specialist for most SME’s to carry out themselves.

There was a general consensus amongst the respondents that the site investigation is carried out at the pre-tender or tender stage of a project with 50% (6 respondents) stating pre tender and 42% (5 respondents) stating tender stage. It is important to ascertain what stage the site investigation is carried out at to determine the effect of site investigation on pre construction planning. If site investigations were not carried out until work on site had started for instance, the impact upon planning would differ.

In asking who has access to and uses the site investigative information, it has been established that a number of parties access and use the information. Some respondents were a little vague in their replies, simply stating that the contractor and sub-contractors used the information, where as others gave more detail indicating that the structural engineers, designer, estimator, contracts manager etc will use the information for different purposes. When asked what the information is used for, a wide range of functions were given for site information featuring, design, pricing, health and safety, soil analysis and calculating risk. This indicates that the site investigative information can impact many parts and stages of a project again highlighting the importance of having a thorough site investigation carried out.

In summary the results are as follows:

- 100% of respondents state that a site investigation is always carried out for new build projects.
- 1 respondent noted that site investigation is not carried out for refurbishment projects.
• 83% of respondents employ a specialist contractor to carry out their site investigation work.

• 92% of respondents carry out the site investigation at the pre tender or tender stage of a project.

• 100% of respondents stated that the site investigation information is always used.

• When asked how easy the site investigation information is to use 42% replied very easy, 17% replied easy, 33% replied neither easy nor difficult and 8% replied difficult. No respondents replied very difficult.

• Site investigative information was used by the contractor, sub contractors, structural engineers, estimator, contracts manager and the designer.

• Site investigative information is used for design, pricing, health and safety, soil analysis and calculating risk.

The outcome from the questionnaire survey is that the contractors who took part all reported that site investigations are carried out and are of an adequate standard. However, research tells us that the success of site investigation information and pre contract information is not full appreciated, therefore establishing conflict between what the SME contractors feel is happening and what research tells us is actually occurring. Further work to address the issues that have arisen from the survey will therefore include the following:

• What extent does the SI for new build achieve

• Who determines and how do they determine the extent of the SI

• The reason why some SME’s do not consider SI for refurbishment work

• How is the site investigative information used for calculating risk?

CONCLUSION

This paper has discussed the issues surrounding risk, uncertainty and complexity in relation to pre construction planning, specifically looking at the role of site investigation at the planning stage. The importance of carrying out an adequate site investigation has been highlighted and the role of the site investigation amongst SME’s at the preconstruction stage has been established. The study shows that a site investigation in some form is being carried out for each new build project they undertake. The contractors all felt that the site investigation carried out for each of their projects is adequate and that the information is used to good effect; however without further research this cannot be confirmed.

The main outcome from this study has therefore been to highlight the conflict between what contractors understand to be happening and what research is telling us, contractors feel that there is no problem with SI information whereas research has identified that inadequate site investigation is a significant problem that results in losses in time and expense. These findings have raised the need to undertake further work in this area.

The findings from this project will be investigated further to verify the information gained. This study is seen as a pilot study for the rest of the research and as such has incurred a number of limitations, mainly in the sample size and low response rate.
This will be addressed through further research work. The use of a pilot study will allow for the research to be better designed to achieve the final aim.

The methodology for further work will include a wider literature review in the area of risk, uncertainty and complexity and pre construction planning and the stages and documentation that are required. It is anticipated that case studies will be used to build on the knowledge and achieve the global aim of establishing the level of project complexity at the pre-construction stage and how it relates to the risk of project completion on time.

REFERENCES


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