INNOVATIVE USE OF ECC (NEC3) FOR PROCUREMENT AND MANAGEMENT OF INFRASTRUCTURE PROJECTS WITH LIMITED FUNDING: BERVIE BRAES CASE STUDY

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In this case study from Scotland, we demonstrate a successful use of the benefits of the NEC3 contract in a situation when only limited project funds are available. Following an action research (AR) methodology and aiming at maximising the value for the Client and the general public from the available funding, an innovative approach was devised and used during the procurement process of a £3 million infrastructure project for stabilisation of a high coastal slope with residential properties at risk from potential instability. Environmental protection, natural disaster risk management, as well as sustainability in the built environment featured highly on the Client/Consultant procurement/design agenda with public participation throughout the duration of the project. General, fixed, and variable items in the Activity Schedule, as well as an alternative Activity Schedule, enabled the Client to control and direct spending on the project based on the risk analysis and design management by the Designer. This approach offered flexibility to the construction Contractor in terms of selecting methods, materials and labour that will ensure positive balance between profit and costs. Practical problems stemming from the innovative approach encountered during the construction process are discussed in the light of contract management strategies and use of the same approach in the future. The management of health, safety, and environmental risks before, during, and after the construction, as well as the sustainability benefits from the innovative approach are also discussed.

Keywords: procurement, research method, risk management, sustainability, value management.

INTRODUCTION

Public procurement has been utilized as an important tool for achieving economic, social and other objectives (Arrowsmith 2003), as it is possible to reduce project capital cost through selection of a most appropriate procurement method by an average of 5% (Gordon 1994) . A number of problems with procurement have been

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reported recently where the projects had to be abandoned or suspended (Hansford 2013). Procurement method used and the type of client procuring the project had an effect on the project success, especially with traditionally procured contracts (Masterman 2002; Conlin et al 2012).

It is the responsibility of the client to use the funding, however limited, to provide services based on their procurement policy and management requirements. While the procurement policy requirements normally include economic goals (e.g. “more for less” or "lean" procurement), environment protection or “green” procurement, and social goals, the procurement management requirements normally include inter alia quality, timeliness, financial and technical risks cost (more than just the price), minimizing business, maximizing competition, and maintaining integrity (Cox and Townsend 2009). The relative importance of the objectives' and the trade-offs between the requirements, as well as the lack of skills and knowledge (Bowen et al 1997) make it difficult for the policy makers and public procurement practitioners to efficiently manage infrastructure project delivery.

Procurement selection process evolved from the early models (Building EDC 1983), through multi-attribute decision analysis (Chan et al 1994), analytical hierarchy process models (e.g. Al-Tabtabi 2002), fuzzy set theory models (Ng et al 2002), computer-based expert systems (Brandon et al 1988), screening process modelling (Alhazmi and McCaffer 2000), to computerised decision making tools based on case studies (Luu et al 2003, 2005), none of which have been widely adopted in practice (Chan 2005). Recent advances in procurement research include foci on team relationships and communication, detailing the role of the client, project success in relation to different components of the procurement approach, risk allocation, and the impact of environmental and sustainability issues on the procurement process (Morledge and Smith 2013).

One of the main options for procurement of engineering works in the public sector is the New Engineering Contract (NEC). Developed in the UK in 1993, it has become widely used internationally, especially since its 3rd edition, NEC3, was published in 2005 (NEC3, 2005). The main difference form the other standard forms of contract is the link that NEC3 provides between the standard contractual subjects and a project management scheme which relies on strict planning/programming, deadlines, and notices but also rapid decision-making. The main concepts underlying an NEC3 contract are the stimulus to good management through detailed programming requirements, flexibility, and the adoption of spirit of mutual trust and cooperation through successful management of project events by engaging contract parties in a problem-solving dialogue throughout the project (Shaw, undated). The proper use of the contractual mechanisms by the contract parties should mitigate the problems often associated with the traditional procurement routes (Conlin et al 2012) and decrease the risk which is often the prominent criterion that determines the selection of a procurement method (Love et al 1998). However, the challenge for the contract parties is twofold: a major investment in the management resources required to meet the contractual demands, and the need for swift and effective decision making.

Academic research in applied disciplines such as infrastructure engineering and management is aimed at contribution to the solution of practical problems while creating theoretical and conceptual knowledge. In the past, the research methods in these disciplines have predominantly been quantitative surveys (e.g. Luu et al 2003) or case studies (Luu et al 2005) or AI studies (Lewis et al 2011), leaving a gap in the

knowledge of research methodology (Azhar et al 2010). In this paper, action research (AR) methodology, demonstrated through application in a case study, is proposed as an answer to this knowledge gap and theoretical framework behind the subjective and, in many cases, intuitive judgement underlying the management of large, and especially projects with combined technical contextual complexity (Luu 2003).

The aim of this paper is to demonstrate the successful use of the benefits of a NEC3 contract for a project with limited funding through a case study following an AR approach. The objective is to improve the future procurement and construction management practice by implementing the approach and rationale presented in this paper on projects in similar circumstances.

METHODOLOGY

Action research (AR) is an inductive approach to investigation, attempting to solve real-life problems and improve professional practice (O'Brien 2001), where the researchers are involved as co-practitioners in the research setting. It involves systematic observations and data collection which can be then used by the practitioner-researcher in reflection, decision-making, and the development of effective practical strategies (Lewin 1946, Parsons and Brown 2002). The aim of AR is to contribute both to the practical concerns of people in an immediate problematic situation and to simultaneously enhance learning and knowledge on the phenomenon under study. The commitment in AR is dual: studying a system while collaborating with system members to change the system in in what is jointly regarded as a desirable direction. Accomplishing this twin goal requires the active collaboration of researcher and client and, thus, it stresses the importance of co-learning as a primary aspect of the research process (Gilmore et al 1986).

The difference between AR and the general professional practice or consulting is the scientific approach where the researcher/co-practitioner studies the problem systematically, ensures the action is informed by theoretical considerations, refines the methodological tools to suit the problem situation, while collecting, analysing, and presenting data on an on-going, cyclical basis.

AR methodology has been employed in various engineering environments (e.g. Mejia et al 2006, Azhar 2010) and is quoted as the most practicable methodology for creating environments that foster coordination and collaboration among engineering groups (Mejia et al 2006,). Different research tools, generally common to the qualitative research (case studies, journals/diaries, document collection and analysis, participant observation recordings, questionnaire surveys, and interviews) can be used for AR as the project is conducted. As these methods coincide with the prerequisites and perceived benefits from the use of NEC3 family of contracts and some procurement methods (e.g. Luu et al 2005), it was considered that the AR would be an appropriate methodology to study the application of NEC3, as long as the principles considering the ethical considerations in the conduct of AR (Winter 1996) were observed.

AR methodology was used in this project, despite the perceived lack of impartiality of the AR team (O'Brien 2001) that may lead to bias in the research. To minimise personal bias in the reflective conclusions, the action research methodology was supplemented by case study research to provide descriptions of the phenomena/problems encountered and carry out an in-depth investigation. It is considered that the combination of these two research methods contributes towards

improved collaborative engineering and improved decision-making (Luu et al 2005) which are basic concepts of NEC3 (NEC3, 2005). The experiences presented in the following case study follow the structure of the AR model, describing an identify–plan–act–observe/reflect cycle (Figure1) after a brief introduction to the case study where the context and background are presented.

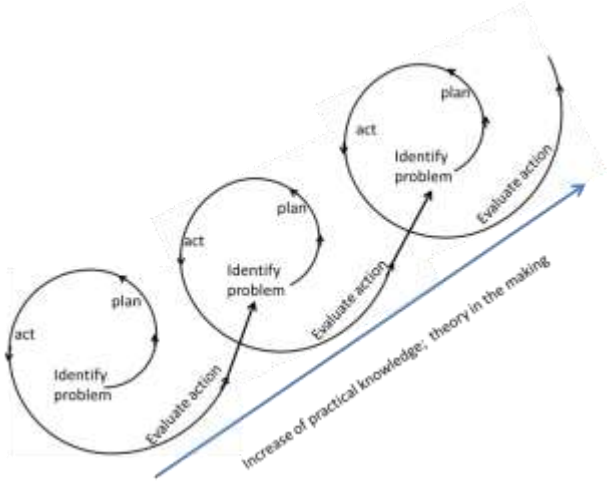

Figure 1. Action Research cycle and application for improving the practical knowledge. (Adapted from O'Brien 2001).

CASE STUDY

Background:

Bervie Braes is an infrastructure project for stabilisation of a 700 m long, 30 m high coastal slope overlooking Stonehaven harbour with the residential properties at the toe of the slope at risk from potential instability. The slope had a history of instability with a number of landslips and soil mass wasting events documented in the last 80 years resulting in the closure of the trunk road bisecting the slope for the past five years due to safety concerns. The closed road and the slope footpaths are still used by residents and tourists for recreational purposes. The slope is owned by a trust that transferred their rights and responsibilities to the local authority (Aberdeenshire Council, the Client) as the owners of the former trunk road. Following a landslide in 2008, the Client appointed a Consultant (Jacobs UK Ltd) who, through forensic analysis, intrusive, and non-intrusive ground investigations developed a number of specimen design options for stabilisation. Client and Consultant (C+C) also developed an Emergency Action Plan for management of the risk of future instability of the slope. The general public, as users of the slope, was involved in the investigation process through Public Consultation Meetings and voted for the most acceptable specimen design solution. Based on the voted solution, the Consultant was commissioned to deliver detailed design, procure the stabilisation works, and manage the construction works.

Acknowledging the main constraints and challenges to the project delivery: limited funding, environmental protection of the slope, and the social goals such as minimising the risk for the residents at the toe while maintaining the recreational value of the slope, the Consultant assembled a multi-disciplinary team, obtained planning permission for the proposed works, and delivered the detailed design within three months from the date of the commission.

The tender, based on ECC Option A, was abandoned after the tender returns indicated estimated values above the available budget and the Client, due to the regulations for public bodies, could not negotiate on the offers.

Problem identification:

Reflecting on the design and procurement process as well as on the ramifications of abandoning the project, the C+C team identified the procurement of stabilisation works within the limited budget, while providing value to the Client and slope users as a problem. Workshops involving C+C team concluded that, due to the risk for the residents and potential liability issues for the Client, abandoning the project is not a viable option. Jointly (Winter 1996), the C+C team decided to adopt an AR approach and investigate new ways of procuring and constructing the stabilisation works. Areas for potential action implementation were identified in the design and procurement process and funding mechanism.

Planning:

Driven by the need for minimising total costs and providing value for the Client, the Consultant envisaged changes in detailed design which, while minimising the import of material for construction (mainly steel) and wastage, would require a change in contract documentation (performance specification) and closer supervision. The consultant considered that these changes would provide net savings of up to 20% of the overall budget. Changes to the funding mechanism and overall budget could not be identified, and the Client accepted the possibility of partial completion of the envisaged works. Based on this, the Consultant mapped the stability risks for a number of sections of the slope and agreed with the Client that the drainage works and the re-vegetation of the slope are of the highest priority and will have to be carried out in full to minimise the risk of surficial stability and erosion of the slope, as well as increase the environmental and sustainability benefits for the slope users.

The Consultant prepared a detailed procurement plan and programme based on the experiences from the original tender process, i.e. previous learning cycle. The C+C team agreed on action to implement the potential savings identified at planning stage, and change the procurement to fit with the overall budget available and minimise the residual risks. Additional step towards minimising the residual risks of slope instability was taken with the installation of a remote ground-water monitoring system (cost: 0.5% of the total budget) which would be used in the interim period between the tender and re-tender for the safety of the residents but available to all contract parties (Winter 1996) during construction for the safety of the construction workers and residents alike.

Action:

To take into account the risk-based stability approach and procure the largest amount of stabilisation works for the available funding, the Activity Schedule was divided into General Items (GI), Fixed Works items (FWI), and Variable Work items (VWI). The GI covered the preliminaries and Contractor's site supervision. The FWI covered the stabilisation in the slope sections where either the slope stability was inadequate and/or the risk to the residential properties was high (the 'must have' stabilisation works). The FWI also included the drainage and revegetation works for the whole slope identified as essential with long-term benefits to the stability of the slope. The VWI covered the stabilisation of the other slope sections listed in the order of

decreasing risk, i.e. the sections at highest risk of slope instability and/or risk to residential properties would be stabilised first.

Apart from minor changes in the Works Information, the other changes in the procurement documentation included the added flexibility to the contract through the use of any savings identified during the construction works for procurement of additional works from the VWI list. This, together with the explicit statement of the overall budget, was seen as a motivation for the contract parties to provide value engineering in order to increase the amount of work commissioned and was emphasized on the tender clarification meetings and interviews which, in turn, were implemented with the aim of creating a process that maximizes the opportunities for involvement of all participants (Winter 1996).

Performance, rather than detail, specification was adopted for a number of FWI and VWI in order to motivate the Contractor to provide competitive tender and ensure a suitable profit margin while demonstrating value engineering to the Client which would satisfy Client's procurement policy and management goals.

The tender assessment process was also modified to allow emphasis on the quality of work offered within the budgetary constraints. The tenderers were asked to provide separate Quality and Financial submissions, allowing the C+C team to assess and score the Quality submission first. The Financial submission was assessed only for the tenders that passed the predetermined quality threshold (Chan et al 1994). The contract was awarded to the tenderer who passed the quality threshold, offered to complete the FWI and the greatest percentage of the VWI within the tender value.

Reflection:

The new tender attracted more attention with 9, including non-UK, contractors expressing an interest. The pre-qualification process placed an emphasis on the experience of the contractors with the works of similar technical difficulty and contractual terms which eliminated 30% of the interested contractors. 50% of the contractors invited to tender, did not pass the quality threshold set to ensure the proposed construction methodology and management comply with the financial and environmental restrictions. The tender was jointly assessed by the C+C team and awarded to the contractor who provided the best value within the contractual constraints.

The action undertaken - modifications in the procurement process - resulted in commissioning of stabilisation works in the most unstable areas of the slope (approximately 45% of the total slope area), as well as works for other areas of the slope with lower risk which amounted to structural stabilisation of more than 60% of the slope area, and preventive measures (new/improved drainage and re-vegetation) installed for the entire slope. This compares with the option of abandoning the project due to budgetary and contractual constraints if the action had not been implemented. Apart from the action taken, the critical decision that ensured the success of the re-tender was the Client's acceptance of the risk of limited works scope of due to limited funding and adoption of AR approach in the re-design and procurement.

The re-design recorded savings of 505 tCO2 through reducing waste, re-use of materials, reducing transportation costs, optimization of material usage, phasing of operations, providing environmental and social value, and performance specification. The overall recorded savings for the project throughout the design and procurement

phases were approximately £2.8 million, achieved through design optimisation and value engineering, which compares to the £2.4 million construction cost.

The C+C team showed that there is a desire and motivation to innovate and see new solutions developed to accommodate budgetary constraints in infrastructure contract procurement which is often quoted as a constraint to the procurement (e.g. Conlin et al 2012) . This project showed how the investigation into the potential of innovations in both procurement and slope stabilisation resulted in a set of experiences structured in such a way that lessons learned were an opportunity to improve further similar experiences and to improve the knowledge on NEC3 application. The obstacles which were encountered during the original tender, such as time constraints due to statutory obligations of the Client or the delivery of the detailed design by the Consultant, were dealt with in a more timely and rational manner during the re-tender due to the experience from the original tendering process.

Collaborative working, identified as one of the main concepts of NEC3, was achieved during the AR cycle through interviews, workshops and questionnaires but also through regular summary and progress reports in recordable format which is another of the cornerstone concepts of NEC3. The involvement of experienced professionals who can make engineering judgements (Masterman, 2002; Hansford 2013) and keeping detailed records of the changes allowed for rapid decision-making and timely estimation of the financial and time effects on the project for the PM. The re-tender, including the re-design and planning for risk between the tenders, was delivered for 30% of the cost of the original tender. This cost was spread over eight months due to the early action to re-tender and the environmental constraints preventing the start of the works.

Critical to the success of future projects adopting this approach would be the understanding of the client's culture and philosophy and critical (self)assessment of the capabilities and contractual responsibilities of all parties to the contract (Bowen et al 1997). It is important that the client recognises their own strengths and limitations, identify skills gaps and more importantly implement an improvement programme (strategy) before considering the adoption of alternative procurement methods.

DISCUSSION

The applied action resulted in an outcome that satisfied Client’s procurement policy and management goals (Bowen et al 1997, Thai 2001), and the C+C team considered that the application of NEC3 with the approach adopted in this study can help deliver successful projects in the right circumstances (Conlin et al 2012).

However, the action resulted in a number of practical challenges for the construction phase which were considered in further AR cycles and are summarised below:

Providing appropriate supervision:
the technical requirements of the re-designed solution required closer supervision by the Supervisor who, through planning and flexible resourcing, had to provide value for the Client but also the necessary coverage of the concurrent operations on the 2 ha large site.

Motivating the Contractor:
being explicit about the nature of the research process from the beginning (Winter 1996) through a number of meetings and workshops, the C+C team detailed the design rationale and the contract philosophy that any savings to the project identified during construction will have to be recorded, and additional works from the VWI

procured to the value of the identified savings during construction. The value of savings identified during construction was 3% of the total project budget and these were translated into additional stabilisation works from the VWI, covering additional 5% of the slope area.

Planning and programming:
The working programme agreed at the start of the process and updated on a monthly basis, together with the regular progress reports and open communication through meetings and workshops between Consultant, Client, and the tenderers were important reasons for success of the re-tendering process. The biggest challenge, however, was to motivate the Contractor to involve sufficient resources in planning of the site operations to match the flexible nature of the contract without breaking the spirit of trust and cooperation. The lack of understanding of the importance of construction programme and the absence of punitive mechanisms under NEC3 contributed to extended time needed for completion.

Implementation of the NEC3 requirements in an AR framework:
The AR team treated the Early Warning notifications as problem identification sheets and achieved efficient problem solving with involvement of all parties in the decision making process. This resulted in 48 Compensation Events during construction, with 30% of them resolved within a month after being identified, 50% after 3 months, and 20% within 6 months.

The perceived benefits of the approach that may help future application include: Delivering more for less: limited budget projects could adopt this approach in conjunction with risk-based design to deliver better value for client and public while encouraging competition and ensuring profit for the Contractor.

Reflective process:
Through recording and reflection on the actions the project participants are able to learn from experience in a practical and methodical way. The benefits of NEC3, combined with AR approach allow the AR team to identify key issues at each stage of the project by using working methodologies leading to improvements of the project through collaboration and support of engineering activities.

Sustainability:
Identification and recording of potential savings throughout the project should be used for motivation of all contract parties on the account of additional works that will be procured for the value of savings identified. “Green” certification that can improve the track record of the parties can be used as a motivation strategy.

Development of collaborative engineering and improvement of praxis:
AR approach aims to generate knowledge about social systems as well as attempting to change these (Hart and Bond, 1995). This approach could be a vehicle to enable practitioners and researchers to collaborate in their efforts to improve the real world of practice, including contract procurement and construction management.

The emphasis of the future application of this approach would be on ensuring the service providers have a relevant proven track record in embracing the NEC3 culture and providing value for the Client. Increasing the speed of information (Tseng et al 2003) would enable collaboration and interaction among the contract parties during the pre-construction and construction phases of the project regardless of their locations and incorporation of information and tools in accordance with the project activity (Mejia et al 2006) or contract conditions. However, all parties would have to

invest in adequate programming/planning resources to cope with the potential expansion of scope and degree of concurrency of construction operations, which is already a prerequisite for successful application of NEC3.

CONCLUSIONS

This study demonstrated that limited budget contracts can be procured using NEC3 contract incorporating Activity Schedule dividing the works into 'fixed' and 'variable' based on risk-based design approach also advocated in the literature (Morledge and Smith 2013). Our research showed that to implement this approach, all parties to the contract have to be motivated and engaged in identifying opportunities for value engineering and/or sustainability benefits. The success of this approach will depend on the level of investment in adequate programming/planning resources and tools by the contract parties (Addis and Talbot 2001) which do not have to be additional to the ones required under NEC3 (diaries, notices, communications) for recording the actions, reflection on them, and identifying new problems and challenges for action during the project phases.

Similarities between the basic concepts of AR and NEC3, make AR suitable methodological framework for improving the practical implementation of NEC3. Based on reflective experiences from this study, it is our opinion that collaborative working can be achieved through open communication and early assessment of the capabilities and contractual responsibilities (including risks; Cox and Townsend 2009) of all parties to the contract. This helped help not only in identifying motivational drives but also stimulated the management of the modified Activity Schedule.

We used AR approach in this study to create a process that maximizes the opportunities for involvement of all participants through questionnaires, meetings, interviews, workshops, notices, formal and informal communication. Most importantly, we used the records from the AR process to enable learning from experience and improvement of the professional practice which can be seen as a single stage of a case-based procurement approach (Luu et al 2005).

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