SUSTAINABLE SCHOOL INFRASTRUCTURE THROUGH EFFECTIVE INNOVATIVE BUILDING TECHNOLOGY SELECTION

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Abstract

The aim of the paper is to provide an overview of a model proposed for the selection Innovative Building Technologies (IBTs) and procurement of services supporting the erection of the IBTs that will ensure the construction of a sustainable school infrastructure. The research followed a case study approach where the practical implementation of theoretic climatic and supply chain management decision making tools was evaluated. The research was limited to the design phases of the projects and it is not clear how decisions will impact the construction and handover phases of the projects. Provisional findings indicate that the selection of an IBT and the services supporting IBT construction resulted in the selection of building systems that are climatically suitable with a manageable supply chain. The value of the research is a model that will guide implementers of IBT projects in the selection of suitable building systems

1. Project Rationale

1.1. Introduction

The government has committed to a decision to implement Innovative Building Technology (IBT) for the construction and refurbishment of the majority of social infrastructure projects such as schools, clinics, student accommodation, early childhood learning centres and housing. IBT can be defined as "*The use of materials and technologies not covered by building standards in the National Building Regulations and Building Standards Act (NBR) (Act 103 of 1977) where such materials and technologies require either a rational design or an Agrément Certificate"*. IBTs are also referred to as Alternative Construction Methods (ACM) or Alternative Building Technologies (ABT) (CSIR, 2013).

This decision will result in implementing bodies, built environment professionals and contractors experiencing changes to procurement arrangements, scope of services and contracting arrangements. The changes experienced on an IBT project are a result of the certification framework supporting the relevant building systems. Because the building systems are not covered in the National Building Regulations (NBR), they are required to be certified by Agrément South Africa.

The certificate holder is, according to the conditions of certification, responsible for the ultimate quality of the building constructed using his building system. The certificate specifies the certificate holder's responsibility as erection, manufacture and design of the building system. The certificate holder can appoint a licensee who will undertake the erection,

but the certificate holder must still provide the services of manufacturing, designing, delivering and quality control of the system. The implementing body must procure these supporting services. The client is faced with the task of ensuring that the certificate holder complies with the conditions of certificate.

The purpose of this paper is to provide an overview of a recommended model that will facilitate the selection of the most efficient building system, along with the procurement of services that support the manufacture and the erection of the selected system. The recommended model was adopted and observed on a project implemented by the IDT in the Eastern Cape province where 30 schools are to be constructed and refurbished.

Implementing bodies must ensure that the model adopted to select a system and procure services supporting its erection and manufacture will result in sustainable infrastructure.

1.2. Background and Problem Statement

The CSIR was appointed by IDT to provide support to their ASIDI Alternative Construction Methods construction projects being undertaken in the Eastern Cape province, where 30 schools were to be built or refurbished using innovative technologies. The CSIR played an advisory role in activities such as; procurement of professionals, building contractors and building systems; monitoring and evaluation of the construction; and formulating contractual agreements that adequately reflect roles and responsibilities of stakeholders in IBT projects. This research is ongoing

The focus of this paper is on the selection of an appropriate building system and the procurement of services facilitating the erection of such system. Guidelines regarding climatic region analysis and supply chain assessment for the purpose of IBTs have been authored.

However, the guidelines must be implemented practically in order to evaluate their effectiveness. Secondly, it is not clear if contractual relationships will have any impact certificate holders' compliance with the conditions of certification.

The questions arising from the research problem were as follows:

i. Are IBT application guidelines provided for construction supply chain management assessment and climatic compatibility analysis adequate for practical implementation?
ii. What is the impact of introducing a contractual agreement between the client and the certificate holder on the compliance of conditions of certification?

2. Previous knowledge about the problem

Work done previously by the CSIR involved the development of a tool that facilitates the selection the best performing system with climatic considerations and guidelines on how best to utilize the tool. There has also been work done by the CSIR that explored the most appropriate supply chain management solutions for IBTs. Although the work completed was theoretical, the 30 schools that are to be built provides an opportunity for the

Köppen- Geiger decision making tool and supply chain considerations to be tested in practice.

Selection of a building system with respect to climatic considerations resulted in the development of an electronic decision making tool utilizing Köppen- Geiger climate map. The map is used to determine the main climatic region where the works are to be executed. Following the identification of the climatic region, the thermal performance of the system must be determined and must match the requirement for that climatic region (CSIR, 2013).

Secondly, building systems must be considered in light of their implications to the supply chain. Building systems either have their components manufactured in the factory or require very skilled labour to erect. The client making a decision to deliver a project with the use of IBT must consider if area in which the works are to be executed has sufficiently skilled labour available to benefit from economies of scale or that trucks delivering building system components will have access to the location of the works with relative ease. If the project has flexible project schedules or considerable time to delivery, the client is free to utilize any of the available building system. However, if the client has time constraints, it is advisable to select a system that compromises of commodity items that do not require specialised labour or extended amounts of time for skills transfer.

The supply chain management considerations for the IBT in question must include the following (CSIR, 2013):

- The IBT selected

- The location of the site as this will determine the accessibility of the site. The location of the site will also determine if there will be labour to erect the building system.
- The capability and the capacity of the certificate holder to provide supporting services for the successful erection of the building system.

The climatic performance of the system will take precedence over supply chain analysis as the supply chain only impacts the construction phase of the system and not the lifetime performance of the system.

3. Research Methodology

A case study research approach was adopted for purposes of this study in order to determine whether IBT application guidelines provided for construction supply chain management assessment and climatic compatibility analysis are adequate for practical implementation. This involved selecting the tendering procedure, the tender evaluation method and contractual arrangements to be used in the process of selecting the building system. Evaluation of the tendering procedure and tender evaluation methods will be discussed in this paper. A recommendation for contractual arrangements will also be made

4. Selecting an IBT

The model proposed for selecting an appropriate system proposes that certain steps be followed. The steps are to be undertaken as follows:

Step 1: Call for expressions of interest from certificate holders

The implementing body is to issue an advertisement that calls for an expression of interest from eligible certificate holders, who in addition to complying with public procurement procedures, must comply with certification requirements as set out by Agrément South Africa.

The IDT regional office issued an advertisement outlining the mandatory documents required for interested certificate holders to be eligible for evaluation. This includes documents necessary for public body procurement such as a valid tax clearance certificates, Broad-Based Black Economic Empowerment (BBBEE) certificate, Companies and Intellectual Property Commission (CIPC) documents and any supplier registration compulsory to the implementing body must be submitted. Any questionnaires that were to be part of the submission must be evaluated. Agrément South Africa requires that the all certificates have an accompanying Quality Management Manual that details the quality management systems to be implemented during the design, manufacture, delivery and erection of the system. The certificate and the QMM must be submitted.

Step 2: Shortlist qualifying respondents

Once all eligible certificate holders have submitted their expressions of interest, submissions must be evaluated in terms of conciseness of mandatory documents, climatic conditions, habitability and, Supply Chain Management (SCM) considerations. Firstly, documents mandatory for public procurement must be evaluated; this includes any questionnaires deemed necessary by the implementing body. Secondly, the certificate and its QMM must be evaluated for suitability with thwe needs of the client. Shortlisting of respondents at this stage must include also the SCM analysis,

which can be completed form the information provided in the response to the call for expressions of interest. The supply chain analysis must evaluate whether the system requires that components be delivered to site where building works are being executed, the implementing bodies must ensure that the roads leading to the site are sufficient for delivery. If the system requires skilled labour for erection, the implementing body needs to ensure that labour can be acquired from the locality. This becomes increasingly important when the lead time for construction is short. A system that requires the use of large trucks for delivery and specialised labour for erection might not be suitable for a project where the lead time is short. Lastly, the systems must be put through a climatic compatibility assessment as described in the background.

Step 3: Enter into Service Level Agreement (SLA)

The certificate holders should then enter into an SLA with IDT. The purpose of the SLA is to ensure that he certificate holder is bound to comply with conditions of the certification, the quality management manual and provide supporting services required to erect the system. An SLA between the client and the certificate holder will create a relationship between the client and the certificate holder that would not exist had a conventional procurement model been adopted. The agreement will also outline the services and the level of service required from the certificate holder; further him compelling to comply with the conditions of certification. The SLA will make clear the certificates holder's roles, responsibility and liabilities with respect to the manufacture, delivery and erection of the building system.

5. Findings and Discussion

IDT found that none of the respondents had satisfactorily complied with submission requirements. It was decided that of the non- compliant responses, eight could be interviewed to evaluate information that was not adequately provided in the submission. Possible reasons for the inadequate information could be a result of inadequate time provided to respond to the call for expressions of interest and the absence of a tender briefing meeting upon the collection of tender documents.

The lacking information pertained to the supply chain, capacity and capability of the certificate holders to deliver components as required by the projects. Interviews were conducted to determine SCM factors, capacity and capability for the eight systems. SCM considerations revolved around issues such as the transport requirements, labour requirements and the lead time for construction. . The eight systems were put through a climatic compatibility analysis, where they were ranked from the most appropriate to the least appropriate for the climatic region where schools are to be constructed.

Of the eight systems put through the supply chain analysis, the top four systems emerging as most compatible were also preferred systems following the SCM analysis. The four systems were selected to be used in the delivery of 30 schools.

The impact of the SLA is yet to be evaluated as the study is still ongoing.

6. Conclusion

Adapting the call for expressions tender method for the selection of suitable IBTs for the construction of school infrastructure will result in the reduction of construction time (CSIR, 2013). The study found that practical implementation of climatic compatibility assessments and supply chain analysis will result in the selection of the most suitable building system for location of the construction in terms of climate and supply chain. The development of an SLA between the client and certificate holder is expected to result in compliance with the conditions of certification as well as provide a detailed specification of the expected roles and responsibilities of the contracting parties. It is expected that the research will culminate in practical guidelines for implementing bodies selecting IBTs and procuring services that support the erection of the system.

References

CSIR, 2013. *Comparative Analysis between Alternative Building Technologies and Conventional Brick and Mortar*, Pretoria: Council for Scientific and Industrial Research, Built Environment Unit.

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