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TO WHOM IT MAY CONCERN

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A Web-based model for collaboration in the supply chain of the building industry

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Abstract

The construction industry is known for its slow uptake of information and communication technology. The type and number of participants vary with each construction project and participants get together for a specific project. These formal relationships are again dissolved after the project is completed. This is inhibiting the industry from using an information technology based approach to the formation of a supply chain. In this study a small building project was used as a case study to document the participants and their role in the building process. The supply chain from an owner/builder perspective was investigated and the flow of information among all participants was followed during the construction of the building. A model of the supply chain, indicating all information flows, is one of the outcomes of this study. The use of information and communication technology to collaborate among the different participants in the supply chain in this project was extremely low. Some participants, such as the draughtsman, used no information technology, whereas others used only basic word processing applications. A Web-based collaboration model is proposed to enhance collaboration among the stakeholders of a small construction project. This study is part of a bigger research project that will not only document how and when information is used in the South African construction industry, but also suggests how modern information and communication technologies can enhance collaboration in the construction industry supply chain.

Keywords: ICT; construction industry; collaboration; information technology; supply chain.

1. Introduction

The construction of buildings differ from other manufacturing industries in that the construction site changes for each project, normally takes place in the outdoors, and the operational office is often not in the same location as the construction site (Chan & Leung, 2004:935; Eadie, Perera, Heaney & Carlisle, 2007:104; Lee, Pena-Mora & Park, 2006:85). The basic processes and management of construction projects are the same, but every construction project varies in final product outcome, size and organisation of the project (Hiremath & Skibniewski, 2004:447; Kimoto, Endo, Iwashita & Fujiwara, 2005:502).

Construction work is collaborative, and project-based (Harty, 2005:513), but collaboration between specific stakeholders is for a short period only (Anumba, Ugwu, Newham & Thorpe, 2002:89). Chan and Leung (2004:935) points out that co-ordination between participants are difficult. The industry is also conservative, use manual processes, is resistant to change and slow in adopting newer technologies (Peansupap & Walker, 2006:371; Stroeken, 2001:135; Titus & Bröcher, 2005:72;).

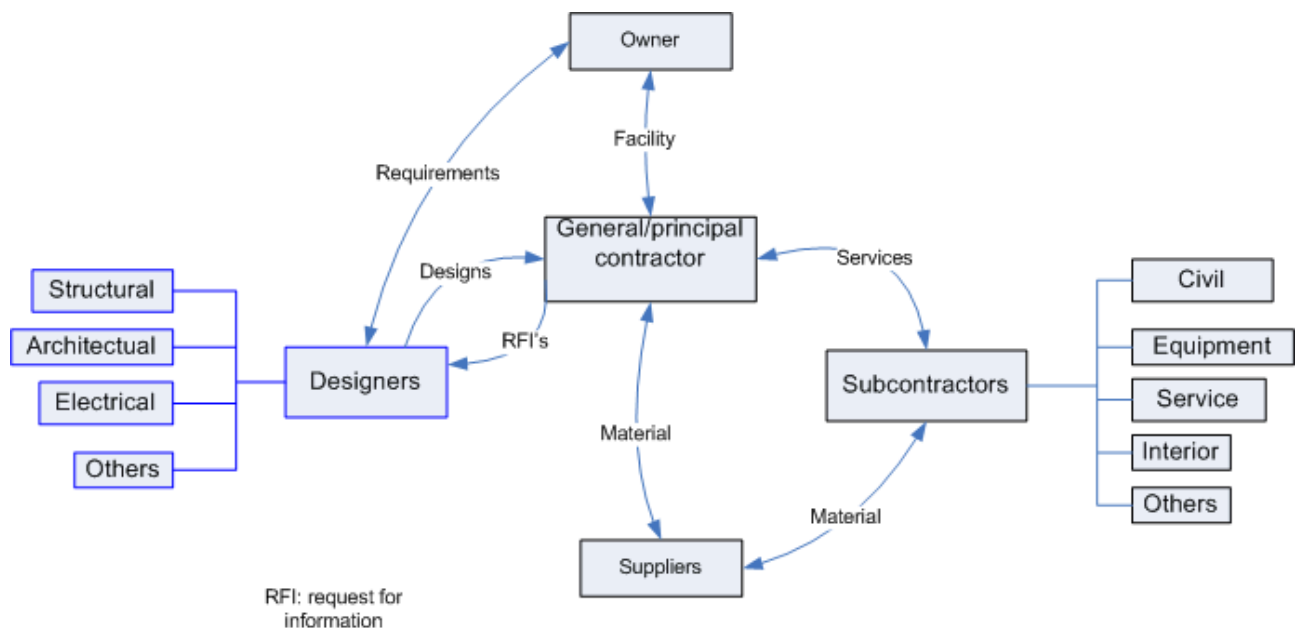
2. The construction supply chain

Boyd and Chinyio (2006:4) state that an improvement in supply chain management can enhance general construction processes. Processes identified by Xue, Li, Shen and Wang (2005:416) as part of the construction supply chain are project management, client service management, supplier relationship management, demand management, order fulfilment, construction flow management and environment management. The construction supply chain is concerned with:

- Improving the decision making between organisations (Xue *et al.*, 2005:416).
- The co-ordination of logistics .planning between the vendor and the customer (Barut, Faisst & Kanet, 2002:161)
- Information flows, activities and the management thereof (Akintoye, McIntosh and Fitzgerald, 2000:161).

Gruneberg and Hughes (2006:13) note that to form the supply chain, a large number of participants must collaborate, while Quader (2006:47) reminds us that manufactures, suppliers, retailers and customers are linked together in the chain. The information flows between all stakeholders are shown in Figure 1. Contractors may use the same or different suppliers.

Figure 1: Information flow in the construction supply chain (Adapted from Briscoe *et al.*, 2001:244; Tserng *et al.*, 2005:245; Xue *et al.*, 2005:417)



2.1 Barriers to the formation of the construction supply chain

The complexity of the construction supply chain makes it difficult to create and manage the chain. Some common problems are:

- The lack of visibility in the chain, and companies often overcompensate with too much inventory (Quader, 2006:47)
- The limited flow and sharing of information (Quader, 2006:48)
- The manual paper based information sharing practices is often the cause of the information getting lost (Bowden, Dorr, Thorpe & Anumba, 2006:670). Vrijhoef and Koskela (2001:174-175) points out that the interfaces between design and engineering, purchasing and engineering as well as purchasing and the site office are common areas where information gets lost and documents are misfiled. Employees also do not understand how documents are linked together in the supply chain.
- The ineffective use of information technology hampers the exchange of documentation and information (Hjelt & Björk, 2006:113).
- It is expensive to develop and introduce a supply chain (Ellman & Orange, 2003:20)
- Larger projects can have hundreds of suppliers, making the chain complex (Briscoe *et al.*, 2001:244).
- Participants will be reluctant to change the way documents are handled in order to fit in with the supply chain (Bechini, Cimino, Marcelloni & Tomasi, 2008:351).

According to Akintoye *et al.* (2000:164) the lack of management support and commitment from participants are some of the barriers to the formation of a construction supply chain. Participants also do not understand the concept and organisational structures do not support participation in supply chains. The same authors found contractors focus on clients rather than suppliers and subcontractors, and often discard them if they are no longer part of the project.

Briscoe and Dainty (2005:324) points out that long-term commitments and relationships are necessary for the formation of a successful supply chain. This is in stark contrast to the fragmented industry where short-term contracts and relationships are the norm (Voordijk de Haan & Joosten, 2000:219). The majority of participants must be part of the supply chain (Ellman & Orange, 2003:20)

2.2 Communication and collaboration in the construction supply chain

Information technology provides the necessary co-ordination that is important for information sharing in the supply chain (Barut *et al.*, 2002:161). Conditions that must be in place for the supply chain to work effectively, according to Bechini *et al.* (2008:349-350) and Neubert, Ouzrot & Bouras (2004:264), include that:

- Participants must agree on how business processes must work together, what information will be shared and how documents will be handled.
- Data collection methods must be specified across the supply chain.
- Business processes need to change as the barriers between organisations disappear.

Communication problems in the supply chain can be attributed to, according to Alshawi and

Ingirige (2003:351), and Love and Irani (2003:649), a lack of integrated systems and the non-sharing of information. Love, Li and Mandal (1999:8) found that a sequential supply chain obstructs decision making and information flow while Barut *et al.* (2002:162) emphasise the importance of accurate management and sharing of information in the supply chain. Quader (2006:48) suggests that Web-based technologies can enhance information flow and sharing.

3. Research methodology

A small construction project was selected as a case study to determine the information methods and flows that are typical of such a project. The owner commissioned the building of a small cottage in a small seaside village in the Eastern Cape, South Africa. The village has only one small shop. The suppliers of services and building material are situated in nearby towns, respectively 27 and 50 kilometres away. The owner is resident 650 kilometres from this new cottage.

The purpose of the study was to explore and document collaboration practises in a small construction project. This is part of a bigger study that will determine how, when and how information is shared among participants in construction projects.

The research questions for this study were:

1. Who is involved in such a construction project?
2. What information is shared between the role players?
3. How do they share the information?

Information technology is not used to its potential in the construction industry. The researcher was interested if this was true in such a small project.

Buildings practises are well documented and was not part of the scope for this study. The focus of the study was information and collaboration practises. This project was chosen to study as the owner was willing to participate, share documentation and supported the researcher with this study.

Data collection started with interviews with the owner and analysis of the documentation of the project. As the owner played a major role in the project, he was in possession of most of the documentation generated by the project. The principal contractor was interviewed to confirm some facts and get another perspective on the case. The principal contractor is experienced and understood the construction procedures and processes involved. His input regarding the local environment was invaluable.

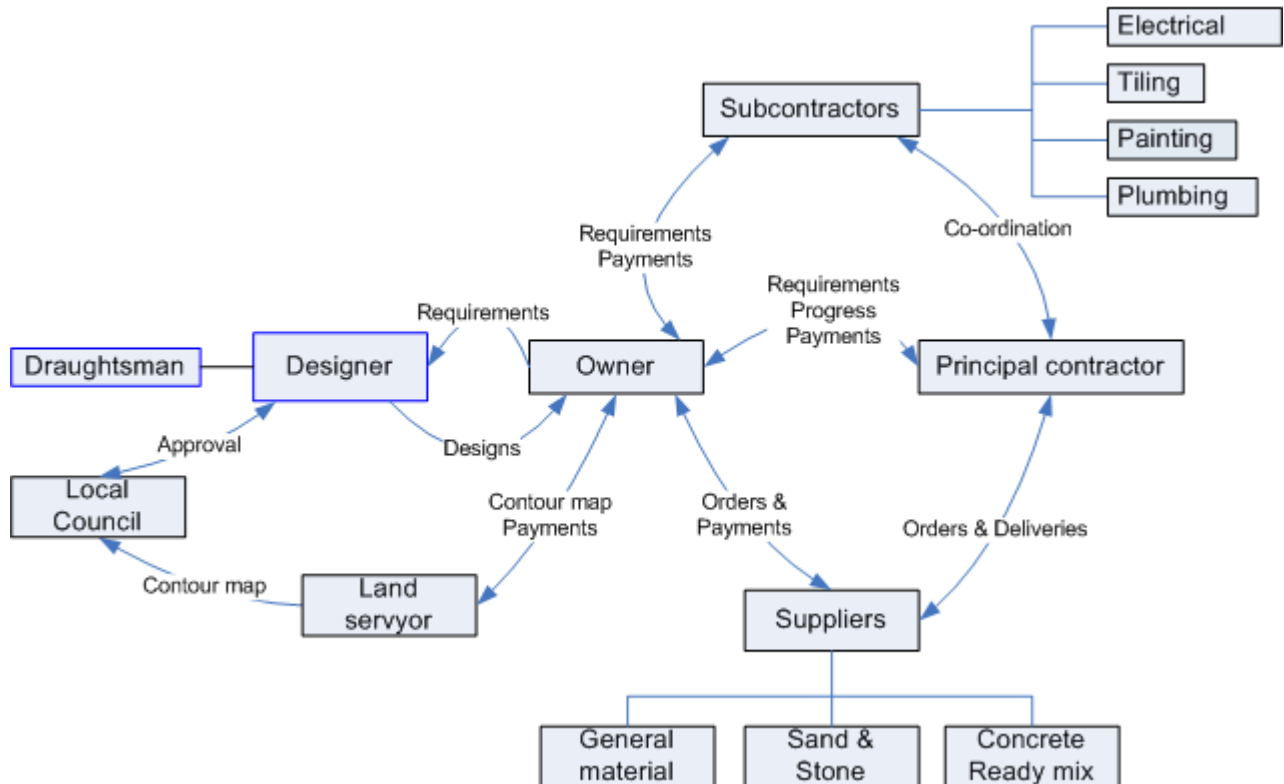
4. Findings

The information requirements were analysed from the supply chain perspective as the supply chain links all participants together. The general supply chain model, as seen in Figure 1, is modified to display the sharing and flow of information between each participant. Figure 2 depicts this modified model for the construction project used in this study.

The owner played a large role in the process and shared responsibilities with the principal contractor for the ordering of building materials. The owner also appointed all subcontractors

and suppliers and was responsible for any payments to them. Project organisations vary a lot as discussed by Bennett (2003:17-20) and this project correspond to a similar project organisation described by Zhiliang and Liang (2004:2-3). Project management was done by the principal contractor, but he liaised with owner on how and when to do tasks.

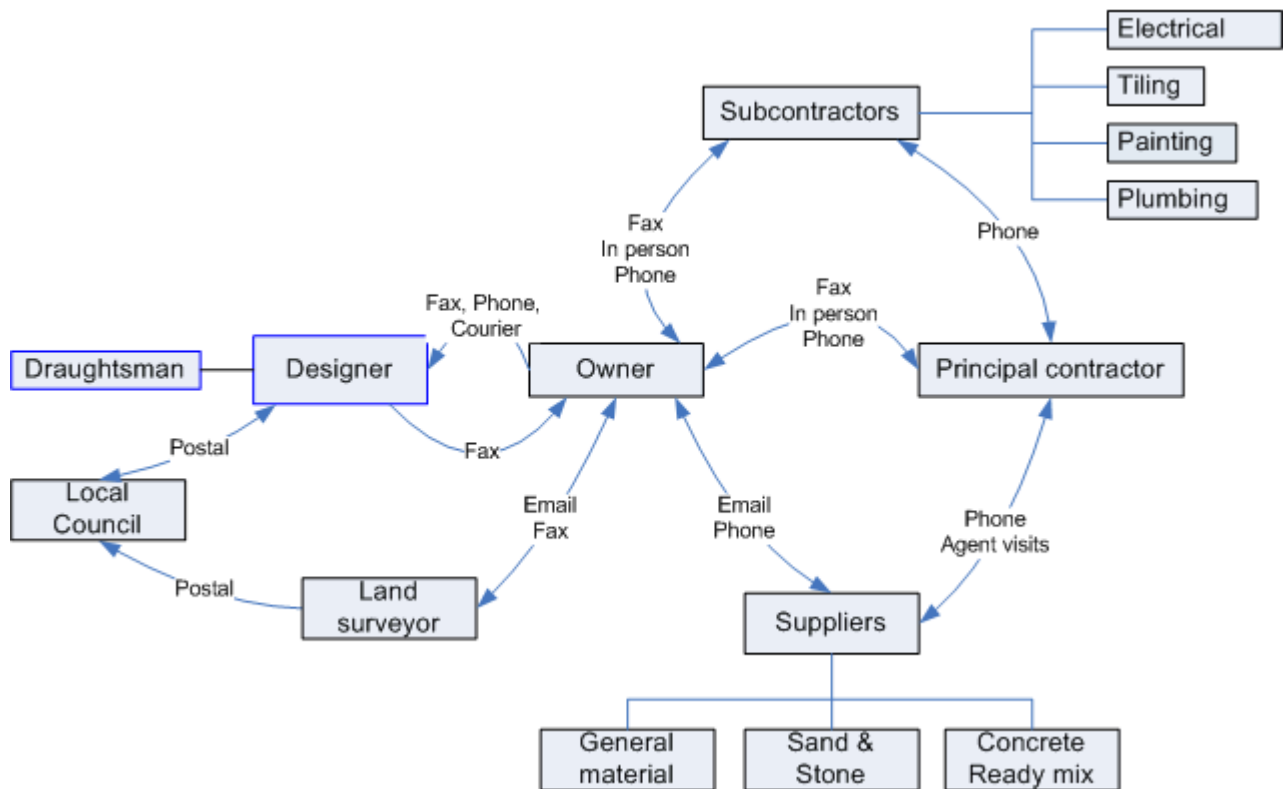
Figure 2: Supply chain for a small construction project



In Figure 3 the communication methods used is added to indicate how participants communicated with each other. The telephone, landline and/or mobile, and facsimile were the main communication method. Personal visits were also important to the owner and he visited the site several times. Visits were used to establish the progress made, confirm the quality of work, contact suppliers and even to pay for services rendered. The principal supplier visited the site every Monday morning to collect the orders for the week. The owner also preferred personal contact with the designer, land surveyor and subcontractors. Emmitt and Gorse (2003:119) pointed out that face-to-face communication is perceived by contractors to be the most effective way of communication. A courier service was used to send designs between the owner and the designer. The normal postal service was also used to deliver documents to the local council. The owner communicated by email to some of the supplies and made use of online banking for payments.

The designer had no access to computers and all designs and documents were done by hand. The principal contractor had access to word processing software and thus a computer; he has no email or Internet facilities. In contrast, the owner used the Internet for research and communicated where possible to suppliers by email.

Figure 3: Communication methods used in the study



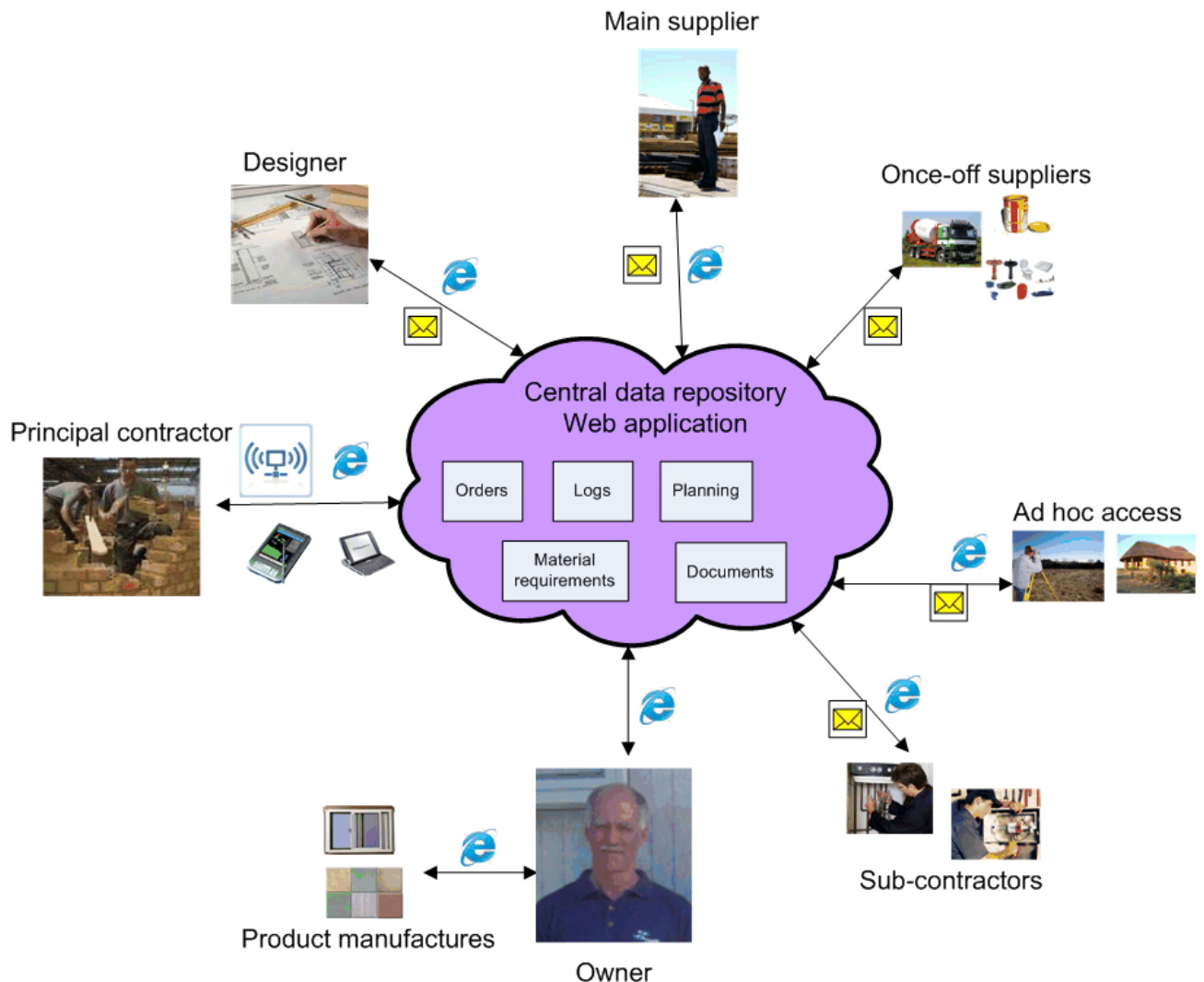
5. Proposed supply chain model

One of the objectives of the research is to develop a collaboration model that can be used by contractors, owners and suppliers to improve collaboration during the construction process. The proposed model links all participants together. This model is aimed at the smaller construction project with a small number of participants. A database where all documents and the bill of quantities for all the required building materials are stored is central to the model. It is different from a document management system in that it must have the ability to connect to the supplier for automatic orders when the required material is selected by the contractor.

The functionality of such as system must include ease of use, log keeping of all changes, order processing, payments, and reporting. Access from remote locations with mobile phones, notebooks/netbooks is essential. The proposed model is thus more than just a document management system.

In this study, the principal contractor has long term relationships with the subcontractors and the principal supplier. As pointed out by Briscoe and Dainty (2005:324) this is one of the requirements for forming a supply chain

Figure 4 Adapted Web-based collaboration model



The industry is slow in adopting information technology. Smaller contractors typically have limited exposure to the Internet and the advantages this can bring to their companies. The biggest challenge will be to convince and demonstrate the advantages web applications can have on their businesses. Research into the use of information technology and the associated applications that will make a difference in the South Africa construction industry is limited.

The results published here are part of a bigger research project that aims to enhance collaboration among participants with the use of technologies. Technology (and the Internet) can not be considered a replacement for personal contact, but can enhance information sharing and management.

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9. Images

Images used in this paper are available from the following locations as accessed on 17 April 2009.

<http://www.electricianfairfaxva.com/wp-content/uploads/2009/02/electrician.jpg>

<http://www.roadtransport.com/blogs/big-lorry-blog/2008/07/a-double-green-volvo-mixer-on.html>

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