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THE USE OF ICT TO RE-ENGINEER PURCHASING IN IRISH CONSTRUCTION

by

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Thesis submitted to the University of Dublin, Trinity College,
for the Degree of Doctor of Philosophy

January 2007

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"Radical process-based change is more likely to be achieved when people identify and accept all the changes that actually need to occur in the organisation"

Ashley Braganza (2001)

DECLARATION

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ABSTRACT

The process traditionally adopted in the purchasing of materials in the construction industry is investigated. There are millions of trading documents, such as orders, delivery notes and supplier invoices, currently exchanged on paper, each having to be re-keyed as they pass between different locations and computer applications. Traditional paper-based purchasing processes in construction are wholly inefficient, with a high dependency on manual tasks, re-keying of information into standalone software packages, extensive reproduction of paper documents and mislaid documentation is commonplace.

The thesis provides a review of existing Information and Communications Technology (ICT) tools, which will enable a more efficient purchasing process to be realised in an industry that is traditional, fragmented and project-based in practice. It is internationally accepted in the business world that ICT is a tool that improves the efficiency and effectiveness when applied appropriately to a modern business process. More importantly, however ICT investment should be coupled with the re-designing of business processes, in order to achieve significant business benefits.

In-depth observation studies identify the inefficiencies that currently exist in the mainly paper-based purchasing process adopted in the construction industry. In particular, lessons are learnt following a significant ICT investment by a major Irish contracting organisation, to improve their purchasing process.

Surveys carried out by the author suggest that there is a low level of awareness of the capabilities of appropriate technologies to support their purchasing procedures within the Irish construction sectors. Many lessons can be learned from other sectors surveyed.

The thesis presents the case for re-engineering the purchasing process by seeking to adopt a fully integrated ICT solution, which will achieve a dramatic improvement in the overall levels of productivity with subsequent cost reduction. Two major pilot projects are presented which provide documented evidence that this re-engineering of the purchasing process has tangible and quantifiable benefits, with much to offer contractors and suppliers in the Irish construction industry.

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Finally to my Mum and Dad, who I know, are proud of me. In particular, my Dad Alan, who died in May 2002. I love him and miss him dearly. To you Dad I dedicate this work.

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LIST OF ACRONYMS

2D	Two Dimensional
ANSI	American National Standards Institute
ASC	Accredited Standards Committee
Auto-ID	Automatic Identification
B2B	Business-to-Business
B2C	Business-to-Consumer (customer)
BASDA	Business Application Software Developers Association
BPR	Business Process Re-engineering
BRE	Building Research Establishment
BRT	Business Round Table
CERP	Construction Enterprise Resource Planning
CICA	Construction Industry Computing Association
CID	Construction Industry Directorate
CIF	Construction Industry Federation
CII	Construction Industry Institute
CIM	COINS Image Manager
CITA	Construction Information Technology Alliance
CMMS	Construction Materials Management System
COINS	Construction Industry Software Solutions
COME	Construction Materials Exchange
CPA	Construction Products Association
CSO	Central Statistics Office
DETR	Department of the Environment, Transport and the Regions
DETR	Department of Enterprise Trade and Employment
DLC	Davis Langdon Consultancy
DoEHLG	Department of the Environment, Heritage and Local Government
DOF	Department of Finance
DTI	Department of Trade and Industry
eBusiness	Electronic Business
EC	Electronic Commerce
eCatalogues	Electronic Catalogues
EDI	Electronic Data Interchange
EFT	Electronic Funds Transfer
eInvoice	Electronic Invoice
eMarket	Electronic Market
EPA	Electronic Purchasing Agent
ePO	Electronic Purchase Order
ePOD	Electronic Proof of Delivery
eProcurement	Electronic Procurement
ERP	Enterprise Resource Planning
ETC	Electronic Trading Community
EU	European Union
GOC	Government Office of Commerce
GPRS	General Package Radio Service
GRN	Goods Received Note
HTML	Hypertext Mark-Up Language
IC	Information Channel

ICT	Information and Communications Technology
IT	Information Technology
MMS	Material Management Systems
MRO	Maintenance, Repair and Operation
MRP	Material Requirement Planning
OCR	Optical Character Recognition
OECD	Organisation for Economic Co-Operation and Development
PC	Personal Computer
PDA	Personal Digital Assistant
PII	Partners In Innovation
PO	Purchase Order
POD	Proof of Delivery
RFID	Radio Frequency Identification
RFP	Request For Proposals
ROS	Revenue commissioners Online Service
SCM	Supply Chain Management
SGML	Standard Generalise Mark-Up Language
SIG	Special Interest Group
SMEs	Small to Medium sized Enterprises
TQM	Total Quality Management
UK	United Kingdom
URL	Universal Resource Locator
VAN	Value Added Network
XML	eXtensible Mark-Up Language

CHAPTER 1

INTRODUCTION

1.1 INTRODUCTION

Over recent decades, industry generally has come to recognise the inefficiencies that exist in paper-based systems. Many sectors of industry have replaced their paper-based systems with electronic systems. The construction sector, however, lags behind other business sectors in harnessing the greater potential of Information and Communications Technology (ICT) (Thomas and Hore, 2003; Gunnigan et al., 2004).

Building materials can account for up to 50% of all costs on a typical construction project (Tavakoli and Kakalia, 1993). There are many millions of trading documents produced by both main contractors and suppliers, such as purchase requisitions, purchase orders, delivery notes, supplier invoices, supplier statements and remittance advice notes (DoF, 2002). Each of these documents has to be re-keyed individually as they pass between different locations and computer applications (Hore et al., 2004).

It is well known that the adoption of ICT to support the materials procurement process in the construction industry has been sporadic and piecemeal. Very significant inefficiencies and problems still exist in the Irish construction industry with evidence of mainly both paper transactions and non-integrated electronic solutions (Hore and West, 2005a).

Existing ICTs such as the Internet, Bar-coding, Radio Frequency Tagging, Electronic Data Interchange (EDI), Electronic Catalogues (eCatalogues), Enterprise Resource Planning (ERP) software and handheld wireless devices have facilitated eCommerce within many business sectors (Hore and West, 2005b).

The author's research findings have shown that through a thorough understanding of the current inefficiencies that exist in construction purchasing, together with an awareness of the current technologies available, it is possible to re-engineer the purchasing process, in order to achieve a dramatic productivity improvement and significant administrative cost savings by the effective use of an appropriate integrated ICT solution. It will be seen that the biggest savings can be achieved through the exchanging of purchase orders, delivery notes and supplier invoices electronically (Hore and West, 2005c).

1.2 THESIS OBJECTIVES

The overall aim of this thesis is to re-engineer the purchasing process by enabling an electronic match of the purchase order, delivery note and supplier invoice, thus

enabling a significant improvement in both productivity and overall purchasing administration costs.

In order to achieve this aim, the following objectives will be realised.

1. Identify the inefficiencies that currently exist within the material purchasing process in construction.
2. Review the appropriateness of currently available ICT tools to support electronic purchasing in the construction industry.
3. Examine the application of Business Process Re-Engineering (BPR) and the enabling role of ICT, in seeking to achieve worthwhile productivity and administrative cost savings in the purchasing of materials in construction.
4. Observe the inefficiencies present in a traditional paper-based administration and management system for ordering, receipt and payment of building materials in a large contracting organisation.
5. Examine the extent to which the top Irish construction building contractors and building suppliers are currently exploiting electronic purchasing, the drivers and barriers to electronic purchasing and the likely future direction of Electronic Commerce (EC) in the Irish construction industry.
6. Observe the inefficiencies remaining in the administration and management systems for ordering, receipt and payment of building materials, following the implementation of a standalone ERP software solution in a large contracting organisation.
7. Examine the extent to which the top Irish companies are currently exploiting electronic purchasing, the drivers and barriers to electronic purchasing and the lessons that can be learned from other business sectors by the Irish construction industry.
8. Demonstrate by use of a pilot project, that delivery data can be successfully captured electronically and be acceptable as a "Proof of Delivery" for the construction industry.
9. Re-engineer the purchasing process within a contractor's organisation, by enabling an electronic three-way match of the purchase order, delivery docket and supplier invoice, thus enabling an improvement in both productivity and overall administration costs per purchasing transaction.

1.3 METHODOLOGY

The research methodology adopted involved five interlaced phases of work: a literature review, observation studies, industry questionnaires, process re-engineering and pilot studies.

Initially an extensive literature review was undertaken to identify relevant literature on purchasing procedures adopted in the construction industry including research on inefficiencies and innovations that existed in the construction purchasing process. The literature review progressed by investigating the various ICTs that were currently adopted to support the purchasing processes in the construction industry. The final stage of the literature review involved extensive research into the management theory of BPR, which culminated in the adoption of a particular BPR methodology developed by Li (1996).

The methodology progressed to carrying out an observation study in 2002, where the purchasing processes and the ICT used by a large Irish construction company were observed. In particular, the inefficiencies that were present in the observed purchasing process were identified.

Following the first observation study, a survey of the top Irish contractors and building suppliers was carried out in early 2004. The aim of the survey was to determine the level of ICT usage in their purchasing processes, together with the drivers and barriers to the adoption of a more integrated ICT purchasing process within the Irish construction supply chain.

A second observation study in the same construction company was carried out because they had invested in an ERP system to improve their business processes. This observation study involved identifying the inefficiencies that remained following the ICT investment.

Subsequently, a second survey of top Irish businesses was undertaken in late 2004. The aim was to determine the level of ICT usage among the top Irish companies in their purchasing processes, together with the drivers and barriers to the adoption of a modern integrated ICT purchasing process.

With this background, the purchasing process was re-engineered with a view to addressing the principal problems which had been observed, taking the experience of other industries into account and making use of opportunities offered by existing ICT.

Arising from the proposal to re-engineer the procurement process, the final step in the methodology involved carrying out two pilot projects, in 2004 and 2005. The 2004 project sought to prove that Electronic Proof of Delivery (ePOD) was an appropriate solution for construction deliveries. The aim of the second (2005) pilot was to demonstrate that the solutions and opportunities offered by the re-engineering of the purchasing process were demonstrated by achieving a three-way electronic match of the purchase order, delivery docket and supplier invoice information.

1.4 OUTLINE OF CHAPTERS

This thesis commences with a literature review, in Chapter 2, of the purchasing practice and objectives of purchasing in a contracting organisation. The particular problems and inefficiencies of the currently mainly paper-based purchasing process are identified, together with the opportunities for electronically supporting the process. Currently available technologies are discussed, together with their applicability in purchasing processes. Examples of successful electronic markets for the construction industry are highlighted together with the importance of Supply Chain Management (SCM) and its link to the enabling role of ICT. The managerial concept of BPR is discussed at length, together with a methodology to affect the re-engineering of purchasing practice in construction.

Chapters 3 and 5 concentrated on observing purchasing procedures adopted within a large Irish contracting organisation, carried out in 2002 and 2004 respectively. The 2002 study reported on a mainly paper-dependent process, which was found by the author to be wholly inefficient and costly to administrate. The 2004 study reported on an improved process, following the investment by the company in an ERP system.

Chapter 4 and 6 concentrate on the design, distribution and analysis of two online electronic purchasing surveys carried out in 2004. The first survey focused on the top construction companies in Ireland and the second survey focused on the top companies in Ireland. Both surveys found that the overall use of ICT in construction purchasing was very low and relatively unsophisticated, in comparison to other business sectors.

Chapter 7 and 8 document two live pilot projects that were carried out in 2004 and 2005 respectively. The 2004 pilot project focused on ensuring that delivery data can be successfully captured electronically and can be acceptable as a "Proof of Delivery"

for the construction industry. The 2005 pilot project demonstrated that the foundation of the re-engineered solution is the achievement of a three-way electronic match of the purchase order, delivery note and the supplier invoice. A critical evaluation of the success of achieving this three-way match is given.

The thesis concludes with a brief description of the research undertaken, the principal conclusions and an evaluation of whether or not the research objectives have been met. A series of recommendations are made for further work in this area of growing importance.

CHAPTER 2

THE USE OF INFORMATION COMMUNICATIONS TECHNOLOGY IN THE PROCUREMENT OF MATERIALS IN THE CONSTRUCTION INDUSTRY

2.1 INTRODUCTION

The use of ICT in construction purchasing has been sporadic and piecemeal. Very significant inefficiencies and problems still exist in both paper transactions and non-integrated electronic solutions. EC technologies can significantly contribute to the realisation of these expectations by increased transparency, productivity and competitiveness, as already demonstrated by other sectors (DoEHLG, 2002). Despite over two decades of significant advancements in ICT, the adoption of such technology in the Irish construction industry has been largely piecemeal (Forfas, 1999; Hore and West, 2005a).

At present the extent of use of ICT in construction purchasing is relatively unsophisticated, mainly dependent on telephone, facsimile machines and networked personal computers. At the simplest level, the electronic transmission of business documents offers savings in paper and postage (Hore and West, 2005b).

By going a step further, businesses can make strides in communicating with their partners, at relatively low cost, through direct links between their computers. Existing technologies such as the Internet, Bar-Coding, Radio Frequency Identification (RFID), EDI, Electronic catalogues and ERP Software have facilitated EC functionality within many business sectors (Hore and West, 2005c).

In the field of Business-to-Business (B2B) interactions, there is a huge untapped potential for productivity gains. In Sweden (Laage-Hellman and Gadde, 1996), Finland (Wegelius-Lehtonen, 1995) and in the UK (Dawood, 1997), materials management has been identified as an area where significant cost savings could be made. Laage-Hellman and Gadde gave an account of the progress made by the Swedish construction company Skanska in its attempts at introducing EDI into its purchasing system. The cost of processing an invoice, at that time, was found to be SEK 300 (approximately €75). Laage-Hellman and Gadde concluded that this cost could be reduced by 90% by using EDI.

Li (1996) argues that the benefits of ICT deployment are marginal, if simply imposed on an already inefficient construction process. He argues that the processes should be redesigned to maximise the use of ICT. Hammer (1990) described how heavy

investments in ICT in the 1980's delivered disappointing results, largely because companies tended to use technology to mechanise old ways of doing business.

This Chapter will seek to highlight the inefficiencies that currently exist in the mainly paper-based purchasing process in construction and how greater efficiencies can be achieved by adopting a more integrated ICT EC solution. The author will consider the appropriate technologies currently available to support electronic purchasing, research work in this field, alternative EC models and the importance of data exchange standards in achieving an integrated EC solution. The Chapter will finally progress to discuss the need to re-engineer the current purchasing process in the Irish construction industry.

The author contends that the biggest savings from Electronic Business (eBusiness) can be achieved from exchanging orders, proof of delivery and invoices electronically. B2B savings can be realised on the elimination of duplicate data entry by achieving a three-way match of the purchase order, delivery advice note and the invoice. This electronic three-way match will led to a re-engineering of the construction purchasing process. The author concludes that this re-engineering of the purchasing process will necessitate the main players within the Irish construction industry to adopt a data exchange standard (Hore and West, 2005c).

2.2 PURCHASING PRACTICE IN CONSTRUCTION

2.2.1 Traditional Construction Material Purchasing Procedures

Materials can account for up to 50-60% of a construction project cost (Tavakoli and Kakalia, 1993). The traditional process of procuring materials in construction is dependent on a number of factors. For example, the size of the project, size of firm, organisation structure of the firm and the roles and responsibilities of the employees within that organisation can dictate purchasing procedures. The process typically involves both centralised and decentralised personnel. The sophistication of the process varies widely, with many of the more established firms possessing company manuals detailing the procedures and standard forms that staff should adopt (Canter, 1993).

Figure 2.1 depicts an outline of the material purchasing process during the construction stage.

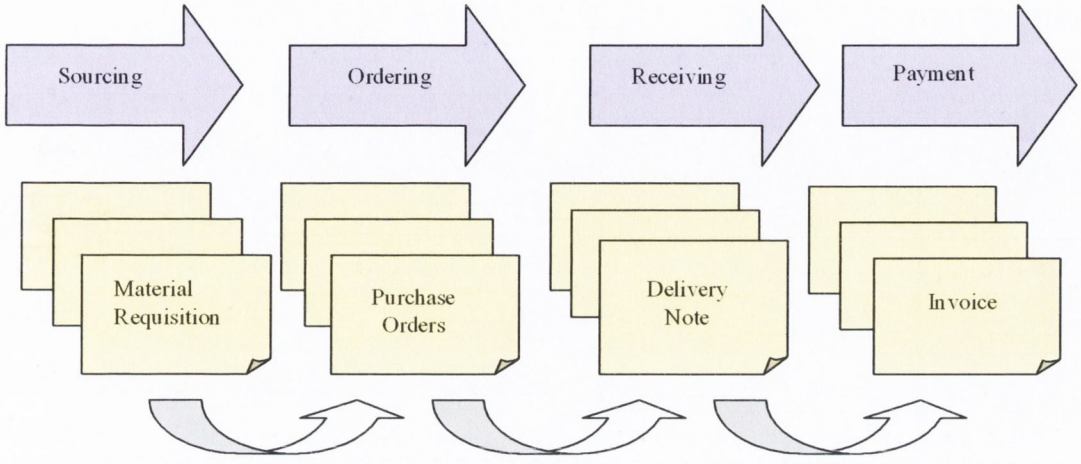


Figure 2.1. Traditional material procurement process

Purchasing procedures typically involve a paper-based communication process between the purchaser and supplier. It invariably commences with the sourcing of the materials. This involves site personnel requisitioning materials on a daily basis, as to their requirements. Once a suitable supplier has been selected, the next step in the purchasing process is to raise and issue a purchase order to the supplier. On delivery of the materials to site, a delivery docket is signed by the contractor and forwarded to head office as proof of delivery. Payment of the invoice will be made following the matching of the invoice to the original purchase order and signed delivery docket.

From the requisition of materials to payment of invoices, different paper-based documents are prepared by hand or on networked personal computers, photocopied, passed to alternative departments and filed by different groups of participants in the process. Figure 2.2 shows a typical paper-based purchasing system (Calvert, 1995).

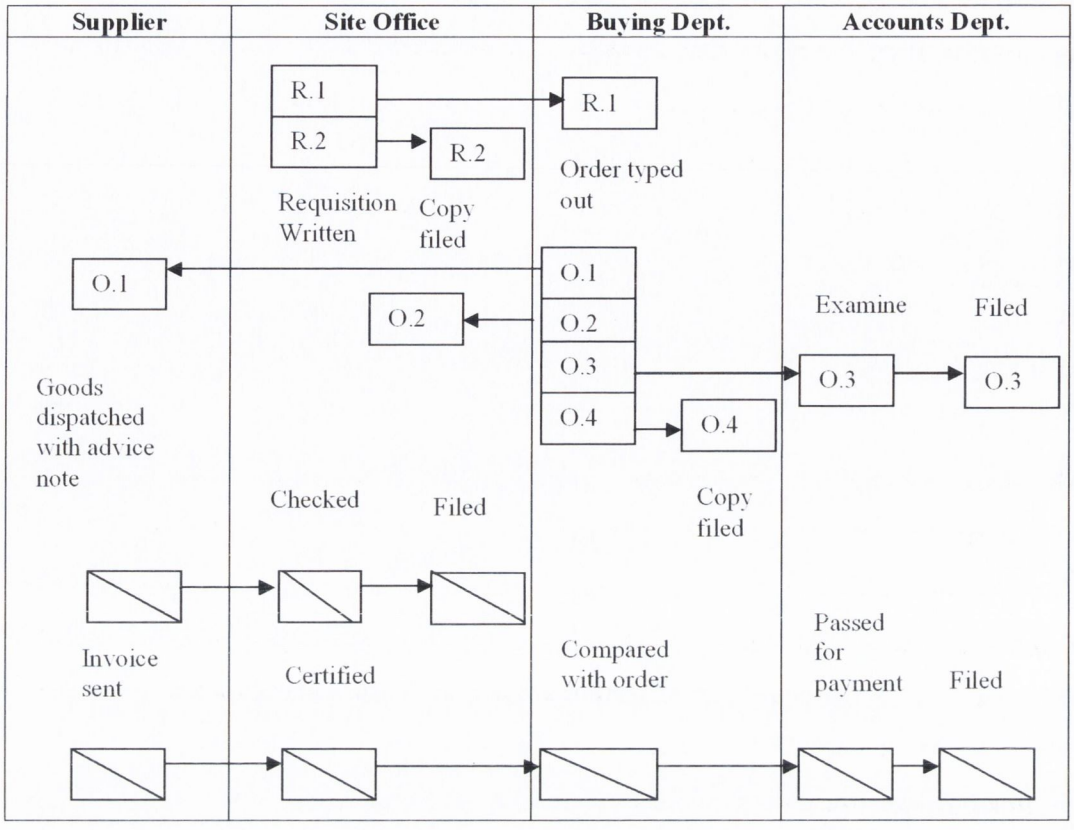


Figure 2.2. Paperwork required in the purchasing system (Calvert, 1995)

In this paper-based document system, the site office prepares two copies for the requisition of material (R1 and R2). One copy is sent to the buying department and one copy is filed. The buying department then prepares four copies of the purchase order (O1, O2, O3 and O4). One copy is sent to both the selected supplier and the site office, while the accounts department and the buying department keep the remaining copies for their records. The site office will receive an advice note and invoice issued by the supplier when materials arrive on site. The invoice will be compared with the purchase order by the buying department and after confirmation, will be passed to the accounts department to issue payment. The process may vary somewhat from organisation to organisation, but is, in main, as described.

Classic purchasing processes in construction are paper-based, where documents are used to create other documents. As a result, the probability of an error increases as information is transcribed from one document to another. Although paper documents can

be inputted into a computer system, data entry requires multiple transcriptions of the data. As a result, such processes can result in the introduction of additional errors into the system. Paper-based systems also are dependent on ensuring that all appropriate departments get copies of the documents necessary to do their job. If even a small percentage of those documents become lost or misplaced, there can be gaps and delays in the system (O'Leary, 2000).

2.2.2 Objectives of Construction Purchasing

The aim of any materials management process is to achieve efficient acquisition and use of materials at the right time, to an acceptable price and, most importantly, to a desired quality (Stukhart, 1983; Bell, 1986). Leenders et al., (2002) elaborated that the purchasing function should obtain the *right materials*, in the *right quantity*, for delivery at the *right time* and the *right place*, from the *right source*, with the *right service*, and at the *right price*. Leenders et al., compares purchasers to jugglers, attempting to keep all these seven *rights* simultaneously in the air.

If purchasing procedures are not efficient, purchasing administrative costs will be excessive. The objectives of purchasing should be achieved as efficiently and economically as possible. Purchasing managers should be aware of the dramatic improvements that an integrated ICT system can bring to purchasing procedures. For example, opportunities to reduce transaction costs include automating requisitions, purchasing cards, electronic proof of deliveries and electronic invoices. Companies with efficient purchasing processes can create competitive advantage through reduced costs, improved flexibility and reaction time, while allowing purchasing personnel to concentrate on value-added activities (Leenders et al., 2002).

2.2.3 Traditional Purchasing Practice in Construction

There are a variety of models that can be adopted in construction purchasing. Dand and Farmer (1970) described how purchasing can be dealt with by site personnel under the control of a site manager and within guidelines set out by senior management.

Alternatively, a general buyer can be employed to be responsible for the purchasing of materials for individual projects. In larger companies, buyers can be made responsible for geographical areas or groups of contracts. In larger organisations, buyers may be required to specialise in particular material purchases or to deal with particular suppliers.

Canter (1993) described the options in regard to the organisation of the buying and its position within the framework of the company as a whole. To a large extent, the choice will depend on the nature of the company and the type of work it carries out. The alternatives identified by Canter (1993) include: -

- A centralised approach whereby all purchasing is organised and carried out by one person or within one department.
- A de-centralised approach whereby sites, departments or areas are responsible for their own purchasing needs.
- A centralised/de-centralised approach, which seeks to attract the benefits, associated with the individual approaches.

Canter suggests that the best approach is a combined centralised/de-centralised system, which means all major items are purchased centrally by one source. However, localised or departmentalised purchasing is also allowed, in order to take account of local circumstances, but within a framework and guidelines set out by the person responsible for the overall buying function.

2.2.4 Particular Problems to be Addressed

Purchasing procedures typically involve a paper-based communication process between the purchaser and supplier, as already stated. In the United States of America, since 1980 there has been a series of studies addressing the problems evident in material management in the construction industry, sponsored by The Business Round Table (BRT) and the Construction Industry Institute (CII). The studies brought a greater awareness of the importance of material's management in achieving project savings (BRT, 1982) and costs and benefits of material's management (CII, 1986). Bell and Stukhart, (1986) recognised the importance of ICT and its role in the purchasing function

of a construction company, concluding that the purchasing function must be fully integrated into the overall ICT management system.

Evidence shows that the construction industry is lagging behind other industries globally in adopting new technologies (Kong et al., 2001). Kong et al. identified the limitations of the traditional material procurement process, thus: -

- The process has specific business hours, it can only work with suppliers within a defined geographical region;
- the process can only collect a limited amount of information about suppliers and their products through the collection of physical catalogues;
- physical catalogues are cumbersome to use and require large storage areas;
- catalogues can become dated very quickly, and make searching and comparison of prices and quality a nebulous task;
- the process is very time consuming and
- the probability of errors occurring is very high as information is transferred from one document to another.

The paper-based system is also dependent on ensuring that all appropriate departments obtain copies of the documents necessary to do their job. As stated earlier, if a small percentage of those documents are lost or misplaced, there can be delays in the system and orders may go unfulfilled. Every step is reliant on input from one or more individuals and there are frequently problems in the process. For example, the requirements of the contractor may be misinterpreted by the supplier, a docket could go missing, transcription errors occur, the invoice may not be correct, the goods may not be all delivered at the same time, the delivery docket may not match the order, payment could be held pending matching of documents, etc. Any of these problems can add significant delay and cost to the process. Although the construction industry has seen major changes in technology, the industry still remains highly labour-intensive, de-centralised, and dependent on uncertain economies. Nevertheless, many clients and contractors are making changes in management and technology, despite the short-term uncertainty in the industry. To stay competitive in the long term, evolutionary change must be introduced.

Construction businesses trade with hundreds, often thousands, of companies in any year. This result is a vast amount of time wasted undertaking a range of tasks, such as: -

- Re-keying;
- retrieving documents;
- requesting copies of lost documents;
- archiving paper and
- manually analysing data.

The combinations of all these limitations make it increasingly difficult for contractors to stay abreast of market conditions and, thus, select the most suitable materials and suppliers for a given project (Kong et al., 2001).

The number of invoices exchanged each year within the Irish construction sector has been estimated at many millions, with similar numbers of orders and dispatch notes, as well as a smaller number of statements, credit notes and remittance advice documents (DoF, 2002). With quoted savings from electronic invoices ranging from €2 to €10 per invoice, and much greater savings predicted when the full transaction cycle is conducted electronically, the potential benefit to the industry from achieving the widespread adoption of electronic trading will be worth hundred of millions of Euros (DoF, 2002).

2.2.5 Opportunities for Electronic Support

Dand and Farmer (1970) spoke of the inevitability of mechanisation and automated purchase order systems in construction purchasing. Bell and Stukhart (1985 and 1987) identified that the three most important attributes of a successful materials management system were pre-construction planning, communications and a comprehensive, yet flexible, set of computer programs. Bell and Stukhart were not clear at that time what degree of computer control would be the most effective for a given type or size of construction project. Bell (1986) indicated that an on-line computer system that exerted line item control over bills of materials, purchase orders and material receipts would be extremely cost effective. Bell (1987) concluded that the cost of developing and executing

materials management computer programs was significant, but the cost has been quantitatively justified through the results they provide.

Bell and Stukhart (1987) promoted the use of computer aided Material Management Systems (MMS) in achieving improved labour productivity, reduced bulk material surplus and improved vendor performance. Stukhart and Bell (1986) concluded that the key to successful material management system implementation is not the computer, but people dedicated to making the system work and educating the organisation so that people have confidence that the system will work when they need it. Bell and Stukhart concluded that one of the most common misconceptions is that a materials management system can only improve if senior management expend the resources to attain a sophisticated computer capability. Stukhart and Marsh (1986) concurred that the implementation of materials management is in the application of good management procedures, concluding that these procedures must work before the computers do.

Figure 2.3 illustrates that the purchasing process involves four stages, namely, sourcing, ordering, receiving and payment. At each stage there are discrete activities to be carried out that typically involve the creation of various printed documents, faxing, photocopying, scanning, posting and re-keying of information into computerised databases by both the contractor and supplier, all of which can be supported by ICT applications.

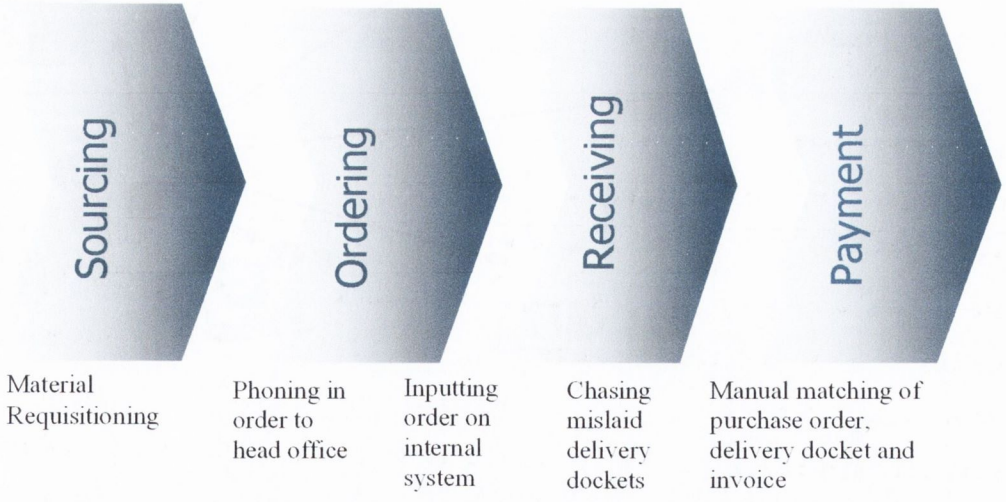


Figure 2.3. Opportunities for electronic support of the purchasing process

2.2.6 Key Drivers for Change

The nature of the construction industry is different to other industries, such as the manufacturing or retail sector, where processes and the working environment are well defined and controlled (Gann, 1996). The temporary nature and uniqueness of construction projects is reflected in one-off locations, one-off designs solutions and one-off project teams, which led to a very fragmented communication platform (see Figure 2.4). This has led to poor communication and inefficient information practices that have contributed to the emergence of dysfunctional supply chains (Love et al., 1999). This, in turn, has created challenges for the application of information technology in the Irish construction industry.

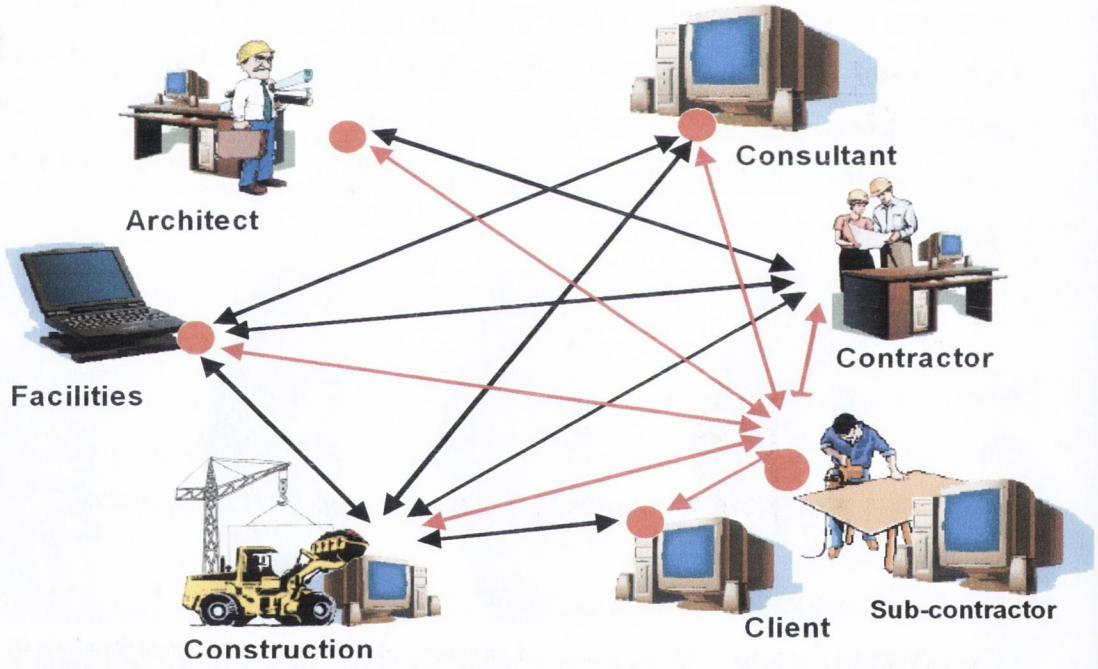


Figure 2.4. Fragmented construction industry (Sarshar et al., 2000)

Construction sectors in many countries around the world are increasingly recognising the importance of ICT as a communication tool. It is now becoming accepted that the preferred communication model for managing information on a construction project

should be based on a central project model, through which, all the information is disseminated (Figure 2.5). A common tool used is a project extranet. There is a proliferation of extranet products available in the market, each vendor advocating that their product is the best in their class. Difficulties arise with the use of such technologies, not least in deciding who will pay for this additional cost. Issues of security, training, ICT infrastructure etc. will all need to be addressed before these communication tools are successfully adopted.

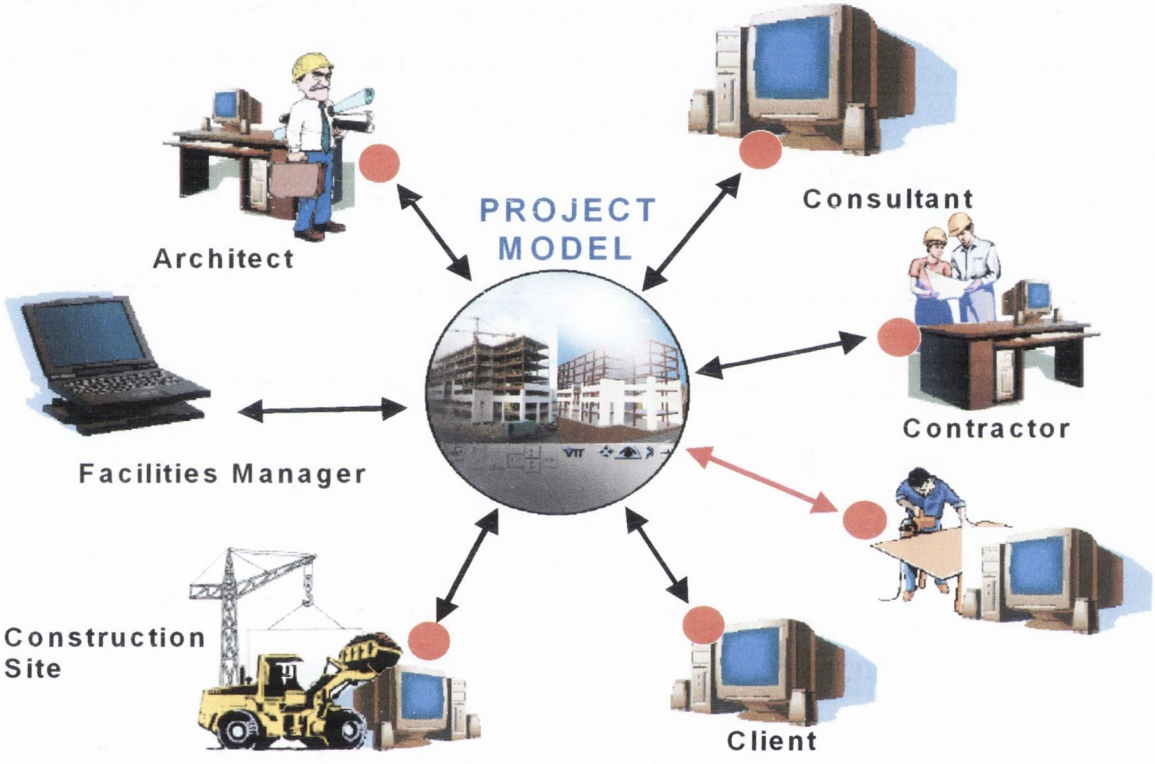


Figure 2.5. Preferred communication model for construction (Sarshar et al., 2000)

In a report commissioned by the Department of Trade and Industry (DTI) in the UK in 2002, key drivers were identified with respect to changes in eBusiness in the UK construction industry (DLC, 2002). The report concluded that the fragmented nature of construction coupled with the large number of business transactions on even quite small construction projects was a significant challenge for the industry. In an earlier report

commissioned by the DTI in 2000 (DLC, 2000), key drivers and likely future directions in eBusiness in the UK construction industry were identified, namely:

- **Economy and speed of construction.** A fundamental driver for eBusiness is economy, to replace intermediary functions (middlemen), to accelerate order and delivery times, to shorten communication distances and to reduce transaction errors and costs.
- **Improved business relationships.** Effective design and construction requires a high degree of collaboration on these activities and for good working relations between all members of the team. Additionally, clients are increasingly looking to develop long-term partnering arrangements with fewer key suppliers, devoid of adversarial business relations. Such relations depend on close working towards mutual goals and information sharing.
- **Product and process improvement.** Closer integration of design and construction is highly desirable. Construction can be characterised as a series of separate and largely sequential processes undertaken by designers, contractors and suppliers each of whom has little individual commitment to the long-term success of the product.
- **Technology and entrepreneurship.** Available technology and the will to exploit ICT (technology push) is increasingly a key driver in the adoption of e-business in construction. The development of communication protocols, such as eXtensible Mark-Up Language (XML), supported by widely available telecommunications infrastructures, is providing cheaper and more accessible methods of exchanging construction information.

2.3 TECHNOLOGY AND PURCHASING

2.3.1 Electronic Commerce

Electronic Commerce (EC) is defined as the exchange of goods or services via a system based on electronic communication or storage (Baron et al., 2000). Figure 2.6 illustrates the timeline in the advanced ICT applications led to EC.

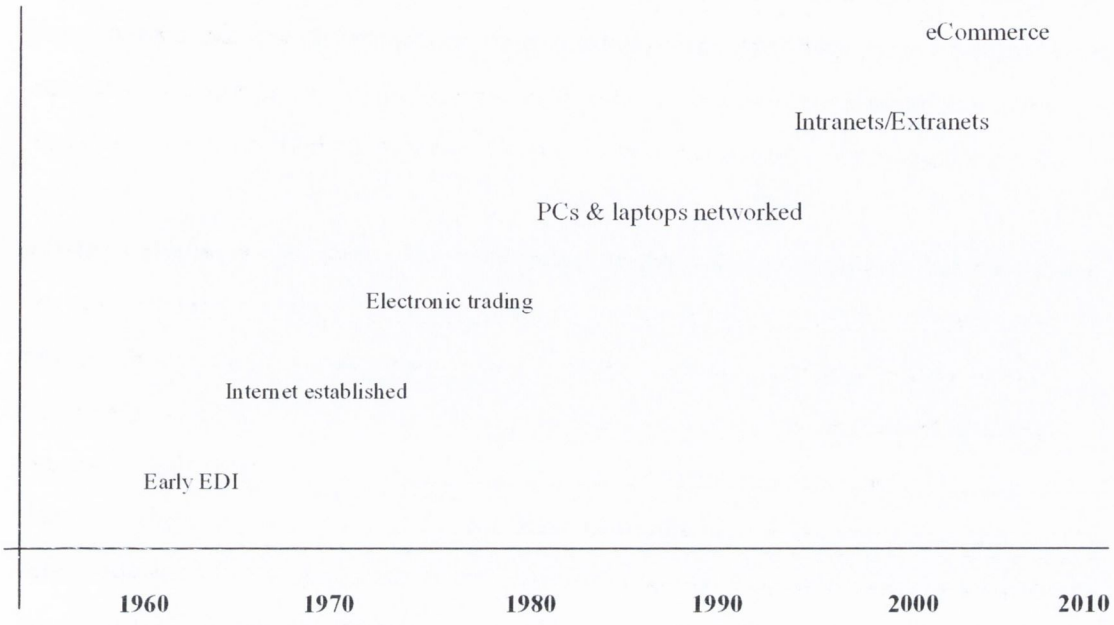


Figure 2.6. Indicative timeline of ICT applications in eCommerce (Evangelista, 2003)

EC applications began in the early 1960s with such innovations as EDI. EDI added other kinds of transactions processing and extended the types of participating companies from financial institutions to manufacturers, retailers, services, and other forms of business. However, the applications were limited to large organisations and a few small businesses at that time. The most pervasive force in the evolution of EC was the introduction of the Internet in the early 1970s.

In the early 1990s, with the introduction of Personal Computers (PCs) and Laptop PCs, EC applications expanded rapidly. The emergence of Intranets and Extranets created the first real opportunity for electronic markets. After nearly three decades of not-for-profit operation, the network was transformed into a worldwide digital marketplace practically overnight. When information exchange became electronic, both subtle and dramatic changes in the nature of human and organisational communication occurred (Porra, 2000).

Almost every medium to large sized company in the world has a website. For example, in 1999 General Motors Corporation (www.gm.com) offered more than 18,000

web pages of information, which included more than 100,000 links to its products, services, and related topics. EC changed almost all functional aspects of a modern business enterprise, particularly in industries such as financial services, travel, and retailing (Shaw, 2000).

Business transactions conducted electronically fit into two categories :

1. Business-to-Customer (B2C) where companies sell direct to consumers over the Internet.
2. Business-to-Business (B2B) where two businesses make transactions electronically.

It has been the area of B2C EC that has made most gains. For example, websites such as Amazon.com, eBay.com and Ryanair.com have all extensively facilitated consumer business over the Internet. Adoption of B2B EC is slightly slower. B2B EC is an electronic means of carrying out business transactions between two or more businesses. B2B incorporates everything from manufacturing to service providers. An example of such a method of carrying out business would be a company that uses the Internet to place an order from the suppliers or retailers, receive electronic invoices and make payments electronically (Anumba and Ruikar, 2002).

2.3.2 Electronic Commerce in Construction Purchasing

The uptake of EC in the Irish construction industry has been relatively limited and ineffective as compared to other engineering sectors such as the automotive or aerospace industry (Betts, 1989). There are several factors that have limited the uptake of EC in construction, including the high cost of initial investment associated with building the required infrastructure, training of personnel, quantifying the return on investment, security of online transactions, integration with legacy systems and interoperability of distributed software application over the Internet (Shaw, 2000). For most construction projects, teams are formed for the duration of the project and these last only for as long as

the project itself. This temporary nature of relationships in the industry provides little incentive for investing innovative technologies such as EC.

Another major barrier to the implementation of EC in construction relates to the investment justification for construction firms, especially Small to Medium sized Enterprises (SMEs). Elliman and Orange (2000) stated that SMEs simply do not have the capital needed to implement EC technologies to support their business and project activities.

There are established technology tools used in everyday construction purchasing processes, including fax machines, fax/modem cards, Internet fax and e-mail. E-mail allows users to transmit messages back and forth within an organisation and to external parties. E-mail can be used to communicate with suppliers and, in some cases, is a means for suppliers to access and respond to Requests for Proposals (RFPs). Voicemail is another communication tool that can, if used properly, save time, providing accurate information and improve communications between buyers and internal customers.

Some of the more important technologies that can support electronic purchasing in construction are now discussed in some detail.

Automatic Identification Technologies

Automatic identification (auto-ID) technologies consist of a technology for automatically gathering information and a computer database to manipulate the data. The system includes a means to automatically identify, track and locate transaction items and enter this information into a computer database. The technology is also known as Keyless Data Technology. The keyless nature of the technology overcomes the need to re-enter information contained in relevant documents (Finch et al., 1996). The most common auto-ID technology is bar coding. Recent advances in Two Dimensional (2D) symbologies now allow significant amounts of information to be stored within the bar code label itself. Auto-ID technologies allow electronic readable information to be attached to a variety of objects using bar coding.

Liou (1992) examined the benefits of using keyless data acquisition, describing the technologies currently available for auto-ID, including bar codes, Optical Character Recognition (OCR), RFID, hand writing recognition, magnetic strip and voice

recognition. The technologies are used in situations, which require rapid and accurate data entry into computer systems. A number of unique characteristics inherent in the construction industry separate it from other manufacturing industries. These characteristics generally support the argument for greater use of keyless data acquisition methods by the construction industry (Coble and Kilbert, 1994).

Many people are familiar with the use of bar codes in retailing, where packages are identified with a bar code system that has certain key information that triggers a computer database to give price and quantity information. The database can contain location, supplier, price and inventory data. Stukhart and Pearse (1989) and Shukhart and Cook (1990) described how bar codes could assist in the automation of the construction materials management process. They can be particularly useful in purchasing, in receiving inbound materials and order generation. Benefits include quick and accurate data entry and faster checking and clearing of deliveries.

One of the major obstacles preventing broad acceptance of bar codes in the construction industry is the lack of industry standards. Construction industry standards will not become a reality until major owners and contractors take the initiative to establish action groups empowered to draft such standards and the industry becomes aware of the benefits and possibilities of bar code use (Skukhart and Pearse, 1989). Problems will arise with the implementation of bar codes because individual initiatives led to "islands of automation", meaning users within companies or industries cannot connect across boundaries. Unless bar codes extend beyond simple applications, their overall contribution to automation is significantly reduced (Stukhart and Cook, 1990).

In the UK some experimental applications of bar coding in the construction industry have been reported by Baldwin et al., (1994), Finch et al., (1996) and Marsh and Finch (1998). However, the experience in the UK has been limited to a number of organisations and specific stages within the construction supply chain. There is minimal use of bar codes among construction related companies but considerable interest exists in developing bar code standards for materials management applications (Marsh and Finch, 1998).

RFID refers to a branch of automatic identification technologies in which radio frequencies are used to capture and transmit data. RFID technology offers hands-free

tracking of products, animals, equipment and personnel. A transpack is activated when it comes within the range of a reading station. The data are stored in the memory of the transponder and is transmitted to the reading station where the data are read and made available to the user. Both range and reliability of the data are the key problems. This technology is currently being referred to as "object-to-object" technology. Companies are rapidly adopting this technology to reduce costs, enhance security, and help customers in many industries. RFID technologies are still in their infancy; as they become more sophisticated and widespread, they will begin to reshape companies, supply chains, even entire industries (Ferguson, 2002). RFIDs or smart tags could well replace bar codes as they provide an array of advantages over the use of bar codes, for example.

- Items do not have to be read one at a time. RFID tags communicate wirelessly, where whole carts, cartons, or pallets of products can be read in an instant.
- Items do not have to be near the reader. A smart tag can be read at a distance and without a clear line of sight.
- The technology does not require pristine conditions. Smart tags can withstand temperature extremes and harsh treatment. They can be used even under extremely adverse conditions, such as in an artic oil field.
- Far richer content can be carried. Bar codes carry relatively simple information; a smart tag can carry extensive, specific information, giving each item a unique identity and history.

An ICT carrier study led by the British Research Establishment (BRE) and part funded by the DTI, considered the uses of RFID in other industries and whether there was potential to transfer the technologies to construction (CPA, 2002). It was found that it is not easy to ascertain which RFID technologies will be adopted from the wide variety of standards currently available. The BRE concluded that, in order for RFID to be widely adopted within the construction industry, it must be thought of as part of an overall system, working alongside existing methods and technologies. New systems must be integrated smoothly within existing practices, making it important for barcode and RFID technologies to become partners within a single ICT system.

Handheld Computers

Handheld computers or devices are in widespread use in the US construction Industry. Commonly referred to as Personal Digital Assistants (PDAs), they have gone through a large-scale development process by multiple companies, starting in the 1980's. Handheld computers could be described as simple portable computers that can be operated with an electronic pen or stylus (Newell, 1994). Although virtually all the major computer manufacturers have developed a form of the pen computer, some have clearly outdistanced others in the area of new, innovative technology. Leaders in computer technology have formed associations with telecommunications companies.

As early as 1993, IBM and Bell South in the US launched the Simon computer. The features of the Simon device include; handwriting recognition by use of a stylus; keyboard; calculator; phone; wireless email; electronic address book and auto dialing; calendar; bar code and pager. Alexander et al., (1997) concluded that the design of integration into a handheld computer varied for each component, requiring continual analysis of the compatibility of each component within the overall system design. These components could include a digital camera, a General Package Radio Service (GPRS), an inclinometer, digital compass, a bar code system, microprocessors, pen and touch interfaces and construction software.

The integration of keyless data entry systems with pen computers provides another technological leap forward in the speed and reliability of information being processed and distributed (McCullouch and Gunn, 1993; Newell, 1994; Coble and Kilbert, 1994). Today keyless data systems have enjoyed tremendous success in many sectors, including supermarket checkout systems, postal delivery operations and law enforcement documentation. Restaurants can now use touch computers for customers to order and pay for their food. Phone calls are transmitted and customer assistance handled by voice activated computers.

In conjunction with the use of bar codes, the pen computer can be utilised to record information, greatly simplifying tedious estimating and project scheduling duties (Alexander et al., 1997). The pen computer can also be used to reconcile daily job production activities, accident reports and to provide field communications (Coble and Kilbert 1994). In conjunction with a digital camera, the pen computer can be used to

enhance the written word with visual support (Coble and Kilbert, 1994; Finch et al., 1996).

Enterprise Resource Planning Software

ERP software attempts to integrate the business functions of an enterprise to create a single software programme that runs off one database (Jimpsheng Shi and Halpin, 2003). An ERP system has been defined by Fui-Hoon Nah et al., (2001) as 'a package business software that enables a company to manage the efficient and effective use of resources (materials, human resources, finance etc.) by providing an integrated solution for an organisation's information processing needs.'

ERP has its origins in manufacturing and production planning systems (Fitzgerald, 1992). The early systems were created three decades ago with the advent of Materials Requirement Planning (MRP), which primarily organised the storage and allocation of materials production. Later the manufacturing industry expanded these organisational efforts to include the allocation of production equipment and labour. The term ERP was used when the production-orientated systems were integrated with purchasing, finance, human resources and other front-office applications to enhance the management of all business operations across the enterprise (Soliman et al., 2001).

In recent years, ERP systems have expanded to include functionality such as EC and supply-chain systems (Hare, 1999). Today, an ERP system is more than traditional software. It is the ICT backbone of the corporate infrastructure (Bechler, 1997). It provides an integrated multifunctional, and multinational business management tool (Thompson, 1996; Gibson and Holland, 1999; Tinham, 1999).

ERP removes the old stovepipe computer systems used in accounting, purchasing, human resources and replaces them with a single, unified software programme. All departments get their own software, except the software is linked together, so that someone in accounts can integorate the purchasing software to see the details of a purchase order. Most ERP software is flexible enough that one can install some modules without buying the whole package (Soliman and Youseef, 1998). The implementation of ERP systems in recent years has, so far, yielded more failures than successes in large

construction organisations. A typical ERP system implementation can take one to three years to complete and costs tens of thousands of euros (Voordijk el al., 2003).

Jimpsheng Shi and Halpin (2003) established the case for the development of a Construction Enterprise Resource Planning (CERP) system. The expected benefits of the CERP system promoted by Jimpsheng Shi and Halpin included information sharing, improved transparency of management responsibilities and improved management efficiency. The research carried out by Jimpsheng Shi and Halpin (2003), concludes that current ERP software products cannot meet the needs of the construction industry, as the software was primarily developed for the manufacturing industry. They advocate that the basic features of a CERP system should be project oriented, integrated, open and expandable, scalable, remotely accessible, transparent, reliable and robust.

The author will be proposing the adoption of all these features in the CERP system to be adopted in the re-engineering model proposed in Chapter 8.

Electronic Data Interchange and eXtensible Mark-Up Language

With the growth of microcomputer usage in supply management in the 1980's, an exciting and challenging development was the capability of direct electronic transmission of data and standard forms between a buying firm and its suppliers. This concept was known as EDI. EDI is the electronic exchange of business documents (purchase orders, invoices etc.) from one organisation's computer to another in a standard format. The advantage of EDI includes labour savings, elimination of communication time lag and reduction in data entry errors. Some disadvantages of using EDI include the potential high cost; limited accessibility; rigid requirements and the fact that EDI offers only basic transactional information those computers can share but cannot accommodate any special instructions.

EDI is the direct computer-to-computer exchange of standard format business documents. This technology is generally credited with reducing purchasing and accounting related costs, increasing purchasing professionalism, eliminating paperwork, increasing purchasing lead times, reducing data transmission errors, and improving materials management planning (CII, 1993). EDI has become the preferred way of

compressing and transmitting data between a buying firm and its suppliers in many sectors (Leenders et al., 2002).

EDI standards are developed and maintained by the Accredited Standards Committee (ASC) X12 developed under the guidelines of the American National Standards Institute (ANSI) of the US. The standards are designed to work across industries and company boundaries. Specific EDI standards have been developed for the automobile, transportation, grocery, and warehouse industries. The fragmented structure of the construction industry has undoubtedly hampered adoption of EDI as a means of electronically transferring information between parties within the construction process (Gibson and Bell, 1990).

A more general and powerful electronic date exchange language called eXtensible Mark-up Language (XML) has been developed in recent years. In general, XML allows users to define different tags, in order to convey the meaning of the data. XML is a derivative of Standard Generalised Mark-up Language (SGML). Many industries are also familiar with Hypertext Mark-up Language (HTML), which is also derived from SGML. XML replaced SGML, and made it more general purpose, actually removing some complexity. XML is a mark-up language for documents containing structured information. Structured information contains both content (words, pictures, etc.) and some indication of what role that content plays. It uses identifying tags that allow information exchange without having to reformat the data for retrieval and viewing. A comparison of XML against EDI is shown in Table 2.1.

	EDI	**XML**
Optimised for:	Compressed messages	Easy display and programming
Requires	Dedicated EDI server	Web server
Server cost	$10,000 to $100,000	$5,000
Uses	Value Added Network	Existing Internet connection
Message format	Months to master	Learned in hours
Requires	C++ programmes	JavaScript, Visual basic, Python or Perl script writers
Readable by:	Machine	Human and machine

Table 2.1. Comparison of EDI and XML (Cheng et al., 2002)

EDI uses a fixed file format. It employs a field de-limiter to separate the individual data elements, which are identified by their position in the file structure. The field structure is, therefore, rigid and the information contained cannot be displayed. It can only be read into a computers' database. This is acceptable if both the sender and receiver have matching systems but very limited otherwise. XML on the other hand can be displayed in a web-browser as a document. The data transmitted can be identified and retrieved into a database application. Furthermore, it is extensible. This means that, because each element of data is separately identified, all of the elements do not have to be present in the message, only the elements that are required by the message definition, the XML schema.

The lack of a common data exchange standard in the UK construction industry increases the implementation costs (Cole, 2004). According to Whittle (2002), there are over 2000 XML standards for an invoice alone.

The barriers to the effective use of EC can be overcome if the infrastructure for EC use is created properly. Security issues can be handled through firewalls and secure encryption technologies. Currently most of the communication, both within and outside construction businesses, takes place, by exchanging emails. Most of the email messages are routed between the Internet service providers over public telephone networks and, therefore, are no more secure than a conventional telephone call. Customer confidence can be addressed with the help of secure trading standards and updated consumer laws (Anumba and Ruikar, 2002), and more recently, encryption.

Electronic Catalogues

Stanoevska-Slabeva and Schmid (2000) defined Internet-based eCatalogues as an interactive multimedia interface between buyers and sellers on the Internet, which support product representation, search and classification and have interfaces to other market services such as negotiation, ordering and payment. Kong et al., (2001), saw eCatalogues as an interactive front-end interface that provides classified and structured product information, and supports product searching, comparison and evaluation, with the capability of linkages with other EC services such as biding, ordering and payment.

Major vendors have begun putting their product catalogues online, where buyers can conduct their procurement process directly through the web. Web-based eCatalogues have fundamentally changing B2B procurement (Shaw 2000). Physical catalogues are too cumbersome to use and can quickly become out-of-date. CD-Rom catalogues, albeit easy to handle and store, also become dated very quickly. Web-based electronic catalogues allow for more effective interaction between the supplier and the buyer, alleviating the need for physical storage and making continuous updating effective and efficient.

eCatalogues are becoming the gateway to EC on the Internet. Most of the research and applications to-date have centred on supplier-based catalogues (Kong et al, 2001; Coetzee and Boshoff, 1998). An eCatalogue is generally used by individuals or organisations to present the items available for sale in a more timely and effective manner than possible using a physical catalogue. Alternative terms used for the eCatalogue concept are storefronts, web-stores, web-catalogues and Internet-catalogues. Suppliers and buyers are recognising that electronic catalogues are a new means of assessing both old and new markets (Wyckoff, 1997; May, 1997).

Kong et al., (2004) and Kong et al., (2005) have developed XML schemas to enable information sharing between EC systems for construction material procurement. The researchers developed a system known as 'E-Union, which employs a centralised single access product searching model. In this model, the E-Union member can keep his or her own database structure of product information. This product demonstrated the feasibility of providing interoperable construction product catalogues.

E-Procurement Models

Web-based procurement systems create electronic links between suppliers and buyers (Kemerer, 1998: Sirinivasan et al, 1994; Wang and Seidmann, 1995). Shaw (2000) described how these links could be organised in different ways. As shown in Figure 2.7, buyers and suppliers can either form direct connections (a) without an intermediary, (b) with intermediaries, or (c) acquire the goods through Electronic Markets (eMarkets) (Strader and Shaw, 1997). Current EDI systems are mostly implemented through (a) and (b) through Value Added Networks (VAN's) or private lines. eMarkets (c) enable buyers to check online catalogues of a pool of suppliers and then submit purchase orders

electronically. Shaw (2000) advocates that web-based systems tend to be more market orientated, which will translate into lower costs.

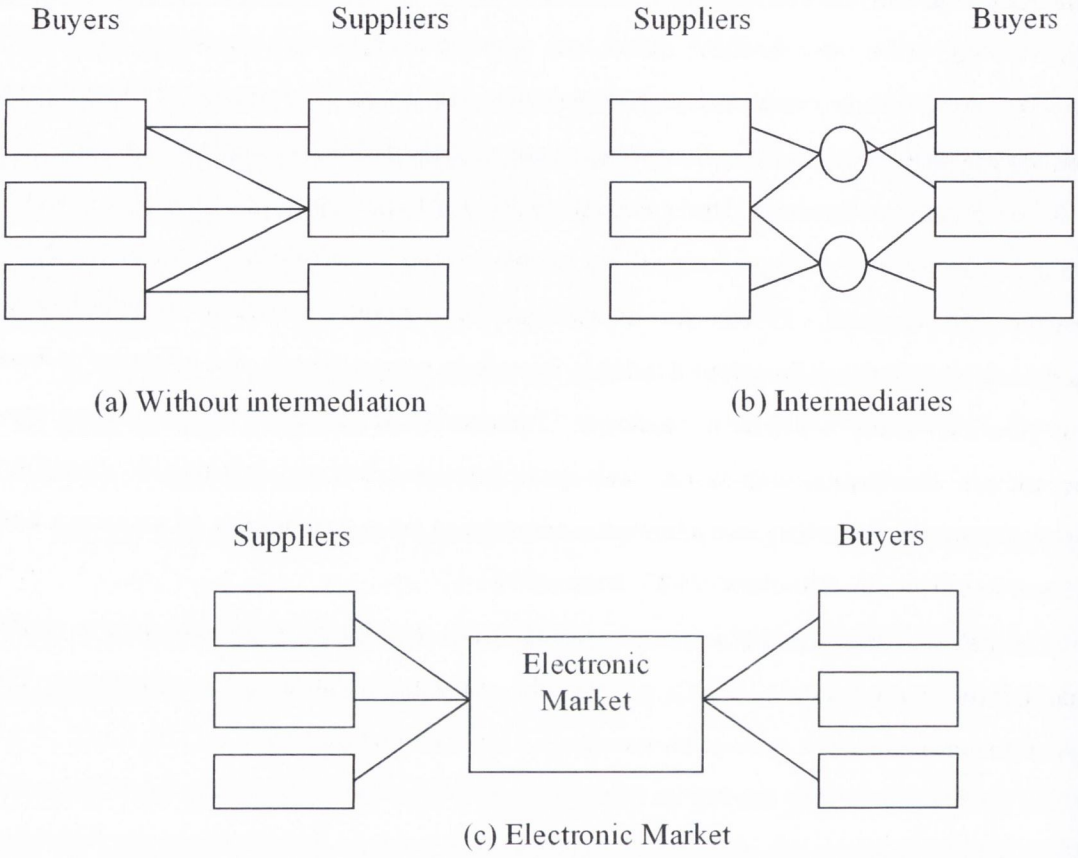


Figure 2.7. Three types of buyer-supplier communication structure (Shaw, 2000)

eMarkets can occur under several circumstances, but in general this model brings together multiple suppliers and buyers to one common website hosted by a third party. Suppliers can either upload their eCatalogues to the market site and receive order notification in the manner of their choosing (e.g. email and fax), or the eMarket can contain a link that enables a buyer to punch-out to the supplier's own website.

The development of EC models in construction is a fast-moving business. Due to the mix of technologies and standards, EC has become one of the most complex areas in the information systems business world. The concept of a hub/eMarket has been around for

some time but there have been very few 'commercial' hubs that have survived in recent years. The biggest problem is the cost of setting up the 'hub' and the ongoing costs. Organisations like CommerceOne and Ariba were selling this concept and charging very large fees. Many of these early hubs were set up by commercial ventures – groups of buyers coming together – and then trying to force their suppliers to trade electronically through the hub – expecting an improved level of discount and sometimes paying transaction charges.

There is great deal of work in linking the hub to allow it to integrate directly with the back-office system – especially for the suppliers who were often expected to supply a catalogue of their products in a proprietary electronic format. There have been several attempts in the UK construction industry to set up these hubs – Construction Industry Software Solutions (COINS), Ramsey Exchange, ebuildTM, VHCOMETM and Persimmon. The UK Government Office of Commerce (GOC), at the time of writing this thesis, is attempting to set up its own hub, at its own cost. Whilst these hubs offer tremendous benefit to the buyers, they have few advantages to the suppliers. The GOC project, called Zanzibar, will be free to users and will go live in November 2005. The author is of the opinion that, without the buyer's buy-in, they are unlikely to succeed, as it has to be a win-win situation for all parties, for it to work effectively.

2.3.3 Examples of Electronic Commerce Models in Construction

Coetzee and Boshoff (1998) described how the South African construction industry was developing a product called eZbuild in collaboration with IT companies and the major banks. eZbuild consists of a core building product library, tender management and bill of materials systems, integrated with an Internet enabled ordering and payment gateway. eZbuild gives contracting companies access to building material suppliers, via the Internet, from a compiled bill of materials. The core information element of the eZbuild procurement process is the bill of quantities. The construction site can request delivery of items from the electronic shopping mall, through an Internet browser. The electronic shopping mall generates an electronic order. The order is forwarded to the supplier by means of a structured email, who then delivers the material to the site. Acceptance of

materials delivered to site is communicated back into the project server against items ordered. This immediately makes the information available for cost control purposes at head office. The supplier confirms delivery of items on the construction site by emailing the information back to the electronic shopping mall. The electronic shopping mall generates an invoice. The invoice is forwarded to head office by means of a structured email. Head office downloads information from the electronic shopping mall into their accounting system. Payment can be effected by instructing the electronic shopping mall to transfer funds from the contractor's bank account to that of the supplier.

Kong et al., (2001) presented an eProcurement system that was being adopted in China. The system was called Construction Materials Exchange (COME). The system adopts an on-line delivery model of operation. It is a trading model based on the eMarket model, which enables buyers and suppliers to execute EC. Currently the professional version of the EC system has over 2,000 buyers, 29,000 suppliers and 1,000 agents registered in the COME system. The system contains over 2,000 construction materials classified into 17 categories with a maximum of 4 levels of information. With this structure, the search for product information commences at a general level. If more specific information is required, then the searching process led to the next level of information. A General Package Radio Service (GPRS) system is provided to assist the search of material information in specific geographic regions of China. By using GPRS, the buyers define the searching areas by selecting the cities on the map or by specifying a circular area with a given central point and its radius. The system will then find all suitable material information within an area with associated costs for transporting the material and/or products from the suppliers to the buyers. The continued commercial existence of COME was confirmed by Li et al., (2003), in their paper on GPRS technology for EC applications in construction.

In 2002, the CII carried out a comprehensive study of EC applications in the US construction industry (CII, 2002a). Their findings showed that there were four main types of EC models being deployed in the US construction industry at that time, namely:

- E-mail communication – simple replacement of the passage of paper with the use of an electronic format of the same documents, coupled with an audit trail of communications.
- Basic supplier-focused Electronic Procurement (eProcurement) for catalogue items – using the services of suppliers who make their catalogues available online.
- Buyer/supplier integration using common eProcurement packages – in this situation there was an intimate connection between the buyer and the supplier that is often accomplished through the use of the same software package and, perhaps, service provider.
- eMarkets hosted by third parties – though this was a model that many thought would dominate, many of these approaches have failed as participants, especially suppliers, decided they did not need a middle entity between them and their customers (CII, 2002a).

The CII study concluded that many organisations did not know what issues to consider. The researchers found that EC was much more a people and culture effort and less of a technology or process effort. They further concluded that owners were leading the implementation of eProcurement models, with the greatest successes occurring with Maintenance Repair Operation (MRO) and commodity-type items.

Ruikar et al., (2003) suggested that re-engineering of the construction business process through EC could be facilitated through the use of the 'Information Channel' (IC) developed by BIW Technologies in the UK. The IC is an online project collaboration tool where building industry participants can collaborate with their partner and clients using Web technologies. According to Ruikar et al., (2003), with the help of the IC, the entire construction supply chain can communicate and archive information (records of what was done, when, by whom etc.) throughout the lifecycle of the construction project. Following a detailed review of this research work, the author is of the opinion that this work is wholly impractical and would not achieve a re-engineering of construction business processes.

Perera and Karunasena (2004) developed a Construction Materials Management System (CMMS) to overcome the drawbacks associated with materials management in Colombo, Sri Lanka. The CMMS product has five modules, that is, materials requisition, purchase, delivery, reports, and system maintenance. CMMS was developed by three very large Sri Lankan contractors, in order to ensure its ability to address their material management needs.

An interesting, but impractical approach, in the authors' opinion, is the concept of an Electronic Purchasing Agent (EPA), as advocated by Hadikusumo et al., (2004). In most of these B2B portals, suppliers have to key-in their material data and price into the portal database. Contractors accessing the system have to browse the portal to retrieve supplier and material information. In terms of reliability, if a supplier failed to update their product data in a B2B portal database, the contractor will not receive the most up-to-date information. In order to solve this problem, Hadikusumo et al. suggest a proactive means of electronic purchasing, where a supplier has to maintain its own servers that store material data, and the contractors buyers visit the suppliers database for retrieving the necessary information. The EPA was developed adopting this rationale but has not been commercialised.

2.3.4 Importance of Supply Chain Management in realising eCommerce in Construction

The term supply chain refers to "the links between a firm and its supplier, through to its distribution organisation and on to its customers" (Moore, 1998). In other words, a supply chain is a buyer-supplier relationship (Patterson et al., 1999). In a construction context, a supply chain refers to the linkages of those parties participating in a construction project, since they are all involved in the supply of resources. Cox (1990) and New (1997) have suggested that supply chain research in construction should focus on the development of interactive inter-organisational relations such as partnering. The construction industry is fragmented and adversarial in nature, which led to poor communication and inefficient information practices that have contributed to the emergence of dysfunctional supply chains (Love et al., 1999). Loraine (1994) advocated a network structure of organisational

relations as is found in the concept of partnering. Figure 2.8 illustrates two simplified structures adopted in the construction supply chain.

Note:
(a) is a traditional vertical structure. The client or the developer of the construction project leads the whole project in these hierarchical work relationships.
(b) is a network structure. All parties are sharing their resources or competencies in the construction network. This seems to be a value-added component to the traditional contracting structure.

Figure 2.8. Two simplified structures of construction supply chain (Cheng et al., 2002)

Structure (b) differentiates itself from the traditional vertical relationship shown in (a) in Figure 2.8, as it encourages responsiveness, cohesiveness, flexibility, inter-operability and compatibility (Cheng et al., 2002). ICT has a pivotal role to play in improving communication and coordination in construction by acting as an enabler of change (Love, 1996). ICT can be used to support e-business between organisations in the construction supply chain.

Supply chain processes and relationships increasingly are designed to exploit changes in technology. Changing supply chain processes have evolved from classic paper-based systems and documents, towards re-engineered processes that involve electronic capture and transmission of less document information. Supply chain relationships have evolved from loosely coupled relationships into virtual organisations, coupled with integrated ERP systems (Broens et al., 1999).

Atkin et al., (1995) researched into improving supply chain management in the UK construction industry. Particular recommendations were the utilisation of an electronic communications infrastructure, shared project planning information direct from project planning packages and electronic processing of orders and payments within supply chain relationship frameworks. Atkin concluded that the supply chain relationship frameworks would be the essential element to enable parties to a construction contract to trade

electronically. This form of work has found success in other industries, particularly automotive manufacturing (Womack et al., 1991).

In focusing upon the construction industry, Grilo et al. (1996) found that the main reason for the lack of electronic trading relationships is the unwillingness of either party to invest in a technological infrastructure that is characterised by the inherent risk of managing a supply relationship within an unclear legal framework. The litigious nature of the construction industry provides a strong barrier to electronic trading. The trading power of large buyers has been a method by which other industries have forced electronic trading onto suppliers (Atkin et al., 1995). Despite the inherent difficulties of trading electronically within the context of the UK construction industry, there are examples of contractors forming partnering relationships that rely on electronic trading (Nunn, 1995). The commercial issue of using ICT to manage suppliers has been well addressed in other industries. Hammer and Champy (1993) described how the Ford Motor Company had dispensed with invoices and rationalised its supplier and inventory management processes utilising the leverage of ICT.

Due to the rapid changes in construction, the relationship between ICT and SCM now appears to be so close that it has even become difficult to establish whether ICT is a driving force or is simply an enabling technology. Hanfield and Nichols (1992) suggest that ICT tools should not be used in a vacuum. They must be integrated into a system that brings customers, suppliers and all activities in the supply chain together. The central concern to the individual supply chain member, from an ICT perspective, is the design systems that facilitate open and rapid communication and information sharing across the supply chain. Once a supply-chain wide connection has been established, steps should be taken to (1) eliminate the need to re-enter information at each step of the order processing, (2) more closely integrate supply chain partners by providing them with real time status information and (3) connect the organisation more effectively into the larger EC community. Establishing integrated supply chains that provide end customers and supply chain member organisations with the materials required, in the proper quantities, in the desired location, at the right time and at the lowest possible cost lies at the very heart of SCM (Handfield and Nichols, 1992).

O'Leary (2000) described how supply chain processes and relationships are increasingly designed to exploit changes from classic paper-based systems and documents, towards re-engineering processes that involve electronic capture and transmission of less documentation. Classic communication between supplier and buyer involves mainly paper-based systems. O'Leary (2000) contends that, increasingly, those paper-based processes are being replaced using EDI. Millman (1998) estimated that the cost of processing a paper-based purchase order was $70, whereas the same transaction performed through EDI would cost less than $1 per purchase order.

2.4 THE USE OF ICT IN ACHIEVING BUSINESS PROCESS RE-ENGINEERING

ICT should enable a firm to become more efficient and effective. In many instances, anticipated benefits fail to materialise until many years after a firm introduces a new ICT application (Alserhan and Brannick, 2003). ICT investments must be accompanied by careful re-engineering of organisation processes, in order to obtain many of the anticipated benefits of the investment. Yet, time and time again, organisations fail to redesign and restructure their business in ways that best utilise these new resources (Tam, 1998). Effective implementation of ICT depends on the organisation's vision of change, so a distinction should be made between the automation and the information roles of ICT. Automating means applying technology, in order to minimise human intervention. Reducing this intervention in production and administration will cut costs and increase flexibility (Davis, 1992).

Technology is a tool that can improve efficiency and effectiveness when applied appropriately to a process. Therefore, the decision maker must carefully assess the process to determine when and where the application of technology is most appropriate and what technology should be selected. If the process itself is flawed then a process improvement programme must be undertaken before the process is automated.

Hammer (1990) concluded that it is not enough to simply impose isolated software packages or systems to address a perceived inefficiency, as this will not result in significant and radical improvements in the business process. In order to achieve this, the

current processes, problems and opportunities for re-engineering must be fully understood and this re-engineering must be founded on a complete reappraisal and re-design of the entire purchasing process from sourcing to final payment of suppliers.

2.4.1 Principles of Business Process Re-Engineering (BPR)

BPR represents an effort to redesign and re-organise a managerial or operational process, in order for an organisation to obtain dramatic improvement in performance and competitiveness (Hammer and Champy, 1993). In their book 'Re-Engineering the Corporation', Michael Hammer and James Champy defined "Re-Engineering" as "the fundamental rethinking and radical redesign of business processes to achieve dramatic improvements in critical contemporary measures of performance, such as cost, quality, service and speed." They further described BPR as a holistic process that led to a complete organisational transformation and stabilisation.

As described earlier, an organisation's business processes are the activities that use various kinds of inputs to create an output of value to the customer. An organisation operates numerous business processes to attain its goals. In the process of BPR, an organisation fundamentally rethinks and radically redesigns its business processes to achieve dramatic improvements in measures of performance such as quality, cost, speed and services.

The implementation of BPR involves many concepts, some of which have been known for several decades, but they were formalised only in the late 1980s and early 1990s when the term "BPR" was coined. When BPR was first implemented, it usually involved a significant break with past business rules and practices - almost requiring an organisation to start over from scratch.

This extreme view of BPR has modified somewhat. It is no longer considered necessary to destroy everything and start anew. Instead, BPR is viewed as a flexible approach that can be executed by proven methodologies and principles (Harrington, 1991 and Betts et al., 1991).

2.4.2 The Enabling Role of ICT in achieving BPR

ICT has been used for several decades to improve productivity and quality by automating existing processes. Hammer and Champy (1993) described how Ford Motor Co.'s accounts-receivable department brought about a reduction from 400 people to 125. This was a quantum change – not an incremental or minor process improvement. The case study illustrates how ICT helped to redesign a process to result in dramatic cost reduction. As part of its productivity improvement efforts, Ford management thought that by streamlining processes and installing new computer systems, it could reduce the head count of its accounts payable department by some 20 percent, to 400 people. But after visiting Mazda's payables department (part owned by Ford), Ford managers increased their goal to an accounts payable process with only 125 clerks.

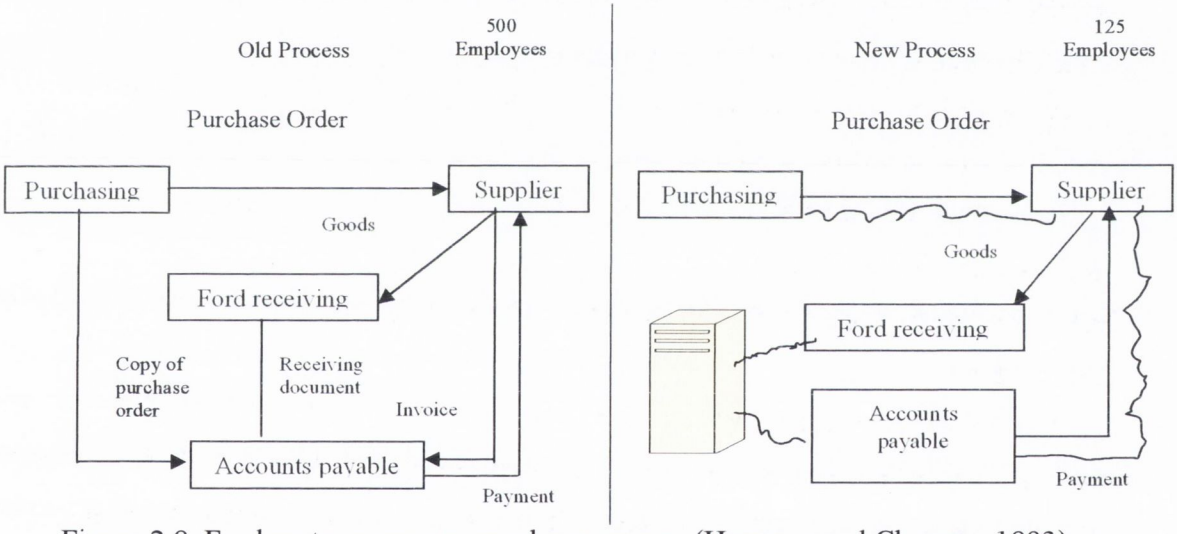


Figure 2.9. Ford motor company purchase process (Hammer and Champy, 1993)

The re-engineered process, illustrated in Figure 2.9 involved the purchasing department initiating an order and entering the information into an online database. Analysis of the existing system revealed that when the purchasing department wrote a purchase order, it sent a copy to Accounts Payable. Later, when Materials Control received the goods, it sent a copy of the receiving document to Accounts Payable. Meanwhile the vendor also sent an invoice to Accounts Payable. If the purchase order, receiving document and invoiced matched, then Accounts Payable issued a payment.

Unfortunately, the department spent most of its time on the many mismatches. To prevent them, Ford instituted "invoiceless processing".

Ford did not send a copy of the purchase order to anyone. The vendor receives notification through EDI. When the goods arrived at the receiving dock, the clerk checks the database to see whether the goods corresponded to an outstanding purchase order. If so, the clerk accepted them and entered the transaction into the computer system (if there was no database entry for the received goods, or if there was a mismatch, the clerk returned the goods).

Under the old procedures, the accounting department had to match 14 data items among the receipt record, the purchase order, and the invoice before it could issue payment to the vendor. The new process requires matching only four items - part number, amount, unit of measure, and supplier code - between the purchase order and the receipt record. This matching was done automatically and the computer printed the cheque, which Accounts Payable sent to the vendor (or an electronic transfer is done). There were no invoices in the system as Ford asked its vendors not to send them.

2.4.3 Re-Engineering Construction Processes

It is possible to assign two meanings to the expression "re-engineering construction". The first is exemplified by sources such as Betts and Wood-Harper (1994), McGeorge and Palmer (1997) and Mohamed (1997). The concern is how to apply Hammer and Champy's (1993) recipe of BPR to the construction industry. The overriding assumption, according to Green et al, (2004), is that BPR has already been successful in other sectors, that are supposedly more advanced in terms of management thinking. The challenge is how to apply the proven technique of BPR to a fragmented and project-based construction industry.

There are a number of difficulties with this approach. First BPR defies universal definition. The terminology is vague and imprecise, such that it is impossible to distinguish BPR from other management improvement recipes (Jones, 1995). Empirical work by De Cock and Hipkin (1997) compared the implementation of BPR with Total Quality Management (TQM), concluding that the concepts can only really be

distinguished in terms of the rhetoric in which they are presented. Despite such problems about lack of definition, BPR has earned a reputation for its "slash and burn" approach (Buchanan, 2000). An extensive literature review in the area of BPR associates BPR with regressive approaches to human resource management (Grey and Mitev, 1995; Grint and Willcocks, 1995; Willmott, 1995; Mumford and Hendricks, 1996). According to Green et al, (2004), the only aspect to BPR that remains consistent is the quest to secure greater output from fewer employees.

The second interpretation of "construction re-engineering" owes no specific allegiance to Hammer and Champy (1993), but to more modern labels that embrace compatible managerial ideas, such as lean construction, supply chain management and partnering. The Egan Report (Egan, 1998) defined lean construction as "a powerful and coherent synthesis of the most effective techniques for eliminating waste and delivering significant sustained improvements in efficiency and quality". Green et al., (2004) suggest that lean construction and BPR share the same characteristics, as they are both rooted in the same ideological discourse.

2.4.4 Steps for BPR

Li (1996) suggested a methodology for implementing re-engineering in construction, which involved four essential steps. Figure 2.10 illustrates that each step involves an experimental loop in the progression of problem solving. The experimental loop typically includes formulating prototypes; testing prototypes and discarding them before solutions take shape.

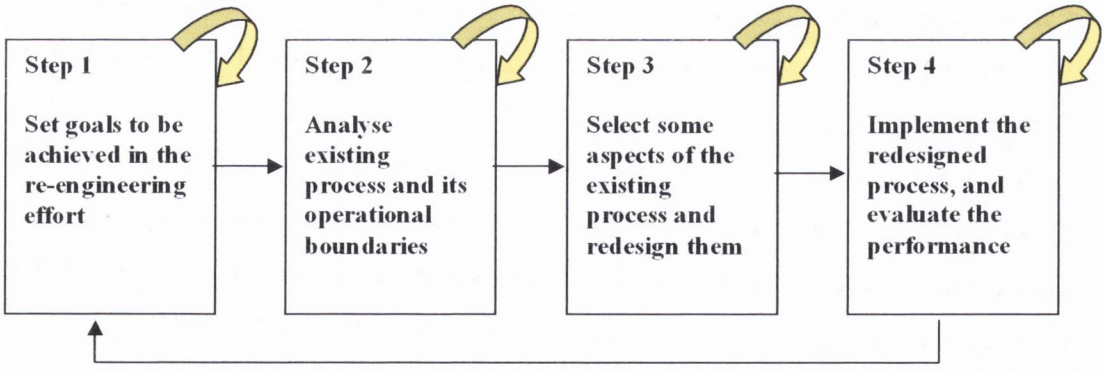


Figure 2.10. Re-engineering process (Li, 1996)

Step 1. Set goals for re-engineering

It is important that the re-engineering team set clear and measurable objectives at the outset of the re-engineering process.

Step 2 – Analyse existing process and its operational boundaries

In analysing the existing process, focus should be directed to understanding the problems and inefficiencies that exist within the current business process.

Step 3 – Select aspects of the existing process to redesign

Re-engineering the entire process is not a practicable suggestion. It is recommended that some sub-processes are identified and creative solutions sought to resolve the problem areas (De Pena and Fisher, 1994). Particularly non-value added activities and activities that consume large amounts of time should be highlighted for re-engineering.

Step 4 – Implement and evaluate the new process

Implementation translates creative solutions into a new construction process. It is important that the new process is piloted for a period of time. Results from the new process should be collected and the evaluation results will indicate whether the re-engineering goals are achieved. It may be necessary to go back to Step 3 to redesign the selected re-engineering aspects.

2.4.5 Re-Engineering the Purchasing Process in Construction

The need for the construction industry to adopt innovative ideas and methodologies in its operation has been emphasised in several initiatives and government reports, such as the the Egan report (Egan, 1998), Latham report (Latham, 1994), etc. However according to recent research, there is a lack of defined or clear objectives within the industry regarding EC adoption (Ruikar et al., 2001). In order to take on board new technologies and avail of the benefits technologies like EC can offer, it can sometimes become essential to re-engineer the current business processes (Ruikar et al., 2003).

O'Leary (2000) identified a number of ideas that could be applied to the purchasing process in the manufacturing industry to assist in speeding up transactions and improving the quality of the information, including: -

- EDI to facilitate speed and quality of information interchange;
- gathering information directly from the source, rather than have one accountant talk to another;
- elimination of invoices, saving administrative work;
- using bar-coded labels to help eliminate invoices and facilitate improved quality of information;
- automating the matching of goods ordered and received;
- developing different payment triggers, such as paying for inventory when received or used;
- interfacing with ERP software to facilitate inter-organisational interchange, and
- developing virtual organisations through integration of their supply chains.

O'Leary (2000) suggests that the origination of purchase orders can be re-engineered by directly inputting information into an electronic form rather than cascading through paper and then into an electronic format. He suggests that in some situations the supplier may better understand the consumer needs and thus be in a better position to write the purchase order and choose how much should be ordered. O'Leary advocated that receiving a memoranda can be accompanied by bar code tags, originating from the vendor, containing information as to who shipped the goods, what goods are contained in the shipment, how much was shipped, etc. These tags could in turn be scanned with the result that the bar coded information is then directly captured in an electronic format.

O'Leary also radically suggested that the process would be better served with the elimination of the invoice. Invoices differ from the purchase order and receiving memorandum (both generated internally), because they provide external evidence of the purchase. As a result, one of the primary forces for keeping invoices is concerned with classic internal controls, such as the internal or external auditor. In some countries the concern for control afforded by invoices is embedded in the law. For example, Belgium,

requires that all invoices be issued for purchases. O'Leary argues that, the more invoices there are to process, the more errors on the invoices and the more errors in the matching. Generating and processing invoices has a large administrative cost, typically measured on a per invoice basis.

Hammer (1990) explained that in the case of the Ford Motor Company, invoices were not needed if all other systems work as they are supposed to. If the supplier sends what is on the purchase order, then the purchase order and the received quantities should be the same. Also if the goods are accompanied by a bar coded summary of the goods, then that information can substitute as an invoice.

O'Leary further examined how to re-engineer the matching of the purchase order, delivery docket and the invoice. O'Leary suggested that re-engineering the matching process has taken two directions. First, the matching process is designed to use electronic-based information, such as direct entering of information from purchasing, scanning received information and using EDI to communicate invoice information. Second, the number of items being matched has been reduced at firms such as Ford (Hammer, 1990). Rather than matching the purchase order, the receiving memorandum and the invoice. O'Leary suggested that only the first two are matched, as the information on the invoice should be redundant.

2.5 CONCLUSION

It is clear that a great deal of inefficiency exists in the mainly paper-based purchasing process deployed predominantly in the construction industry. Currently at each stage of the procurement process there are discrete activities to be carried out that typically involving the creation of various printed documents, faxing, photocopying, scanning, posting and re-keying of information into computer databases, by both contractors and suppliers, all of which can be supported by ICT (Kong et al., 2001). The key causes of this inefficiency include, a fragmented industry, the temporary nature of construction, the uniqueness of construction and a dependence on a single-project model. This has led to poor communication and inefficient information practices that have contributed to the emergence of dysfunctional supply chains (Love et al., 1999).

Atkin et al., (1995) and Grilo et al., (1996) found that the reason for the lack of electronic trading relationships in construction lies in the unwillingness of either party to invest in a technological infrastructure that is characterised by the inherent risk of managing a supply relationship within an unclear legal framework

Improved productivity levels and greater efficiency are possible by the use of an integrated ICT EC solution. There are an array of appropriate technologies, data exchange standards and alternative EC models currently available to support the sourcing, ordering, receiving and payment of materials in the construction industry. Hore and West (2005b) provided examples of EC models currently being adopted in South Africa (Coetzee and Boshoff, 1998) and in China (Kong et al, 2001). The CII 2002 study into the State-of-Art of EC in the US construction revealed that many US construction organisations did not know what issues to consider (CII, 2002a). Research found that EC was much more a people and culture issue and not so much of an ICT or process issue. They further concluded that private owners were leading the implementation of eProcurement models, with the greater successes with MRO or commodity type products.

More recent research by Ruiker et al., (2003), Perera and Karunasena (2004) and Hadikusumo et al., (2004), suggest that the focus is on incremental improvement rather than re-engineering. Supply chain processes and relationships increasingly are designed to exploit changes in technology. Changing supply chain processes have evolved from classic paper-based systems and documents, towards re-engineered processes that involve electronic capture and transmission of less document information (Broens et al., 1999).

The author contends that the industry in Ireland is in strong need of a re-engineered solution, enabling an electronic three-way match of the purchase order, delivery docket and invoice data, thus causing a dramatic improvement in both productivity and overall administration costs. Chapter 8 will seek to present this re-engineered solution.

CHAPTER 3

2002 OBSERVATION STUDY: TRADITIONAL CONSTRUCTION PURCHASING PRACTICE IN A LARGE IRISH CONTRACTING ORGANISATION

3.1 INTRODUCTION

This Chapter concentrates on an independent observation study carried out in 2002, on the relative weaknesses of the material purchasing procedures adopted in a large Irish contracting organisation. Data was gathered from quality manuals, interviews and by direct observation of the procedures over a defined period. The study confirms and quantifies the current inefficiencies within the traditional purchasing procedures adopted in construction and concludes that there is a business case for re-engineering the purchasing procedures in the company observed and by inference, in other similar organisations.

3.1.1 Purpose of Study

The purpose of this study was to observe the weaknesses present in the administration and management systems used for the ordering, receipt and payment of building materials. The principal research problem was to advance an understanding of the practical issues that faced personnel in the administration of purchasing procedures in a large contracting organisation.

This study did not seek to measure the cost and time associated with the traditional purchasing procedure. The observation study results simply sought to identify the problems experienced with traditional paper-based purchasing procedures adopted in contracting organisations.

3.1.2 Methodology

The methodology adopted in this study broadly involved four core stages :

- *Stage 1* – Reading company literature on material purchasing procedures. Documentation consulted included reference to the company quality manual, which was explicit in regards to company procedures.

- *Stage 2* – Interviewing of key staff. This involved carrying out interviews with personnel from purchasing, accounts and a selection of site staff. The purposes of these interviews was primarily to identify the perceived weakness of the material purchasing function.
- *Stage 3* – Selection of a suitable case study project. A case study project was selected following advice from the eastern regional purchasing manager.
- *Stage 4* – Identification and monitoring of particular supplier transactions for a defined period. Three suppliers were selected to reflect a range of material types, namely: -

    - Supplier A – Supplier of specialist concrete fixing products.
    - Supplier B – Supplier of ready mix concrete.
    - Supplier C – Supplier of general building materials.

The selection of alternative supplier types ensured that the study would involve observing of both single product and bulk product type transactions. Supplier transactions over a three-month period were monitored from initial requisition to final payment.

3.2 OBSERVED PURCHASING PROCEDURES

3.2.1 Overview of Company Organisation

The company observed was one of the largest building contracting firms in the Republic of Ireland, with offices in Cork, Dublin, Galway, Sligo, Limerick and Waterford, as well as having substantial overseas involvement. The company operated a centralised purchasing procedure in their eastern and western regions and a de-centralised purchasing procedure in the southern regional office.

The management structure of the observed company is shown in Figure 3.1.

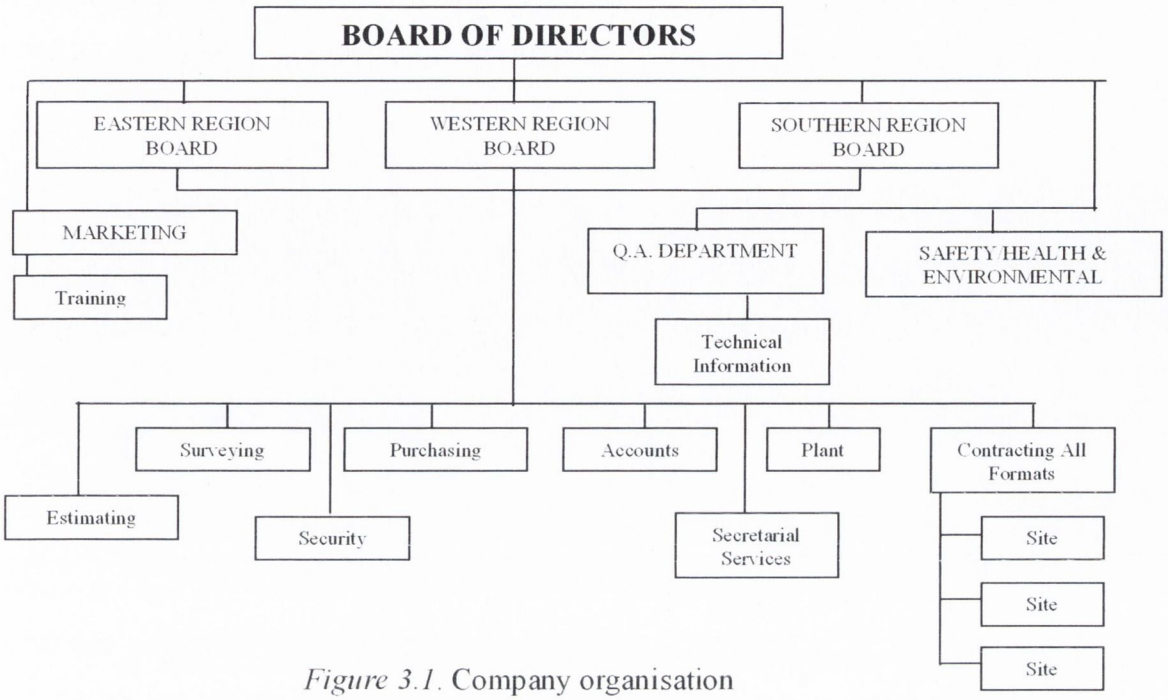


Figure 3.1. Company organisation

3.2.2 Company Quality Procedures

The company possessed a quality manual, which described the organisation, delegation of responsibility, and procedures, which were followed, in order to achieve the company's objectives.[1] Directors and project managers were required to establish and maintain standing instructions and procedures to ensure that the work for which they were responsible meets the requirements of BS EN ISO 9002:1994.

3.2.3 Overview of Purchasing Procedures

The purchasing function was identified as a separate operation under Section 5.0 of the approved quality manual. Each region had a separate purchasing unit, with little or no linkage. This was confirmed in the quality manual with the inclusion of alternative procedures for purchasing materials generally and purchasing materials in the southern region. In effect, the eastern and western regions had an office based purchasing function,

[1] The corporate objective was stated in the Quality Manual as " To achieve continued profitability through construction activities which conform to customers specified requirements".

whilst the southern region had a site based purchasing procedure. The main reasoning for this divergence was established practices within these particular operating regions over many years.

3.2.4 Purchase Order Procedures

In the eastern region the purchasing department consisted of three full time staff, which included one senior buyer. All three staff shared the daily workload, however, the senior buyer had overall responsibility for the department. The typical daily workload of the staff included negotiating price listings with suppliers, checking all material requisitions, issuing purchase orders, sourcing new suppliers and prices, updating suppliers price lists and filing material requisitions and purchase orders.

The process for raising a purchase order is shown in Table 3.1. The quantity surveyor was responsible for preparing a materials schedule (standard form) within one month of the contract start. It was necessary for the quantity surveyor to update the schedule if there were substantial amendments to the contract documentation. The quantity surveyor normally requisitioned major orders for nominated suppliers e.g. sanitary ware, ironmongery etc., ready mix concrete and cut and bent reinforcement. The procedure provided for major material orders and verbal orders included:-

- *Material requisitions and formal purchase orders* - The project team, in consultation with the estimator, identified the material requirements at the start of the contract. The project team prepared the material requisition (standard form). Upon receipt of the material requisition the purchasing department prepared a formal purchase order.
- *Verbal orders* – Verbal orders could only be placed by persons authorised by the contract manager. A material requisition was prepared as soon as possible after placing the verbal order.

Material requisitions were normally faxed to the purchasing department. The purchasing department in turn checked the requisition for the correct authority level; correct completion; compliance with verbal orders and entries in the "remarks" column.

On completion of the checking process the purchasing department would obtain prices either by obtaining quotations or using the most up-to-date paper copy price list. The purchasing department would progress to check the quotation (when obtained) against the information on the material requisition for the correct description of the material; date required on site and quantity required. The process would conclude with the selection of a suitable supplier and the preparation and issuing of a purchase order.[2]

	Eastern and Western Regions	**Southern Region**
Purpose	To control the purchasing of material so as to ensure that suppliers have a clear understanding of Company requirements.	
Scope	This procedure applies to contract related materials in Eastern and Western Regions.	This procedure applies to the Southern Region.
Users	Quantity Surveyor Contract Team Purchasing Department	Quantity Surveyor Contract Team Office Clerk
Documentation	Materials Schedule Purchase Order Site Material Requisition	Materials Schedule Purchase Order Site Material Requisition Site Order Book
Outline Procedure for Main Contracts	Material Schedule by Quantity Surveyor ↓ Agreed by Contract Team ↓ Contract team issues Material Requisitions to Purchasing Department ↓ Purchasing Department issues Purchase Order	Material Schedule by Quantity Surveyor ↓ Agreed by Contract Team ↓ Contract team issues Material Requisitions to Quantity Surveyor/Office Clerk ↓ Quantity Surveyors issues Purchase Order

Table 3.1. Eastern Region purchase order procedures

Site copies of purchase orders were either collected or posted weekly and copies of purchase orders were forwarded to accounts weekly. The purchasing department retained

[2] Approximately eighty percent of all purchase orders were posted to the suppliers with 20% faxed directly to the supplier depending on the urgency of the delivery.

copies of purchase orders and cross-referenced material requisitions with purchase orders. Unlike the eastern and western regions the southern region used a site order book facility.

3.2.5 Receiving Materials

The site agent assigned personnel named in the project quality plan to receive and check materials on arrival at site. These assigned persons checked material on receipt against the delivery documents. The assigned person recorded acceptable material received on-site on Goods Received Notes (GRNs) and attached the supplier's delivery dockets to this form. The material returns were sent to the accounts department weekly and site retained the top copy on site.

Where the material on receipt had been found on inspection to be unacceptable the assigned persons notified the site agent. The site agent notified the contracts manager who raised a site non-conformance report form. In turn, site returned the material to the supplier immediately or identified and stored material in such a way that would prevent its use while arrangements were made for its removal from site. The process for receiving materials on site is shown on Table 3.2.

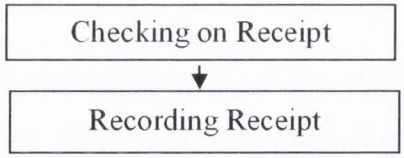
Purpose	To control the receipt and storage of material on-site.
Scope	This procedure applies to material incorporated into contract works.
Users	Site Agent Assigned Persons named in Project Quality Plan (to check material on receipt)
Documentation	Site Non-conformance Report Confirmation of Inspection Material Received Site Daily Diary Sheet Controlling Non-conformance
Outline Procedure for Main Contracts	

Table 3.2. Receiving and storing materials procedures

3.2.6 Payment Process

There was no formally documented procedures for payment of invoices. The payment of material invoices was centrally administered by the accounts department. The department was managed by a head of processing who was responsible for 12 clerical staff, as illustrated in Figure 3.2.

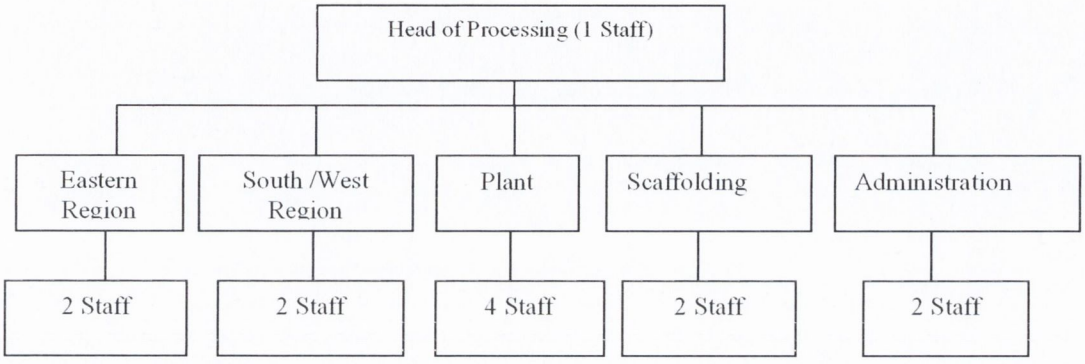


Figure 3.2. Organisational structure of accounts department

All correspondence arriving by post, such as statements, letters, invoices and credit notes, were sent to the head of processing, who then passed them to relevant staff. GRN and accompanying delivery dockets were either handed in directly, couriered or posted to the accounts department. The head of processing was responsible for all concrete and filling material suppliers throughout the country and the balance of correspondence was divided between two staff members, broadly divided into eastern region and southern/western sections.

Invoices were then passed onto relevant staff who proceeded to input the invoice details into the Binary system. Once a particular batch of invoices had been inputted, a register printout of those invoices (including the batch of invoices) were handed back to both the eastern section and the southern/western sections. All invoices received were logged onto the Binary system within 24 hours of receipt, by the particular section. Once returned to the section a single staff member was responsible for checking the register printout for completeness and then proceeded to match the purchase order and delivery docket to the particular invoice. A pre-printed sticker was then placed on each invoice by the inputting staff. The sticker provided a facility to record the region, division, main

contract reference or special contract reference, together with a nominal ledger code[3], as illustrated in Figure 3.3 below.

REGISTER NUMBER		*V.A.T.*	*REGION*	*DEPT.*
CONTRACT NO.	*N.I.*	*CODE*	*VALUE*	
REG. BY:			*PAID BY:*	

Figure 3.3. Invoice allocation sticker

Payment was only made if the matching exercise had been completed successfully in full. In some cases where there was a call-off order, the purchase order was photocopied and attached to the matching invoice. Invoices that were successfully matched to purchase orders and delivery dockets were handed back to the persons responsible for processing payment. Those invoices that were not successfully matched were put to one side until the necessary paperwork was located and matched to the invoice. The matching exercise involved contacting the supplier and requesting credit invoices, proof of delivery etc. The accounts department requested that all invoices were issued by suppliers in duplicate. The top copy was kept by the accounts department and the duplicate was sent to the site for their records[4].

A cheque run occurred twice a month, when staff acted on priority payments. The majority of invoices were paid electronically directly into the supplier accounts. There was a facility to return an invoice to the supplier where there was no matching purchase order. Following the processing of payment, all invoices were filed numerically using the pre-printed allocated reference number. A summary of the purchasing procedures in the eastern regional office is illustrated in Figure 3.4.

[3] This may be materials, preliminaries, external plant or internal plant.
[4] These invoices were normally sent in weekly batches. The purpose of the site copy was to allow the quantity surveyor to check the invoice details against the monthly cost printouts.

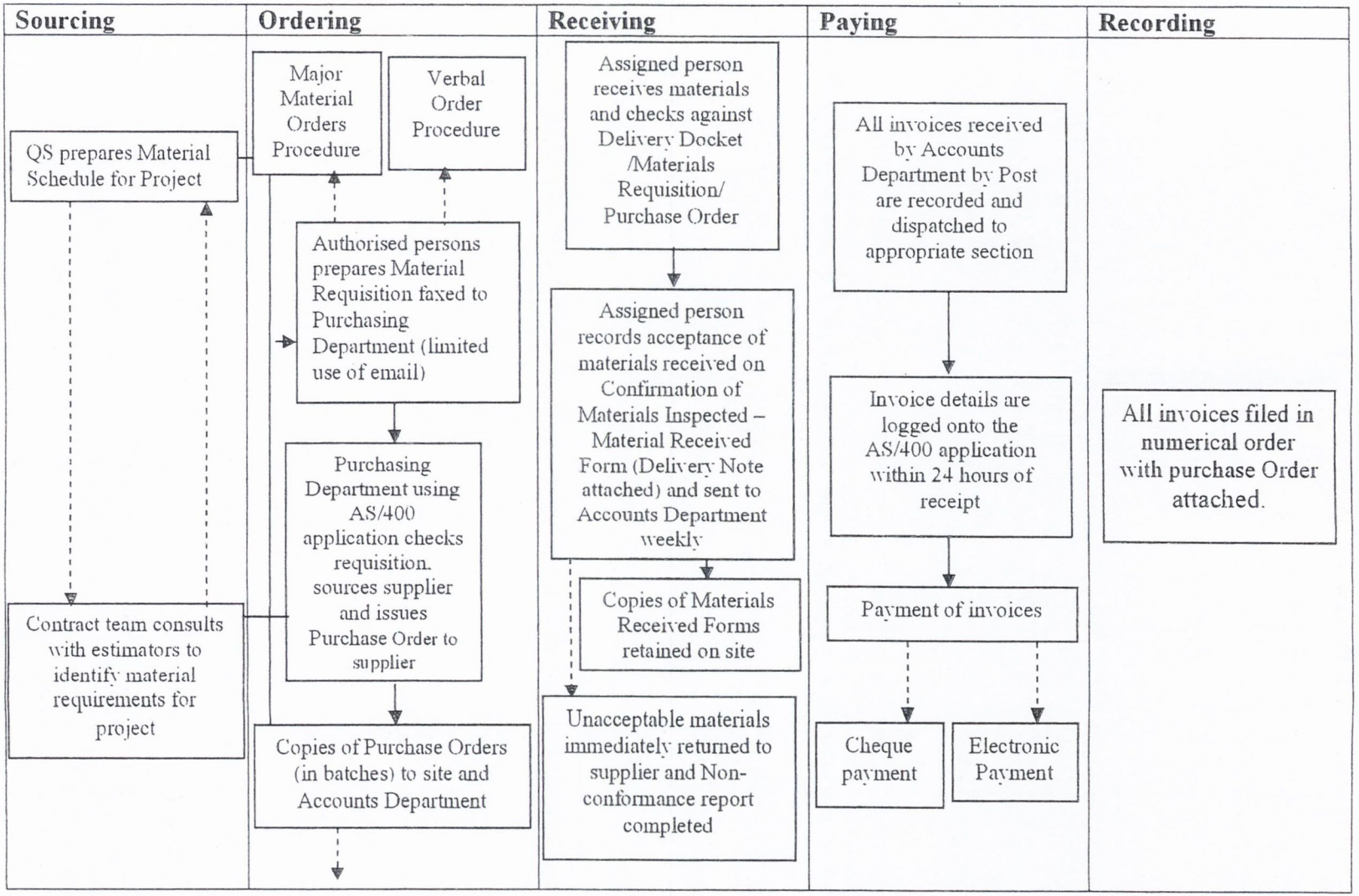


Figure 3.4. Observed Material Purchasing Process

3.3 PERCEIVED WEAKNESSES OF THE SYSTEM

The senior buyer of the eastern region identified the weaknesses of the current purchasing system, as follows :

- insufficient notice given by site to head office to procure materials;
- insufficient information on the material requisition completed by the project team;
- too much time was taken updating supplier price lists;
- no access to the bill of quantities for the purchasing department;
- apparent lack of co-ordination between production staff and quantity surveyors on site and
- an ad hoc approach to material requisitioning generally.

When asked what improvement, if any, could be introduced, the senior buyer suggested the following improvement measures:-

- each site should go through material requirements earlier in the contract and give the purchasing department due notice of such requirements;
- include on the material requisition an indication of the budgetary allowance for that material;
- ensure that material requisitions when completed are as comprehensive as possible and
- introduce a facility to email suppliers for price listing updates.

The head of invoice processing in the southern region identified the endless copying of invoices for query purposes, incorrect prices on invoices and mislaid delivery dockets,[5] as the main weaknesses of the system. There was a general lack of awareness by site personnel that holding onto delivery dockets can cause serious delays to payments of supplier invoices.

[5] This problem is more pronounced where a courier delivers to site. There is a tendency for site personnel to throw out the dispatch note, which is attached to the packaging.

3.4 COMPANY ICT INFRASTRUCTURE

The ICT system was founded on a combination of separate software systems operating largely in isolation from each other. Table 3.3 summarises the systems used in the company together with the purpose of their use.

System	Use	Comments
Binary	Finance (Accounts Payable, Accounts Receivable, Purchasing (East Region), Fixed Assets and Reporting.	The Binary system was a DOS based systems known as AS/400. It was installed in the company in 1992.
Plant	Plant	The plant package was a bespoke system that tracked internal and externally hired plant on construction projects.
Bank Reconciliation	Finance	The Bank Reconciliation was a bespoke system which assisted in the reconciliation of the cheque processing runs.
Microsoft Office - Word	All Departments Quality Documentation	General use including the production of the quality forms.
Microsoft Office - Access	Marketing Purchasing (West Region) Human Resources	Access databases have been set-up by a variety of departments.
Overture	Estimating	A specialist estimating package.
Buildsoft	Estimating Quantity Surveying	Buildsoft is used as a take-off tool when required. Some sites used Buildsoft to ease communication between sites and professional quantity surveying practices.
Power Project	Contract Management	PowerProject is used to manage the project's tasks on a time basis.
Timesheet Systems	Payroll Quantity Surveying	Various timesheet systems were used by some of the major projects to manage internal and external labour returns.
Worksafe	Health and Safety	Worksafe is used to track health and safety statistics and manage the insurance claim process.

Table 3.3. Company IT systems in use

The following observations were made following an investigation of the particular software deployed :

- *Binary* – The system provider had not enhanced the system (with the exception of the self-financed projects) since its original installation in 1992. The purchasing functionality was limited, as the price list data was "as-is", with no view to price history. Purchasing and account departments were not linked.
- *Plant* – The system did not integrate with Binary financials.
- *Bank Reconciliation* – The system did not integrate with Binary financials.
- *Microsoft Office Excel* – Whilst Excel was acknowledged as a powerful tool for ad hoc calculations and manipulation of information, the use as a valuation tool lead to a wide variety of formats used throughout the company.
- *Microsoft Office Word* – The format of the Word forms used for quality documentation were not user-friendly for entering information. Once entered, the information was not shared with a central system.
- *Microsoft Office Access* – The established databases are not shared throughout the company. Information held on these databases was mirrored in other manual and computer systems.
- *Overture* – There was no integration with current and historical cost data, and Supplier And sub-contractor data from the central system. Not all components of the estimate were completed on Overture.
- *Buildsoft* – The software was not used throughout the company.
- *Power Project* – This program was not being used to its full potential, with no link between financial planning and physical planning.
- *Worksafe* – The system quality was very poor. The functionality was far greater than the requirements, causing more work than was deemed necessary. Worksafe was not integrated to any other system.

As is evident in Table 3.3, many of the company departments ICT communications were in complete isolation from one another. There was an array of software solutions employed but with a very limited degree of integration.

In 2001, the company considered using the Marrakech extranet product. The product was a closed-loop extranet, where all customers (purchasers and suppliers) were registered participants and could trade only with other organisations nominated by them. It was decided not to purchase this product, as a more integrated business process solution was required.

At the time of carrying out this observation study, the company had purchased the COINS ERP software system. This provided a single, secure and consistent environment for all the common data within the company. At the time of carrying out the observation study, the system architecture was been installed, on a phased basis, and an on-going training programme of staff was underway. The purchasing module of the COINS system was not operational at the time of completing this observation study.

The software providers claim that the functionality will ensure that all the facets of the construction business would be integrated. For example, the purchasing department could create purchase order information that could readily be viewed by site personnel and the accounts department. The precise capabilities of the software was dependent on which modules the customers would select from the suite of modules made available by the provider. This was important, as not all the COINS modules on offer were selected for use by the contractor.

It will be seen in Chapter 8, that the author encouraged COINS to partake in a pilot project, in order to demonstrate that trading parties can achieve a three-way electronic match of the purchase order, delivery note and invoice, thereby bringing about a re-engineering of the purchasing process.

3.5 OBSERVED PROCESS FLOW CHARTS

This section of the Chapter attempts to map in detail the following purchasing processes observed in the company.

- Materials requisitioning and ordering
- Receiving materials
- Managing payables

A process map key is included in Table 3.4.

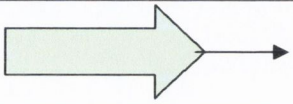
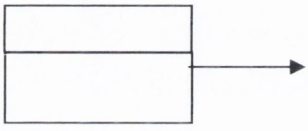
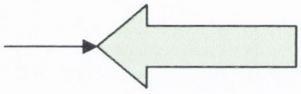
Process Map Key	
Purchasing Materials: Material Requisition & Order	**Process Category Process Name**
	**Start of Process** This may follow from another process
	**Process** The top box contains the name of the department undertaking the process. This lower box will be coloured to the system used to conduct the process. White is a manual process and yellow is the binary process).
	**End of Process** This may lead to another process.

Table 3.4. Process flow key

3.5.1 Material Requisitioning and Ordering Process Mapping

Materials were either purchased centrally or negotiated at site level. Site level negotiations usually included bulk materials of a high order value. The quantity surveyor obtained quotes for the materials. Once the supplier was selected, the quantity surveyor raised a requisition for the materials, including information about the items to be ordered, the quantity required, the supplier and the negotiated price. Purchasing checked the requisition and, if complete, raised a purchase order and send it to the supplier.

For centrally purchased materials, the authorised members of the contract team would raise requisitions to the purchasing department. This included the items and the quantities required. The purchasing department then checked the requisitions for completeness and authority. If the item was not on an existing price list, then the order would be raised

against the current negotiated supplier price. If the item did not appear on the price list, then the purchasing department obtained quotes for that material. Once the supplier and details were negotiated, the purchase order was raised and sent to the supplier. A copy of the order was sent to accounts and to the site. The Binary ICT system was used to raise and print the purchase order. Binary was also used to enter the current supplier price list. Price lists were updated by printing an existing price list from Binary and fax/posting this to suppliers to update suppliers on a regular basis.

The process flow chart for requisitioning and ordering materials is shown in Figure 3.5. The process shows 18 individual potential tasks in the creation of a purchase order. The most widely adopted observed route for processing the purchase orders is indicated in red and involved a minimum of 13 tasks. The author observed that the process was largely inefficient, with the preparation of material requisitions by hand, the manual checking of the requisitions, extensive photocopying and the manual re-keying of information to create the purchase orders. Table 3.5 summaries the tasks that are carried out manually rather than electronically in the material requisition process.

	Tasks	Manual/ Handwriting	Photocopy/ Printing	Manual keying of Info.
1	Check if materials are centrally purchased	√		
2	Prepare material requisition	√		
3	Send requisition to purchasing department	√	√	
4	Check material requisition for correctness	√		
5	Check if materials are centrally purchased	√		
6	Check if item on price list	√		
7	Up-date price list	√		
8	Select supplier	√		
9	Select supplier on Binary			√
10	Enter order and price on Binary			√
11	Post / print out purchase order on Binary	√	√	√
12	Post order to site	√	√	
13	Copy purchase order to accounts	√	√	
	Total	11	4	3

Table 3.5 – Tasks carried out manually rather than electronically in the material requisition and ordering process

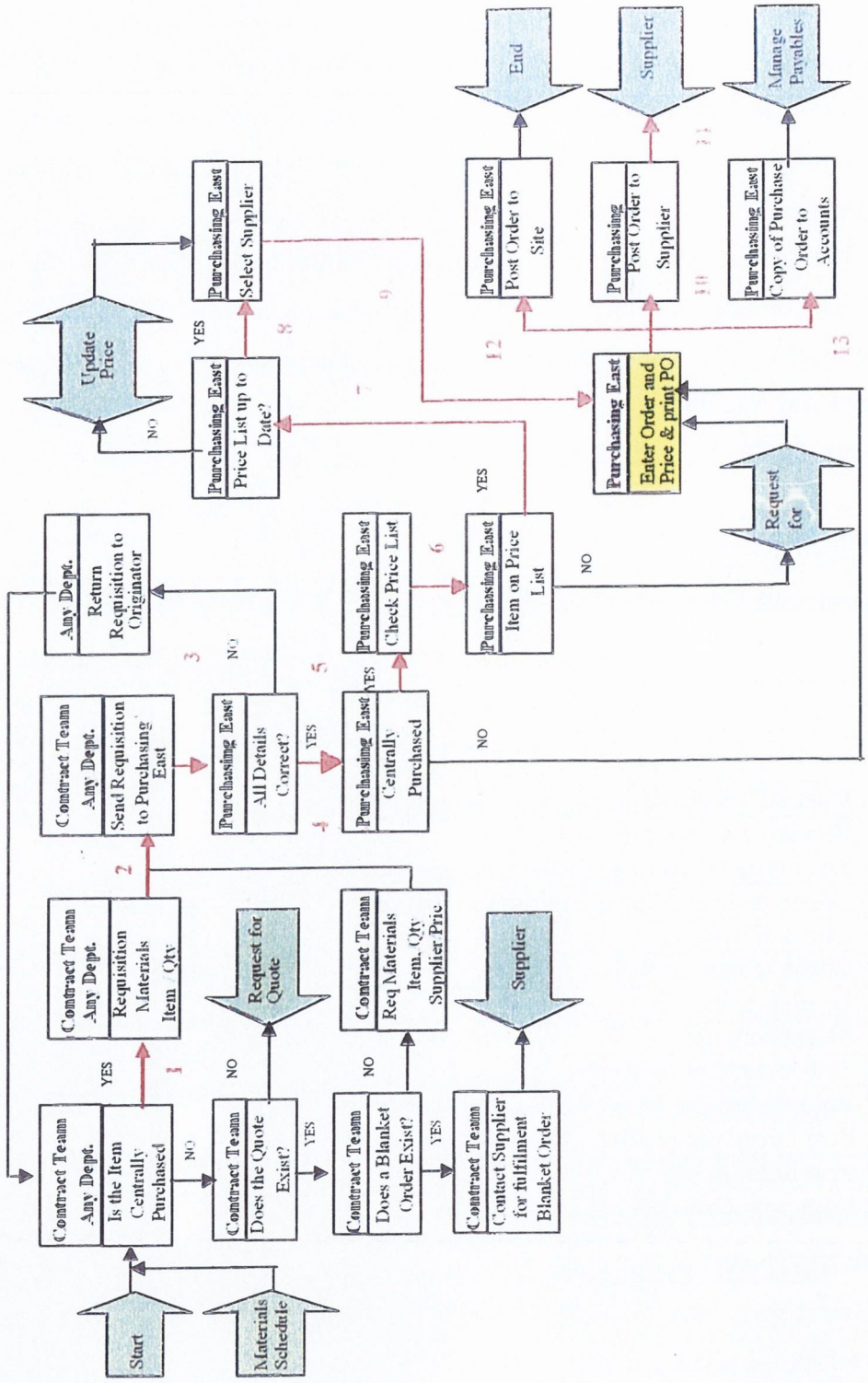


Figure 3.5. Material requisitioning and ordering process map (as observed by the author)

3.5.2 Receiving Materials Process Mapping

When materials were received on site, they were inspected against the supplier's delivery docket. An authorised member of the contract team carried out this inspection. If the receipt was acceptable, the goods were stored in the appropriate area as per the site's quality plan. If the receipt was unacceptable, then the non-conformance procedure was started. The items were either returned to the supplier or held in a non-conformance area of the site. Storage sites were inspected regularly and findings reported in the site daily diary sheet. The receipt was noted onto the confirmation of inspection – material received form and this, together with the delivery docket, was forwarded to the accounts department.

The process flow chart for receiving material is shown in Figure 3.6. The process shows 7 individual potential tasks in the receipt of deliveries. The most widely adopted observed route for processing the deliveries is indicated in red and involved a minimum of 6 tasks. The author observed that the process was highly inefficient, with the all delivery docket information manually entered onto a GRN form, which together with all the signed delivery dockets was photocopied and dispatched to head offices for processing. All this information was then re-keyed by head office personnel into the Binary ICT system.

Table 3.6 summaries the tasks that are carried out manually rather than electronically in the receiving material delivery process.

	Tasks	Manual/ Handwriting	Photocopy/ Printing	Manual keying of Info.
1	Nominate receiving personnel	√		
2	Receive materials	√		
3	Inspect material against delivery dockets	√		
4	Sign delivery dockets	√		
5	Record receipt of materials on GRN forms	√		√
6	Copy GRN/delivery dockets to accounts	√	√	
	Total	6	1	1

Table 3.6 - Tasks carried out manually rather than electronically in the receiving materials process

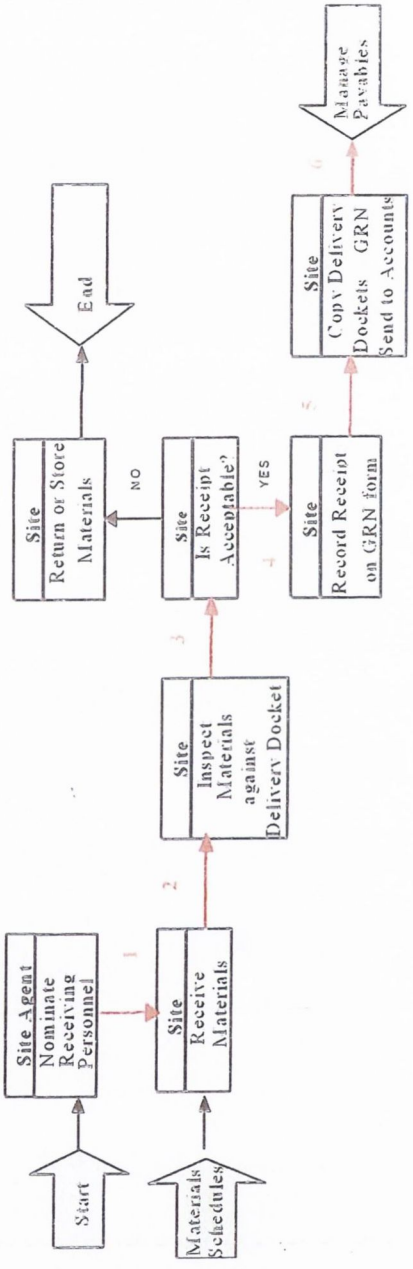


Figure 3.6. Receiving material process map (as observed by author)

3.5.3 Manage Payables Process Mapping

Invoices were received from suppliers and the details were entered into Binary. The author observed that the process was highly inefficient, with once again an over reliance on manually tasks, extensive photocopying and re-keying of information. Binary was updated manually to allow payment to occur on the cheque corresponding to the payment date. When invoices were received that required matching to either the delivery docket or purchase order (or both), these documents were retrieved from their files. Once all documents were available, then they were matched. Once matched, the Binary system was updated to allow payment to occur on the cheque run corresponding to the payment date.

The process flow chart for managing payables is shown in Figure 3.7. The process shows 20 individual potential tasks in the management of payables. The most widely adopted observed route for processing the invoices is indicated in red and involved a minimum of 11 tasks. Table 3.7 summaries the tasks that are carried out manually rather than electronically in the managing payables process.

	Tasks	**Manual/ Handwriting**	**Photocopy/ Printing**	**Manual keying of Info.**
1	Receive purchase order, delivery dockets and invoices into accounts	√	√	
2	Determine matching process	√		
3	Enter details and code into Binary			
4	Matching purchase order, delivery note and invoice			√
5	Check all documents located	√	√	
6	Complete final 3-way match	√		
7	Enter payment authorisation details into Binary code			√
8	Release payment	√		
9	Print cheque and remittance		√	√
10	Collate cheques and remittances	√		
11	Post payment to supplier	√		
	Total	7	3	3

Table 3.7– Tasks carried out manually rather than electronically in the managing payables process

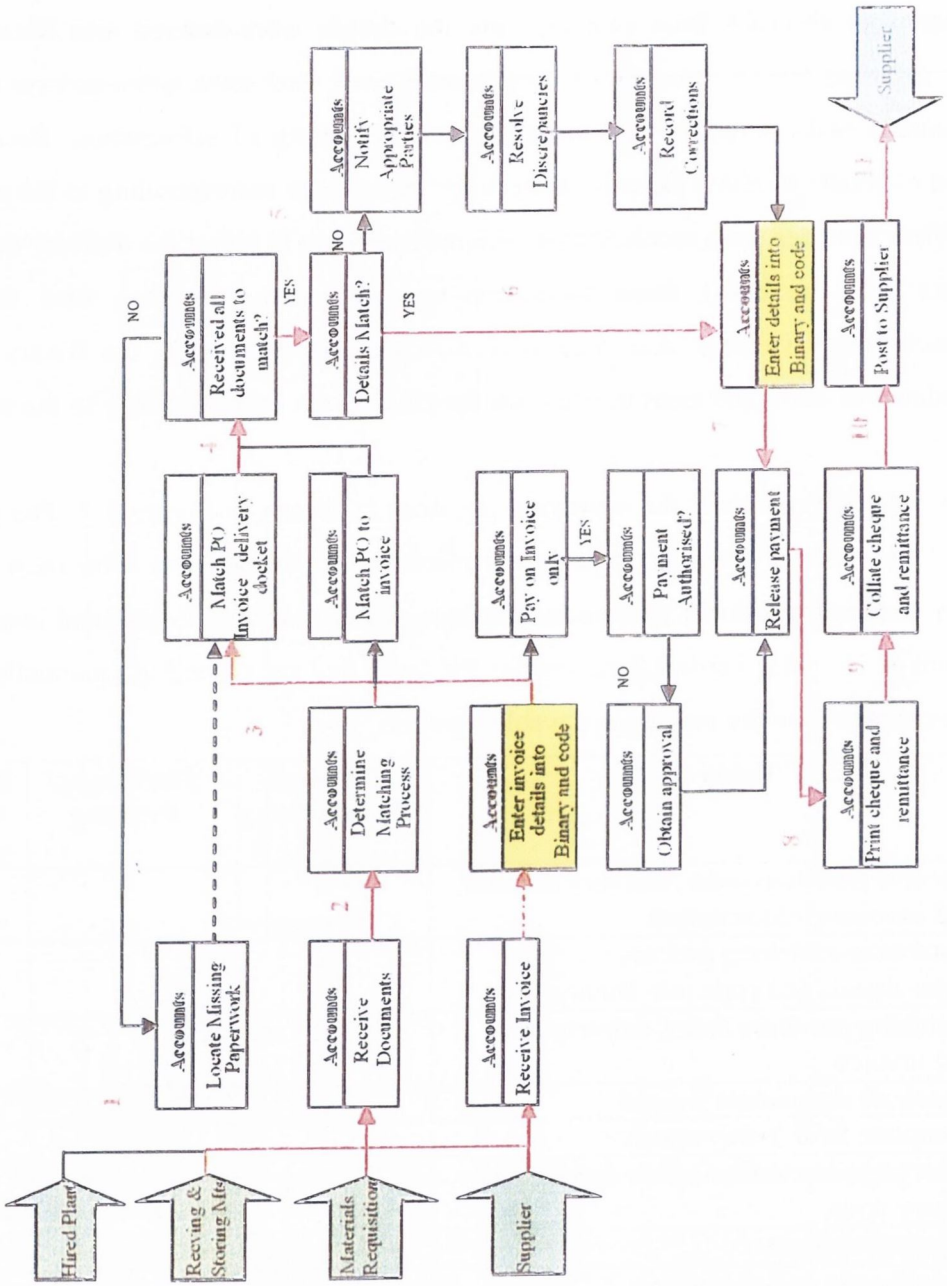


Figure 3.7. Managing payable process map (as observed by author)

3.6 CENTRE POINT PROJECT CASE STUDY

The overall purpose of this case study was to focus on particular supplier transactions over a defined period on a specific project and record the current performance of the purchasing procedures adopted by the observed company.

The case study project was a mixed development consisting of a basement incorporating a public house and nightclub with retail outlets at the ground floor levels, five floors of apartments and a five-storey office block. The strategy adopted in the observation study included the following :

- Select particular supplier accounts to observe.
- Observe and record particular supplier account transactions over a defined period.
- Analyse and interpret the data.

It was decided that three Supplier Accounts would be observed. Table 3.8 summarises the supplier types investigated and periods of observation.

Suppliers Selected for Observation	**Nature of Materials Supplied**	**Period of Observation**	**Number of Invoices**
Supplier A	Multiple low volume transactions for specialist fixings for concrete and blockwork.	November 2001 to August 2002	18
Supplier B	Bulk supplies of in-situ concrete of varying specifications	November 2001 to March 2002	34
Supplier C	Mixture of low and high volume general building materials	November 2001 to February 2002	41

Table 3.8. Summary of supplier accounts investigated

It was important that the author observed alternative supplier types, such as those providing low volume specialist supplies, high volume single products and a mixture of

low and high volume general building materials supplies. The rationale for selecting differing periods of observations was mainly due to the number of transactions that needed to be observed in order to obtain an accurate analysis of the relative efficiency of the transaction processes. Table 3.9 summaries the tables prepared by the author in preparation for the data collection. A sample of transaction data for Supplier C is included in Appendix A.3.

Site

Purchase Requisition

Number	Quantity	Description	Date Completed	Date Req.	Remarks	Office Use Only PO Number

Purchasing Department

Purchase Order

Number	Quantity	Description	Price per unit	Discount	Total value of order	Req. delivery date	Date of issue

Site

Confirmation of Inspection – Material Received

Date completed	Delivery docket no.	Order No.	Quantity received	Material received

Supplier

Delivery Note

Delivery advice no.	Customer order no.	Quantity	Description of goods delivered	Supplier Code	Authorised signature	Date of delivery

Supplier

Sales Invoice

Customer order no.	Delivery advice no.	Invoice date	Invoice no.	Quantity	Desc. of goods invoiced	Part no.	Price per unit	Dis	Net	Total goods	Total incl. VAT

Accounts Department

Payment Process

Date invoice received	Date registered on computer	Internal requisition no.	Missing delivery dockets	Query on price	Purchase order no. on invoice	Non-conformity materials	Terms of payment	Date of payment

Table 3.9 Documents observed

The recording of the data for Supplier B was less time consuming than for Suppliers A and C as the purchasing process was simplified by the fact that the procedures mainly

involved "calling-off" materials on a master purchase order, which was raised by the project quantity surveyor.

In order to carry out a thorough analysis of the data obtained, it was first necessary to locate the information in the head office. An outline of the approach taken by the author is illustrated in Figure 3.8.

Site Material Requisition	**Purchase Order**	**Confirmation of Inspection – Materials Received**	**Sales Invoice**	**Payment Process**

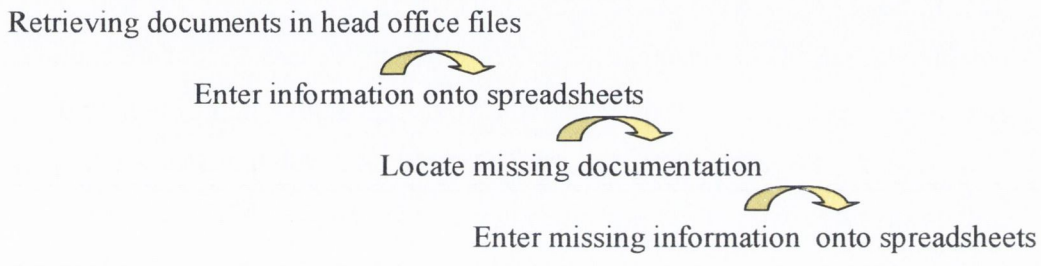


Figure 3.8. Approach to retrieving data in head office

The mode of communication was mostly paper-based or extracted from the Binary system. All copies of site requisitions were filed in the purchasing department under the particular project job number. Site requisitions were filed in date order and were easy to retrieve. Staff in the purchasing department inserted the purchase order against the relevant item(s) on the site requisition sheet. Once all the appropriate site requisitions were entered onto the spreadsheets, it was then necessary to locate the purchase orders referred to in site requisition sheets. In some instances photocopies of site orders were attached to the appropriate site requisition sheets. In most instances however, it was necessary to retrieve duplicate orders that were sent from the purchasing department to the accounts department. These were filed in numerical order and proved more difficult to locate. In a number of cases, copies of purchase orders could not be located. Completed GRNs were also held in the accounts department. These again were filed under the particular job number and were easy to retrieve.

Supplier invoices proved the most difficult and time consuming to locate. It was necessary to gain access to the Binary system and interrogate the system to locate the relevant invoices. The Binary system allowed one to search for invoices received from particular suppliers over a particular time period. These in turn, would provide the matching of purchase order numbers to particular invoices numbers. These invoice numbers had a unique registration number which one could then use to locate the paper copy of the invoice in the filing room. All supplier invoices were filed in numerical registration number sequence and had attached to them the original delivery docket and a copy of the appropriate purchase order.

This approach was taken for all three suppliers. It proved difficult at times to locate some of the supplier invoices, as some had not been filed or had been held due to queries on the invoice by accounts. It was also evident from the spreadsheets prepared, that a number of documents could not be found on file. This problem was most acute in the Supplier A account where 7 purchase orders, 8 GRNs, 11 delivery dockets and 7 invoices were not located.

3.6.1 Observation results

The results of the study are based primarily on the matching/mismatching of particular documents that was evident on the completion of the spreadsheets. The three core issues that are examined include :

- Payment periods of invoices –v- Supplier Credit periods.
- Discrepancies between site requisitions and purchased orders.
- Discrepancies between purchase orders, delivery dockets and supplier invoices.

Payment period of invoices –v- Supplier Credit periods

An obvious interpretation of the data was to evaluate if the supplier was receiving payment within their standard credit periods. Prepared tables summarising the periods of payment from receipt of invoice to payment for each supplier are included in Appendix

A.1. With respect to Supplier A, one invoice was held due to queries on invoice prices during the observation period. Of the remaining invoices, analyses indicated that an average payment period of 62 days was achieved, with the shortest period of 29 days and the longest period of 86 days. The only exception was Transaction 10, where the invoice was disputed. This compared to the credit period agreed with the supplier of 60 days. Figure 3.9 summarises the payment periods observed for Supplier A.

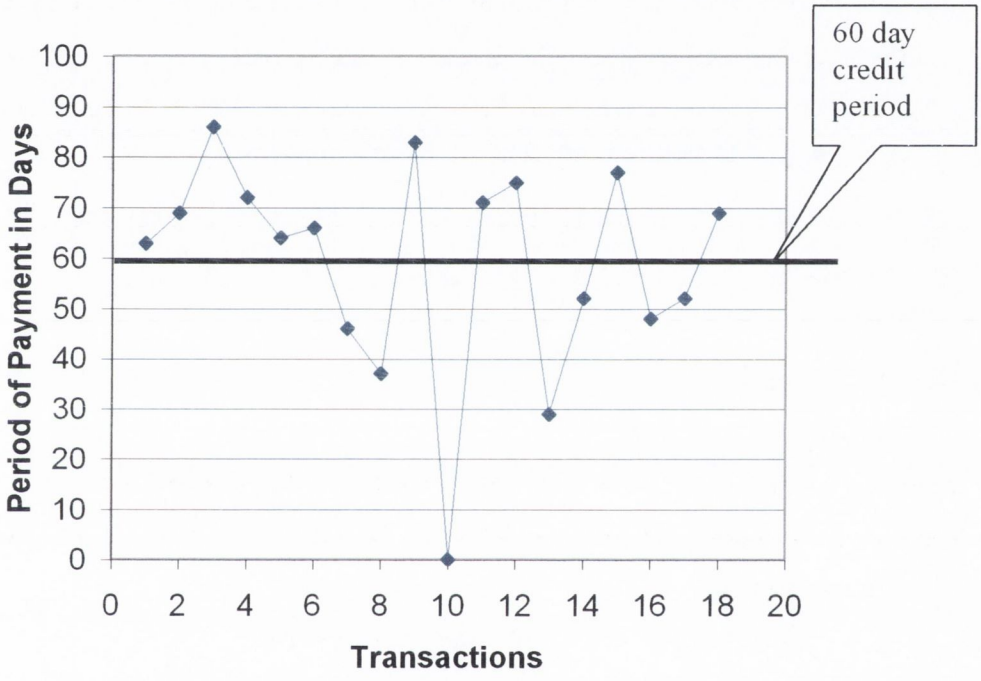


Figure 3.9. Observed payment periods for Supplier A

It can be seen that the distribution of payment periods illustrated in Figure 3.9 was sporadic. The main reasoning for this was the difficultly the accounts personnel had in matching up purchase order, delivery docket and supplier invoices, which will be

discussed later in this section of the Chapter. The incidence of early payments was mainly due to payment approvals coinciding with cheque run dates.

In the case of Supplier B the average payment period was 66 days which was only marginally in excess of the 60 days period negotiated with the supplier. There were nine invoice queries during the period. Figure 3.10 summarise the payment periods observed for Supplier B.

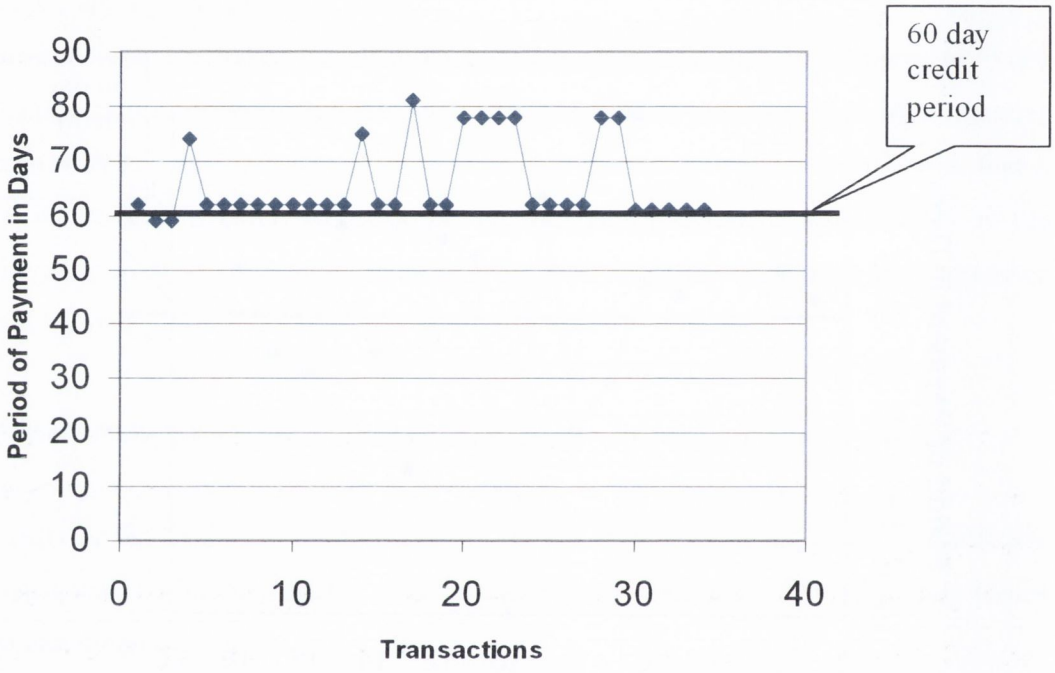


Figure 3.10. Observed payment periods for Supplier B

It can be seen that the distribution in Figure 3.10 that most payments were marginally over the 60 day payment cycle.

With respect to Supplier C, the contractor was unable to maintain the 60 day payment cycle due to the extent of queries on the supplier invoices. Figure 3.11 summarises the payment periods observed for Supplier C. For Supplier C the average payment period

was 113 days, which was far in excess of the 60 days credit provided by the supplier. The longest period of payment achieved was 182 days (some six months).

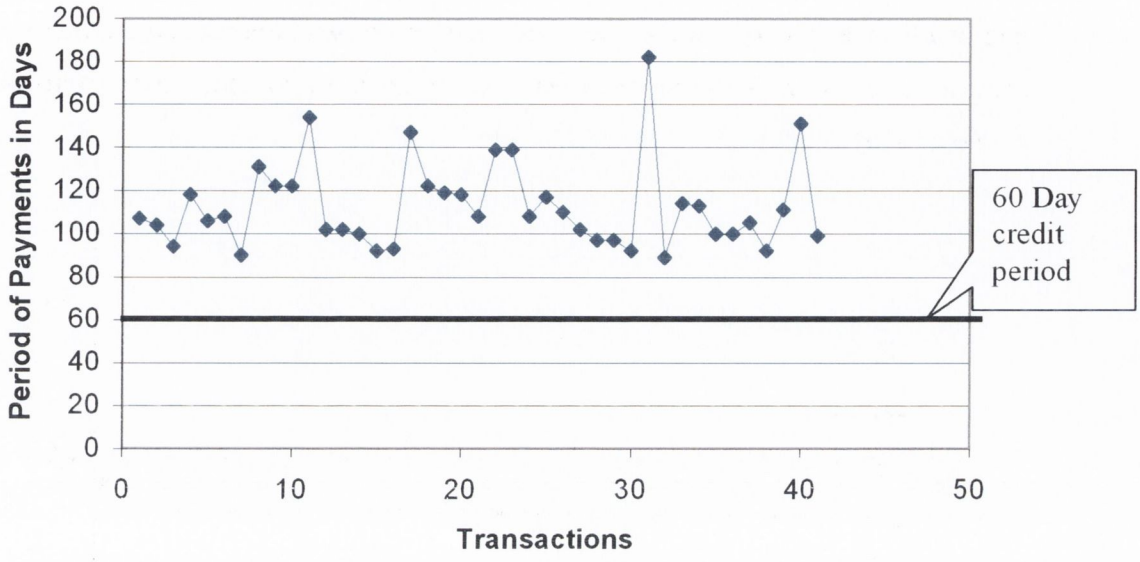


Figure 3.11. Observed payment periods for Supplier C

The erratic and prolonged payment periods associated with Supplier C was as a direct result of the inability of the accounts department to match the documentation in the payment approval process.

It is important for the author to reiterate that the contractors target payment period was 60 days for all three suppliers. Where a three-way manual match of the purchase order, delivery docket and supplier invoice could be achieved the supplier invoices went into a normal payment cycle cheque run. This was particularly evident in Supplier's B account, where 25 out of 34 supplier invoices were paid within 64 days, thus falling on a particular 60 days cheque run cycle.

Discrepancies between site requisitions and purchased orders

Completeness of information on the initial site requisition form was an issue in both Supplier A and Supplier C accounts. There was a great deal of discussion between

purchasing and site personnel before the official purchase order could be dispatched to the supplier. This typically involved the purchasers ringing up the site and clarifying the particular requirements of the site. This was mainly due to the fact that there was insufficient information on the site requisition to prepare a particular purchase order. It also involved the purchasing department ringing the supplier and confirming the order verbally. The supplier at this point typically confirmed that they did not have particular materials or may have suggested alternatives to the original site requisition. In any case, the resultant purchase order in many instances was different to the original site requisition. It was also typical that site would ring up purchasing and request additional materials verbally. In response to this, purchasing added this additional request for materials onto the purchase order.

This problem was evident in the Supplier A account. The main reasoning for this was the highly technical and specialist nature of the material ordered. The information provided by the site was extracted from an on-site supplier catalogue. On receipt of the faxed site requisition, purchasing would typically ring site and clarify the purpose for which certain fixings were required. Purchasing would ring the supplier who would give their advice as to the particular fixings required. It was not unusual for the supplier to recommend additional materials for a particular purpose. Of the 23 transactions observed, only 11 site requisitions mirrored exactly the formal purchase order. In the case of the remaining transactions the purchase orders were quite different in regard to quantity and specification of materials finally ordered.

The Supplier C account was an especially difficult account to track, with respect to particular transactions. The extent of the problem was more acute than the Supplier A account. A profound example of this problem can be seen in transaction one, as shown in Appendix A.3. The original site requisition was for 7 items of material ranging in quantity and specification. This was allocated a purchase order number. This purchase order consisted of 11 items of material, ranging in quantity and specification, which was subject to 11 separate invoices. An additional example of this problem, in respect to the Supplier C account, is shown in Appendix A.3.

This problem was not an issue for the Supplier B account, as materials were being requisitioned by sites by way of a "call-off" telephone call to the supplier direct. Figure 3.12 provides an overview of the observed matching of site requisitions and purchase orders for Suppliers A, B and C.

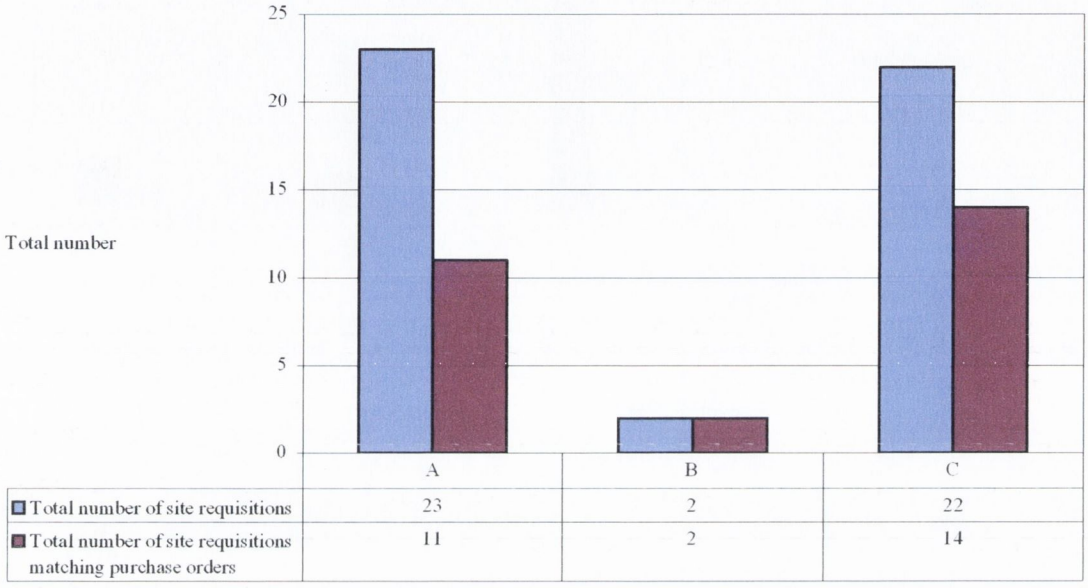
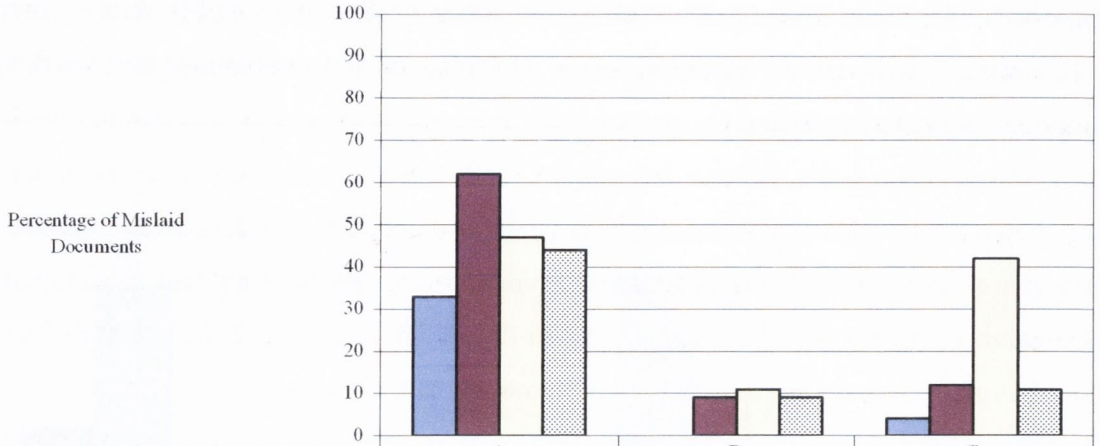


Figure 3.12. Discrepancies between site requisitions and purchase orders for Suppliers A, B and C

Discrepancies between purchase orders, delivery dockets and supplier invoices

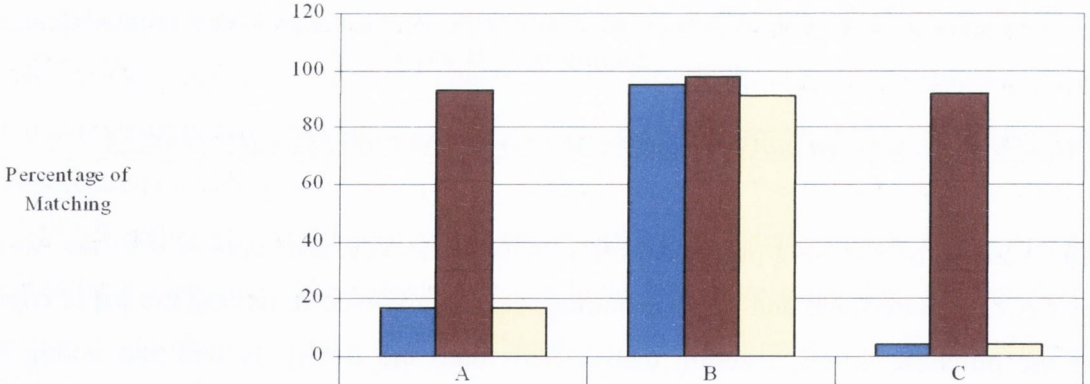
The exercise of matching purchase orders, delivery dockets and supplier invoices, was a particular cumbersome and time-consuming task. It involved retrieving the paper copies of the purchase orders, entering these details onto the Binary system and noting the internal registration number allocated by the accounts department to the particular invoice. Once the internal registration numbers were retrieved, it was then necessary to visit the invoice filing room and physically retrieve the relevant invoice and check the content of the invoice against the original purchase order. The extent of the problem was compounding by mislaid documentation. Figure 3.13 illustrates the extent of the problem of mislaid documents.



	A	B	C
Percentage of mislaid purchase orders	33	0	4
Percentage of mislaid delivery dockets	62	9	12
Percentage of mislaid invoices	47	11	42
Overall percentage of mislaid documents	44	9	11

Figure 3.13. Extent of mislaid documents for Supplier A, B and C

Figure 3.14 summaries the relative success of the three-way matching of purchase orders, delivery dockets and supplier invoices.



	A	B	C
Percentage of Purchase Orders matching Delivery Dockets	17	95	4
Percentage of Delivery Dockets matching Invoices	93	98	92
Percentage of Purchase Orders matching Invoices	17	91	4

Figure 3.14. Relative success of three-way matching for Supplier A, B and C

The three-way matching process achieved a very high success rate in the case of Supplier B. In the case of Supplier B, it was easy to explain this success rate as there were only 2 initial site requisitions raised by the site quantity surveyor. Site called-off the material on a daily basis. The supplier delivered the material to site and secured a signature on a delivery note. Invoices were dispatched to the contractor with an appended copy of multiple delivery dockets. The only discrepancies found in the case of Supplier B involved the invoicing for small load charges, a matter that was not dealt with in the original purchase order but which is standard practice in the industry. The process of locating the necessary information was tedious and time consuming but all paperwork retrieved was matched successfully. This high success rating was the reason for not including a matching of prices table in Appendix A.2.

One of most acute problems lay in trying to match the purchase order to the supplier's invoice. With respect to the Supplier A's account it was not possible to carrying out a complete examination of the matching between purchase orders, delivery dockets and supplier's invoices in all instances, as many of the documents could not be located in the head office. Only 17% of purchase orders located matched the content of the 34 invoiced raised for Supplier B during the observation period.

The quantity and specifications of materials delivered and invoiced largely matched those of the original purchase order. One interesting observation was that, in all instances, suppliers had a particular product code, which was in no case referenced on the purchase orders. In many instances the descriptions for the materials on the delivery dockets and the supplier invoices were more explicit than the purchase order. The main discrepancy was with respect of the divergence in prices between the original purchase order and the supplier's invoices.

Supplier C's account was a very difficult account to reconcile, as it was not possible to carry out an accurate matching exercise. In many cases there were multiple invoices matched against a single purchase order. This was not an untypical practice where materials in effect have been "called-off" from a schedule of rates from a master purchase order. Only 4% of purchase orders located successfully matched the content of the 41 invoices raised for Supplier C during the observation period.

Table 3.10 summarises the relative success of the three-way matching process achieved in this observation study as seen in Figure 3.10.

Supplier	% Matching
A	17%
B	95%
C	4%

Table 3.10. Extent of three-way matching achieved

With respect to both Supplier A and C, the problem of three-way matching of these documents was particularly acute. The extent of the matching of the purchase order prices and the sales invoice prices is shown in Appendix A.2. In the case of Supplier A, 17% of purchase orders matched the delivery dockets and supplier invoices, with respect to quantities and price to within 1€. Supplier C's success rating was even less impressive, with only 4% of purchase orders matching the delivery docket and the supplier invoice. With respect to Supplier B, the extent of three-way matching was very high at 95%, mainly due to the simplicity of the call-off procedure.

It is very important to highlight that a very high percentage of delivery dockets matched the details of the invoice, as this process was controlled by the supplier. Typically the supplier invoice is created from the same electronic file as the delivery dockets, thus there is rarely a difference between the two documents, other than the inclusion of the price in the supplier invoice.

The most alarming discrepancy found during the three-way matching process, was the extent of divergence between the prices quoted in the purchase order and the final price charged by the supplier. Accounts personnel were instructed by senior management not to approve payment of a supplier invoice unless there was a corresponding match with the prices agreed in the original purchase order.

A summary of the key observations of the purchasing process is summarised in Table 3.11.

Material requisitioning & ordering	**Receiving & storing materials**	**Managing payables**
• Most (if not all) of the purchasing process was manual, with little to no reliance on technology. • No central processing of all orders. • There was no global view of materials on order, materials received or materials overdue. • Purchase orders were unknown to the finance department until an invoice was received and processed. • Blanket orders were raised against suppliers both verbally and with a blanket requisition. • Pricing of centrally purchased items was not viewable to remote sites. • Purchasing requisitions were not used for all purchases in the company. • Binary purchasing did not integrate with accounts payable. The reliance was on manual input from one section of the system to the other. • There was no tracking of supplier's fulfilment history. • There was no shared information around the regions on suppliers and pricing.	• Sites in the eastern region did not check pricing on receipt, even through this was stated in quality manuals. • The southern region did not check price against the purchase order, though this process was repeated in accounts during the three way matching process. • Each region had a separate process for materials receipt. • Manual recording and forwarding of paperwork led to problems when paperwork is lost or forwarded late to the accounts department. • Receipts were not posted against purchase orders in Binary – therefore no view of open and late purchase orders unless managed manually.	• Two/three-way matching was manual as the purchase did not appear in Binary's accounts payment system, nor was the receipt recorded. This led to re-handling paperwork many times until matching could occur. • Due to the lack of a link between purchasing and accounts, purchase orders were not raised for many services. Payment was then authorised straight from the invoice, allowing no view to outstanding receipts on these transactions. • New creditors were often entered at the time of invoice receipt, slowing down the payment process. • There was only a short-term view of accounts payable, with invoices entered and raised from manual/non-integrated systems. The company had no view of its medium to long-term cash requirements or liability.

Table 3.11. Key observations of business processes

3.7 CONCLUSION

This observation study confirms the author's contention that many large construction companies, such as the one observed, are wholly inefficient in the way that they utilise ICT. The current ICT infrastructure adopted by the company consisted of a number of discrete software packages that were in no way integrated. The author, however, acknowledges that the observed company was aware of this inefficiency and had reacted by purchasing the COINS software at the time the observation study was carried out.

The results of the direct observations by the author have been illustrated by use of business process maps. Individual process maps for purchase ordering, delivery of materials and invoice payment, show that significant inefficiencies, such as manual work, extensive photocopying and printing and re-keying of information are present throughout the purchase cycle.

The author choose to focus on the purchasing transactions of 3 core suppliers over a defined period, from initial requisition of materials by site personnel to final payment. The result shows that the payment periods for some suppliers can be extended due to the incidence of mislaid delivery dockets and mismatching of purchasing documentation generally. The extent of this problem was particularly evident in regard to Supplier C, where an average payment period of 113 days was observed.

The author is of the opinion that this level of inefficiency was a direct result of the wide range of products supplied by Supplier C. In contrast, the nature of the product supplied by Supplier B involved a limited range of bulk material orders, which by implication involved a significant reduction in the volume of paperwork, thus speeding up and simplifying the matching process and leading to more acceptable credit periods.

The discrepancies observed between purchase requisitions and purchase orders were found to be extensive in Supplier A and C accounts. Whilst these discrepancies were found to be problematic, the company and indeed the author feel strongly that the initial requisition of materials by site personnel will, by implication, involve a necessary interaction between site personnel and head office with regard to determining the particular requirements with respect to the purchase order content.

The most concerning aspect of the observation study results was the extent of documents that could not be found by the author during the observation period. This problem was particularly acute for Supplier's A and C, and less problematic for Supplier B.

The key observation by the author was to directly observe the extent of the discrepancies between purchase orders, delivery notes and supplier invoices. The author attempted to manually match these documents during the observation period.

The main problems observed by the author that caused this mismatching included :-

- Copies of different documents were invariably manually produced by differing persons, which increased the probability of errors occurring between differing documents for single transactions and thus caused the mismatch.
- The paper-based system is dependent on ensuring that all appropriate departments obtain copies of the documents necessary to do their job. Where a small percentage of those documents were lost or misplaced, this caused gaps in the system and caused delays in the matching and subsequent payment cycle.
- The contractor prepared the purchase order based on their specific requirements with agreed prices. On the other hand the supplier reacted to the site requirements, which invariably differed from the original purchase order information, thus causing the delivery note information and subsequent supplier invoice information not to match the original purchase order.

The results of the observation study underpin the contention that the current traditional paper-based approach to material procurement does not work efficiently. There were too many manual tasks observed, extensive photocopying and re-keying of repetitive information by purchasing, site personnel and the accounts department. The author contends that there is a robust business case for re-engineering the purchasing procedures in construction companies, such as the company observed. The key to this re-engineering is the three-way electronic match of the purchase order, delivery docket and the supplier's invoice, thus bringing significant business benefits to the entire supply chain.

CHAPTER 4

2004 SURVEY: ATTITUDES TOWARDS ELECTRONIC PURCHASING IN THE IRISH CONSTRUCTION INDUSTRY

4.1 INTRODUCTION

In Chapter 2 the author reviewed literature on both established and emerging technologies currently being adopted in construction purchasing internationally. The author concluded that a fully integrated ICT electronic purchasing solution could bring significant benefits to both the buyers and the suppliers of materials in the Irish construction industry. In Chapter 3, the author reported on a 2002 observation study, where the author experienced first-hand, the extent of inefficiencies and problems that were present in the material purchasing process of a large Irish construction company.

This Chapter seeks to examine the extent to which the top Irish construction suppliers and contractors are currently exploiting electronic purchasing. The author adopted a methodology, which involved the design and distribution of an online questionnaire to almost 100 Irish construction companies in early 2004.

The results of the questionnaire survey are analysed in order to determine: the major factors that are likely to attract organisations to use EC technologies, the driving forces which attract organisations to implement electronic purchasing, the barriers to preventing organisations from applying these technologies and the future developments which would encourage higher usage of electronic purchasing within the Irish construction supply chain.

It is well accepted internationally that the adoption of EC in the construction industry has been sporadic and piecemeal (Hore and West, 2004). Following a detailed analysis of the results, the author compares the key findings of this survey with similar surveys carried out internationally in recent years. The findings of this survey were presented at a conference in Nevada USA in February 2005 (Hore and West 2005a).

4.2 THE SURVEY

The survey methodology adopted involved two core stages as illustrated in Figure 4.1, namely, a planning phase and an implementation phase.

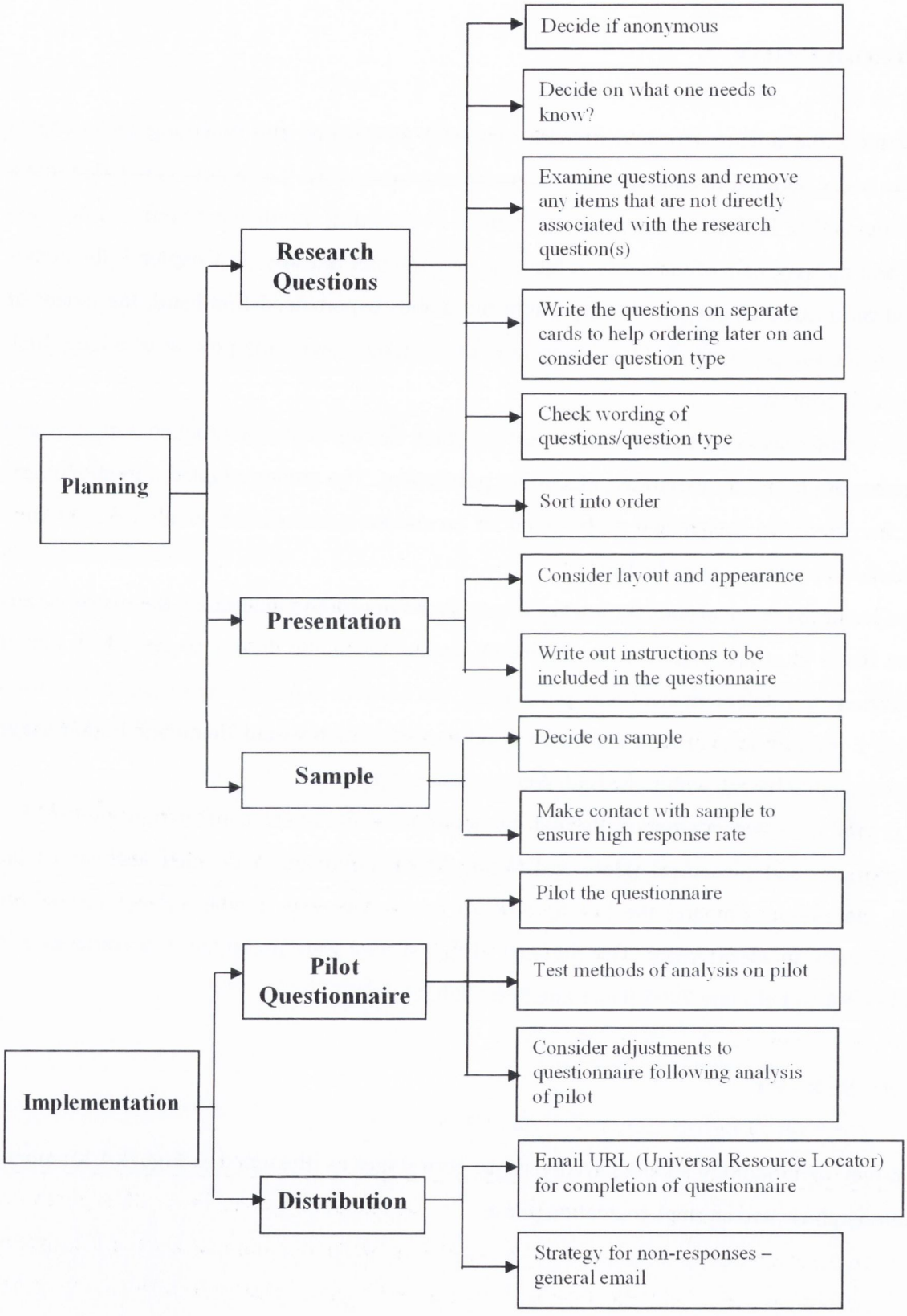


Figure 4.1. Questionnaire strategy

4.2.1 Planning Phase

The planning phase of the questionnaire focused on three aspects, namely:

1. Research questions
2. Presentation of questionnaire
3. Sample selection and size

Research Questions

The foundation of all questionnaires, whether to be mailed or to be used for interviewing, is the questions themselves (Naoum, 1998). At first, the order and wording of the questions were not crucial. The aim was to list the ideas, which could be developed into a questionnaire at a later stage. The findings of the literature reviewed in Chapter 2, combined with the findings of the observation study reported in Chapter 3, led to the identification of four key areas to be investigated.

(i) The current level of ICT take-up by main contractors and building suppliers in B2B purchasing transactions.

(ii) The driving forces which attract organisations to adopt electronic purchasing.

(iii) The barriers preventing organisations from applying these technologies.

(iv) The future developments, which would encourage higher usage of electronic purchasing within the Irish construction supply chain.

The questionnaire was structured in the following order:

- *Company profile*: company type and turnover.
- *ICT Take-Up*: opinion as to the general level of take-up within the Irish construction industry; the general level of ICT usage within the organisation's B2B purchasing transactions; current state of awareness of ICT deployment in construction purchasing; willingness to consider applying existing technologies in B2B transactions; importance of linking EC to business strategies; increasing significance of EC in the next three

years; the extent of use of particular EC technologies and concerns over web-based strategies.

- *Driving forces*: the major factors, which attracted, or are likely to attract, organisations to apply EC technologies. This part of the questionnaire contained questions relating to ten potential driving forces, which recipients were asked to rank in order of importance.
- *Barriers to adoption*: the major barriers, which have prevented the adoption of EC technologies, both for individual organisations and the Irish construction supply chain as a whole. This part of the questionnaire contained questions relating to a total of twelve potential barriers, which recipients were asked to rank in order of importance.
- *Future directions*: future statements which were perceived as important in enticing more Irish construction organisations to use EC technologies. This part of the questionnaire contained questions relating to nine potential future directions.

Presentation of Questionnaire

An online questionnaire was prepared. This involved initially creating the questionnaire in a Word format and then creating a HTML file. The survey sample was accessed by the recipients via a website link, which included a statement as to the background to the survey and detailed explanations as to how to complete the survey. The use of an online method made completion of the survey very easy for the recipients. Once completed, the responses were returned instantaneously to the author of the questionnaire. A copy of the online questionnaire is included in Appendix B.1.

Sample selection and size

All researchers are dependent on the goodwill and availability of the subjects to create a true random sample (Harper, 1991). It was decided to target both main contractors and building suppliers in the Irish construction industry. The initial source was to consult the top 75 contractors and top 75 suppliers by turnover, published by www.irishconstruction.com. Each of the companies listed were telephoned to identify the individual IT managers in the respective companies and to secure their contact details, including their email addresses. A total of 98

companies agreed to partake in the survey, with included 51 contracting companies and 47 suppliers. In respect to particular characteristics of the sample, companies were only asked to provide information on their annual turnover and basic contact information. Table 4.1 shows the distribution of turnover within the research sample.

Size	Turnover (€M pa)	Suppliers	Contractors	Total
Small	<10	5 (10%)	0 (0%)	5 (5%)
Medium	10 – 40	16 (34%)	24 (47%)	40 (41%)
Large	>40	26 (56%)	27 (53%)	53 (54%)
Total companies surveyed		47	51	98

Table 4.1. Research sample: turnover profile of sample

Table 4.1 confirms that the research sample represented a balance between medium to large turnover companies, mainly because they represented the top-turnover companies in the Irish construction sector. The Irish construction industry is made up mainly of many small contractors. Notwithstanding this fact, the target sample chosen by the author will cause a natural bias towards the larger turnover sector of the market.

4.2.2 Implementation Phase

The implementation phase of the questionnaire focused on two aspects, namely, the pilot questionnaire and the distribution and return of the questionnaire.

Pilot Questionnaire

The questionnaire was piloted to test how long it would take recipients to complete the questionnaire, to check that all instructions and questions were clear and to remove any items, which did not yield useful data (Bell, 1996). Table 4.2 identifies the questions and the responses received from two main contractors and two suppliers, when asked to comment on the pilot questionnaire.

	Question	Summary of Responses
1.	How long did it take to complete?	On average between 10-15 minutes.
2.	Were the instructions clear?	It was suggested that an explanation of ICT and eBusiness be included in the survey.
3.	Were any of the questions unclear or ambiguous? If so, which questions and why?	Questions 8 and 9 were quite similar in content. It was suggested that "Drivers" and "Barriers" be clearly distinguished.
4.	Did you object to answering any of the questions?	There was no objection to any of the questions asked.
5.	In your opinion, has any major topic been omitted?	Two of the respondents suggested that a question on "concerns regarding a web-based strategy" be included in the survey.
6.	Was the layout of the questionnaire clear/attractive?	All respondents were satisfied with the layout.
7.	Any further comments?	Respondents were asked to comment specifically on the optional statements included in question 11 on "Future Directions". Some amendments were made to the wording of these statements following respondent suggestions.

Table 4.2. Summary of responses to pilot questionnaire

The pilot responses enabled the author to revise the questionnaire, such that it was ready for main distribution.

Distribution and return of questionnaires

To distribute the survey, an email message containing a link to the survey website (www.cita.ie) was sent to potential respondents. The questionnaire was accessed by clicking on a web link to the survey and completing the same online. Once completed, the survey was sent back to the author's email address for analysis. A date was fixed for completion of the survey, however the author extended the completion date by two weeks and regularly telephoned the non-respondents to encourage a good response rate. A list of the recipients and respondents of the questionnaire is included in Appendix B.2.

Table 4.3 summaries the research sample response rate achieved. A total of 54 responses were received, including 29 from building suppliers and 25 from main contractors. This

represented an overall response rate from the suppliers' sample of 62% and 50% from the contractors' sample, giving an overall response rate of 55%.

Category	Questionnaires Issued	Responses	% Responses
Suppliers	47 (48%)	29 (54%)	62
Contractors	51 (52%)	25 (46%)	49
Total	98	54	55

Table 4.3. Research sample: rate of responses by category

Table 4.4 summaries the turnover profile of the companies that responded to the survey. Of the 30 large organisations surveyed, 16 were suppliers and 14 were contractors, indicating a reasonably balanced distribution. The same distribution is evident for the medium sized companies surveyed. With respect to the smaller companies that responded, the author accepts that there is an element of bias in the responses, as no small sized contractors were invited to complete the survey, as they were not represented in the top 100 list of construction companies in Ireland.

Size	Turnover (€M pa)	Responses from suppliers	Responses from contractors	Total
Small	<10	3 (10%)	0 (0%)	3 (6%)
Medium	10 – 40	10 (34%)	11 (44%)	21 (39%)
Large	>40	16 (56%)	14 (56%)	30 (55%)
Total responses by turnover		29	25	54

Table 4.4. Research sample: rate of response by turnover

4.3 QUESTION SELECTION

The first step involved selecting the correct wording for the questions. In order to decide on exactly what kind of information was required from the respondents, the author decided on a combination of close-ended questions with ordered choices, close-ended questions with unordered choices and partially close-ended questions. There were no open-ended questions in the survey, as it was felt that this type of question was very demanding for the respondent to

complete, given the technical nature of the survey (Salant and Dillman, 1994). The other reason for the avoidance of the open-ended question was the importance that the survey was quick and easy for the respondents to complete. It also meant that the analysis of the data was made easier.

4.3.1 Close-ended Questions with Ordered Choices

This type of question was selected, as quite specific information was required from the responses in regard to:

1. The current level of ICT usage in the Irish construction industry.
2. Current state of awareness of ICT deployment in construction purchasing.
3. Expected involvement in eBusiness and the Internet use within the next 3 years.
4. Degree of concern in regard to the adoption of a web-based strategy for future B2B purchasing.

4.3.2 Close-ended Questions with Unordered Response Choices

This type of question was used where answer choices were provided to respondents, but they did not fall on a continuum. Respondents were asked to choose from among discrete, unordered categories. The respondents were asked to evaluate each choice and select the one that best reflected their situation. The type of question was adopted as the author was knowledgeable on the subject and thus was in a position to provide an informed choice from which the respondents could select.

This type of question was adopted in order to obtain information on the following:

1. The extent of use of particular technologies in sales/purchasing of construction materials. Respondents were given a choice of 11 technologies, for example, bar coding, extranets, smart cards etc. from which to choose and were asked to further identify the extent of the use of these technologies within their B2B purchasing transactions.

2. The concerns that the respondents had with the adoption of a web-based strategy for B2B purchasing transactions. Only those respondents, who had indicated that they had a concern, were further asked to select from an informed list of concerns provided by the author. The purpose of this question was to identify the factors that most concerned the respondents in regards to the use of a web-based purchasing strategy.
3. The opinion of the respondents with regard to a range of 9 statements designed to reflect likely future developments in EC in the Irish construction industry. The respondents were asked to indicate whether their position on each statement ranged from strongly agree to strongly disagree.

Close-ended questions with unordered response choices were also used to ask respondents to rank items. This methodology was adopted in order to gain information on the main drivers and barriers to the adoption of electronic purchasing in the Irish construction industry. Once again, respondents were given an informed choice of drivers and barriers from which to choose, and to rank. In addition, respondents were given the opportunity to add in additional drivers and barriers of their own choice.

This type of question was selected, as quite specific ranking information was required from the responses with regard to: -

1. The drivers, which attract or are likely to attract an organisation to apply existing technologies in construction purchasing.
2. The barriers, which undermine the use of ICT in construction purchasing both within an organisation and within the overall Irish construction industry.

4.3.3 Partially Close-ended

Partially close-ended questions provided a compromise between the open-ended and the close-ended questions. Although answer choices were provided, respondents were given the opportunity of creating their own responses. This type of question was selected, as information was required from the responses with regard to:

1. The current level of ICT usage in the organisations B2B purchasing transactions. In this question respondents were asked to give specific examples of ICT deployment in electronic purchasing.
2. The respondent's willingness to apply existing technologies in B2B transactions. The respondents were asked initially to indicate whether they were unwilling, willing or currently applying ICT in construction purchasing. With this question respondents were asked to provide commentary to justify their close-ended response.
3. The impact of EC on strategic planning of construction businesses in Ireland. With this question respondents were asked to provide commentary to justify their response.
4. The respondent's perception on the increasing significance of EC over the next 3 years. With this question respondents were asked to justify their response.

4.4 ANALYSIS OF RESULTS

4.4.1 Error Structure

It is important to clarify that sample surveys, such as this one, are not precise, as this type of survey produces only estimates of people's opinion (Salant and Dillman, 1994). Since the survey was confined to the top 150 Irish construction companies, the results are only valid for that part of the industry. Therefore, inferences made from the sample response relates only to the 'large or medium' turnover end of the industry. The survey was not targeted at the smaller sized companies, thus no informed conclusions can be drawn about the use of ICT in these companies. As the sample aimed for full coverage of the defined population, no random sampling was therefore required. Dillman (1994) reminds researchers that findings from postal or online questionnaires are only estimates of the population characteristics, as researchers only survey a sample rather than the entire population.

The author described earlier that the defined population was the top 150 companies in the Irish construction industry, evenly distributed between suppliers and contractors. 37% of suppliers and 32% of contractors either declined to participate or could not be reached. This resulted in an overall research sample of 98 companies, made up of 47 suppliers and 51

contractors. A total response rate of 55% was achieved overall. This equated to 62% of suppliers and 50% of contractors who agreed to partake in the survey (see table 4.3).

However on further analysis (see Table 4.4) it can be seen that there was a balanced distribution of responses received from both the suppliers and contractors, both in terms of overall numbers and also in terms of company turnover. The author, therefore, can reasonably conclude that there is no bias in the overall results obtained from either the supplier or the contractor categories.

Where necessary the author will point out results that are especially sensitive to error for one reason or another.

4.4.2 Method of Analysis

Tables for each question are presented in detail in Appendix B.3. For a number of the questions, the results are analysed using rank correlation and cross tabulation statistical techniques. Rank correlation allows a numerical measure of the degree of similarity between the rankings of characteristics or factors in two different populations (in this case contractors and suppliers). The statistical significance of the rank correlation co-efficient is tested for each of these questions. All calculations are included and discussed in Appendix B.4.

Cross tabulation of the results of two different but related questions, allowed an analysis of the similarity or difference in responses to one question for sub-groups of responses to another question. This statistical technique is applied when comparing the responses to particular questions, in order to validate the accuracy or consistency of the responses received.

4.4.3 Analysis of the Results

The author adopted a descriptive method of analysing the results. This included the following steps:

Step 1: Restate the question.

Step 2: Present the analysis of the results in the form of a table, bar chart or pie chart.

Step 3: After analysing and presenting the results, the author comments upon and interprets the results.

For the purposes of brevity, choices provided by the author in the question will not be restated but referred to in the analysis of the results.

Question 1: In your opinion how would you rate the current level of ICT usage in the Irish construction sector?

This close-ended question provided the respondents with an ordered choice of poor, satisfactory, good or very good. For the purpose of the survey, ICT was defined as *"any computer hardware or software that collects, processes, stores, analyses, and disseminates information for a specific business purpose"* (Leenders et al., 2002).

Table 4.5 shows that the majority of both groups were of the opinion that the current level of ICT take-up in the Irish construction industry was poor to satisfactory, with only an average of 7% rating ICT up-take in the Irish construction industry as good or very good. It is interesting to note that the sample knew that they were poor in their level of ICT usage.

	Contractor	**Supplier**	**Overall**
Poor	56%	52%	54%
Satisfactory	35%	41%	39%
Good	9%	7%	7%
Very Good	0%	0%	0%
Total	100%	100%	100%

Table 4.5. Level of ICT usage in the Irish construction industry

Question 2 : Please indicate how you would rate the current level of ICT usage in your organisation's business-to-business purchasing transactions

This question was a partially close-ended question, which gave the respondents the opportunity to indicate if their internal ICT usage could be categorised as no use, little use, some use, moderate use or regular/constant use. The question was partially open as it gave the respondents the opportunity to justify their choice of usage by providing commentary.

Figure 4.2 presents the overall results, which indicates a relatively low level of ICT use within the respondent organisations. The overall usage of ICT reported in construction purchasing was moderately higher overall in the supplier group, in comparison to the contractor group.

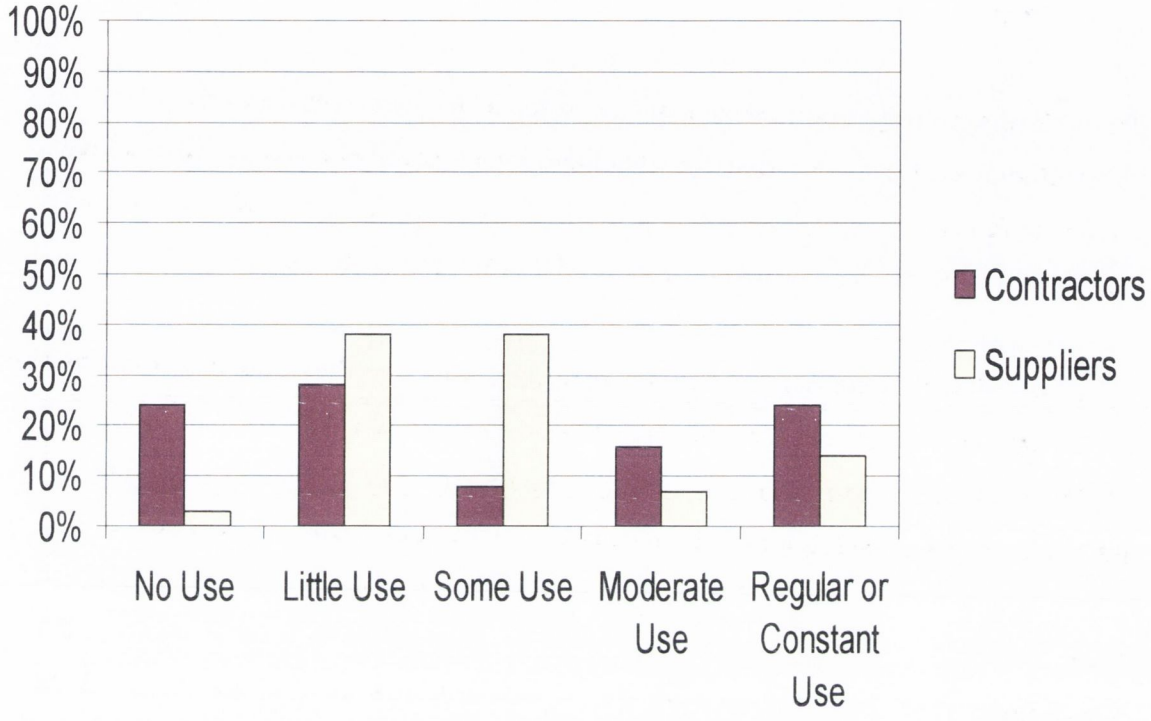


Figure 4.2. Current level of ICT usage in B2B purchasing transactions

From an analysis of the results, the following observations can be made.

1. 52% (24%+28%) of the contractors surveyed indicated that they adopted little/no use of ICT in supporting their B2B purchasing transactions. This figure compared to 41% (3%+38%) of the suppliers surveyed. This would suggest that the majority of the respondents are, in fact, adopting some level of ICT to support their B2B purchasing transactions.
2. On average, 19% ((24%+14%)/2) of respondents indicated that they used ICT regularly to support their B2B purchasing transactions. This was supported by commentary from the respondents, in particular from the suppliers, who indicated that they regularly

purchased raw materials from their suppliers via the Internet. Many of the very large companies also indicted that they had been using ERP software for a number of years to support their business processes.

3. A number of the contractors suggested that very few of their suppliers had an EDI capability, unlike the retail sector.
4. The majority of respondents, who commented on the question, confirmed that they routinely used standard industry software and email to support their B2B purchasing function. In some instances, respondents had developed their own bespoke software solutions.
5. The author can conclude, with confidence, that there is a relatively low level of sophistication in ICT usage to support B2B purchasing transactions. Only 24% and 14% respectively indicating a regular or constant usage of ICT in the contractor and supplier research sample.

Question 3: Please indicate your current state of awareness of ICT deployment in construction purchasing

This close-ended question provided the respondents with an ordered choice of not aware, somewhat aware (heard/read about it), aware (participated/tried some of these activities), moderately aware (occasionally use it as receiver or generator), very aware (use it as a matter of course frequently) of ICT deployment. The purpose of this question was to gauge if the respondents were aware of the ICT options/choices currently available in the market.

Figure 4.3 presents the overall results, which indicate that there was a low level of awareness among the respondents of the technologies currently available to support B2B purchasing transactions, resulting in their evident lack of use.

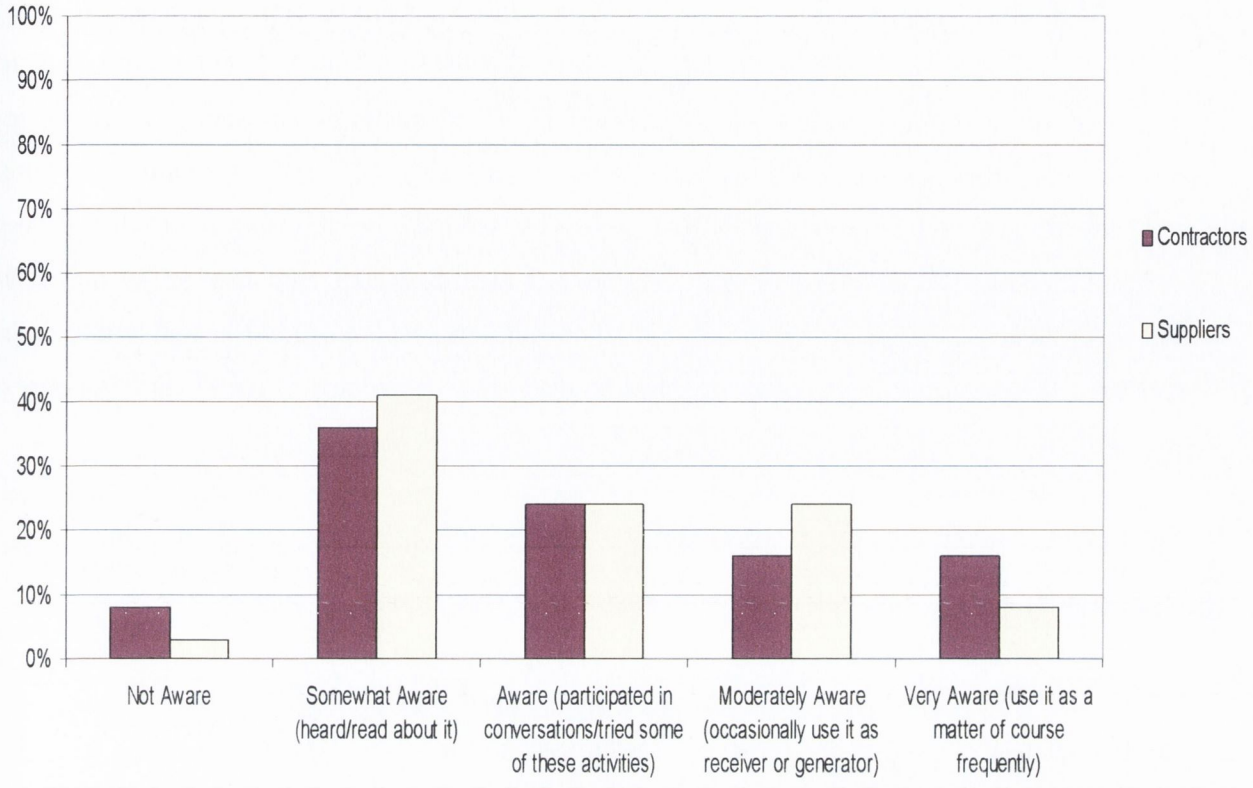


Figure 4.3. Current state of awareness of ICT deployment in construction purchasing

From an analysis of the results the following can be concluded.

1. The results indicate that there was a very close correlation, with respect to the level of awareness, between the responses from both the suppliers and the contractors, with a large majority of both groups indicating that they were aware of the technologies currently available to support their B2B purchasing function. However, the results would indicate that there is a need for education and training to improve the overall level of awareness.
2. The results should be treated with caution, as there was an underlying assumption made by the author, that the research sample was fully aware with respect to what technologies are currently available.

Question 4: Please indicate your willingness to consider applying existing technologies in your business-to-business transactions

This partially close-ended question provided the respondents with the opportunity to indicate if they were: unwilling to consider applying existing technologies, willing to consider applying existing technologies, or currently applying existing technologies in purchasing processes.

The purposes of this question were mainly twofold. Firstly, to gauge whether there was an appetite to adopt existing technologies (as defined by the author in the question). Secondly, to compare these results against the results obtained from Question 2, where respondents were asked to indicate the level of usage of ICT to support their B2B purchasing transactions. The results of this question are made more credible by cross tabulating the responses to this question with those received earlier for Question 2. In addition to the response required concerning their level of willingness, respondents were asked to provide commentary to justify the responses provided.

The results are shown graphically in Figure 4.4. Using Table 4.6 and the statistical technique of cross-tabulation, the following interesting observations can be drawn by comparing the responses of this question, with those of Question 2:

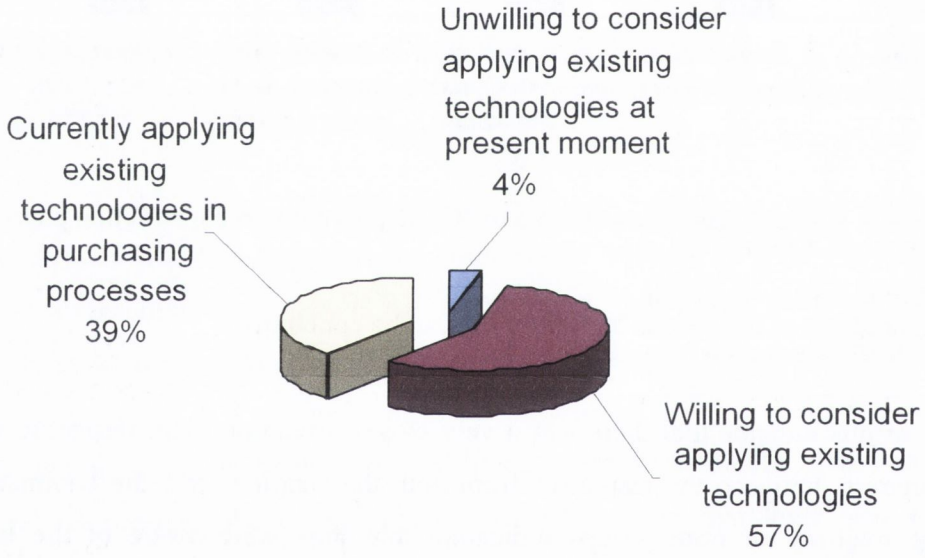


Figure 4.4. Willingness to consider applying existing technologies in B2B transactions

Leading diagonal of values

Question 4: Please indicate your willingness to consider applying existing technologies in your B2B transactions	Question 2: Please indicate how you would rate the current level of ICT usage in your B2B purchasing transactions						
		No use	**Little**	**Some**	**Moderate**	**Regular**	**Total**
	Unwilling	**1**	**1**	**0**	**0**	**0**	**2**
	Vertical %	14.3	5.6	0.0	0.0	0.0	3.7
	Horizontal %	50.00	50.00	0.0	0.0	0.0	100.0
	Willing	**6**	**12**	**8**	**2**	**3**	**31**
	Vertical %	85.7	66.7	61.5	33.3	30.0	57.4
	Horizontal %	19.3	38.7	25.8	6.5	9.7	100.0
	Applying	**0**	**5**	**5**	**4**	**7**	**21**
	Vertical %	0.0	27.7	38.5	66.7	70.00	38.9
	Horizontal %	0.0	23.8	23.8	19.0	33.4	100.0
	Total	**7**	**18**	**13**	**6**	**10**	**54**
	Vertical %	100.0	100.0	100.0	100.0	100.0	100.0
	Horizontal %	12.9	33.4	24.0	11.1	18.6	100.0

Table 4.6. Cross-tabulation of Question 2 and Question 4

1. Only 2 respondents indicated an unwillingness to consider applying existing technologies at the present moment. One of the respondents commented that there were no suitable ICT options currently on the market. The other respondent commented that they would need to replace their current ICT infrastructure before they would look at particular supporting B2B purchasing solutions.
2. Of the 31 companies that indicated they were willing to consider applying existing ICT in B2B purchasing transactions, the horizontal results shows 18 (6+12) companies or 58% (19.3%+38.7%) indicating little/no use of ICT in B2B purchasing transactions. Of the 21 companies who reported that they were currently applying existing technologies in their B2B purchasing transactions, the horizontal percentage shows 10 (5+5) companies or 47.6% (23.8%+23.8%) rating their use of ICT in their B2B purchasing transactions as little or some use (see values circled in Table 4.6).
3. Table 4.6 shows that the highest values on the leading diagonal indicate consistency. There were however, some inconsistent responses with high values off the leading

diagonal which suggests a misinterpretation of Questions 2 and 4 by some of the respondents.

Question 5: Would you agree that e-commerce has significantly affected the strategies of construction businesses in this country?

This partially close-ended question provided the respondents with the opportunity to indicate that they were either in agreement or disagreement that EC has significantly affected the strategies of construction businesses in Ireland. The purposes of this question were twofold. Firstly to gauge overall, how important ICT is to these companies in formulating a business strategy and secondly to see if there was a divergence of opinion between the contractors and suppliers, in positioning ICT centrally in their strategic planning. Allied with the close-ended question, respondents were encouraged to provide commentary to justify their agreement or disagreement as to the strategic significance of EC.

The results are shown graphically in Figure 4.5.

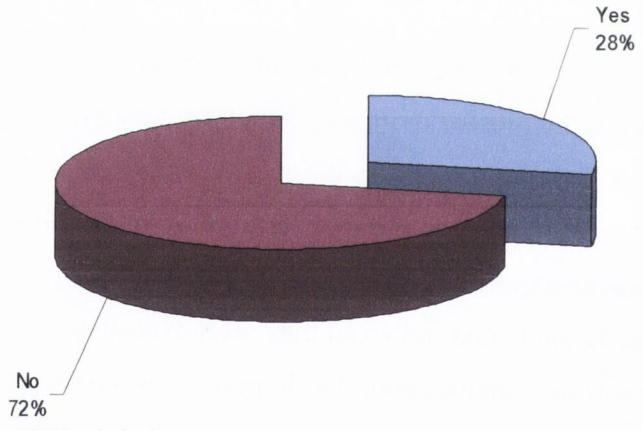


Figure 4.5. Affect of eCommerce on the strategies of construction businesses in Ireland

From an analysis of the results the following observations can be made:

1. 72% of the respondents disagreed that EC has significantly affected the strategies of construction businesses. This percentage level was confirmed by both the contractor and supplier samples.

2. The results of this question suggest that EC does not feature highly in the industry's strategic thinking at the present moment. It will be seen later in this analysis that the respondents treat ICT more as a business tool to improve productivity levels than think of ICT strategically.
3. Thomas (1999) found that only 12% of contracting firms surveyed were of the opinion that ICT can influence business strategy. The majority of those surveyed in 1999 did not have or did not intend to adopt an ICT strategy.

It is important for the author to mention, that the respondents were mainly IT managers and thus may not have been the best people to respond to this type of question. As a direct result, the author cannot rely on the accuracy of the results from this sample with respect to the responses received for this question.

Question 6: Do you expect an increasing significance of e-commerce over the next three years?

The results are shown graphically in Figure 4.6.

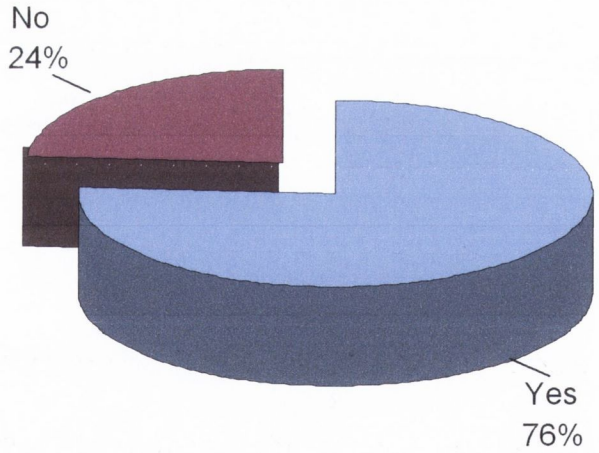


Figure 4.6. Do you expect an increasing significance of eCommerce over the next three years?

From an analysis of the results the following observations can be made :

1. 76% of the respondents were of the opinion that they expected an increasing significance to be placed on EC over the next three years. This would indicate that perhaps there is a change of attitude towards EC, as to the benefits that it could bring to Irish construction companies in the short term.
2. A number of interesting comments were made by the respondents, such as :

    a. 'As more government clients seek to achieve online targets, the construction industry will be forced to adopt new technologies'.
    b. 'The increasing use of the Revenue Commissioners Online Service (ROS) and web banking has proven the benefits of e-commerce and has reduced our administration costs'.
    c. 'Clients and the larger contractors are driving change'.
    d. 'People will always adapt to change in an effort to secure a bigger piece of the market'.

The results of this question suggest that the research sample are aware of the importance of EC and the importance that the Irish government are placing on EC in recent years. A number of the respondents confirmed that they are already partaking in EC activity, albeit they mainly spoke of EC technologies as supporting purchases of stationary and electronic banking.

Question 7: To what extent does your company make use of the particular technologies in the sales/purchasing of construction materials?

This close-ended question had unordered technology choices from which the respondents could indicate their level of use. The purposes of this question were twofold. Firstly to gauge the extent of use of particular technologies, and in particular, to establish which technologies were the most widely adopted by the research sample. Secondly to capture the samples' experiences with the use of such technologies.

The results of this can be seen in Figure 4.7.

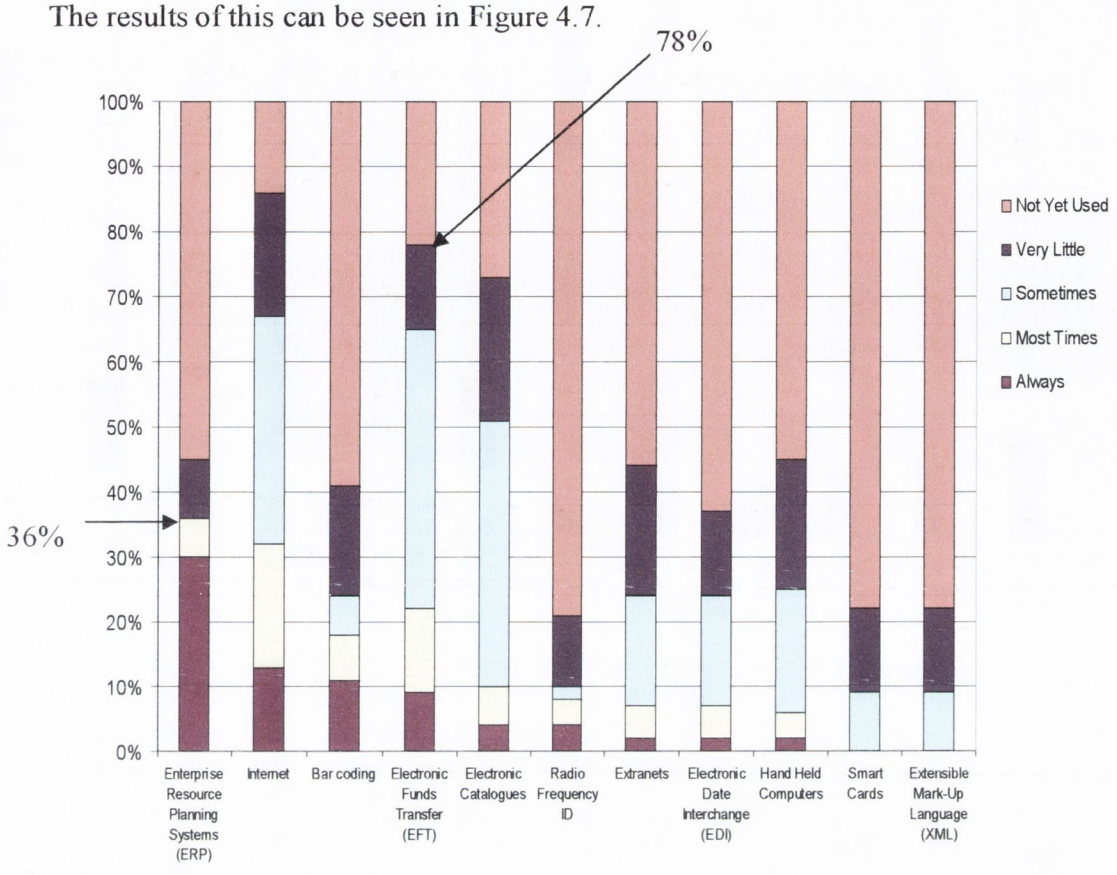


Figure 4.7. Use of particular technologies in sales/purchasing

Note: The most widely adopted technologies are presented in the order of use from left to right of the chart.

From an analysis of the results, the following observations can be made:

1. 36% of the sample indicated that they were using ERP software either always or most times to support their B2B communications and 78% of the sample confirmed that they had used Electronic Funds Transfer (EFT) software.
2. On further analysis, it was evident that there was a marginally greater use of existing technologies in the supplier's research sample, in comparison to the contractor's sample (see Figures 4.8 and 4.9).

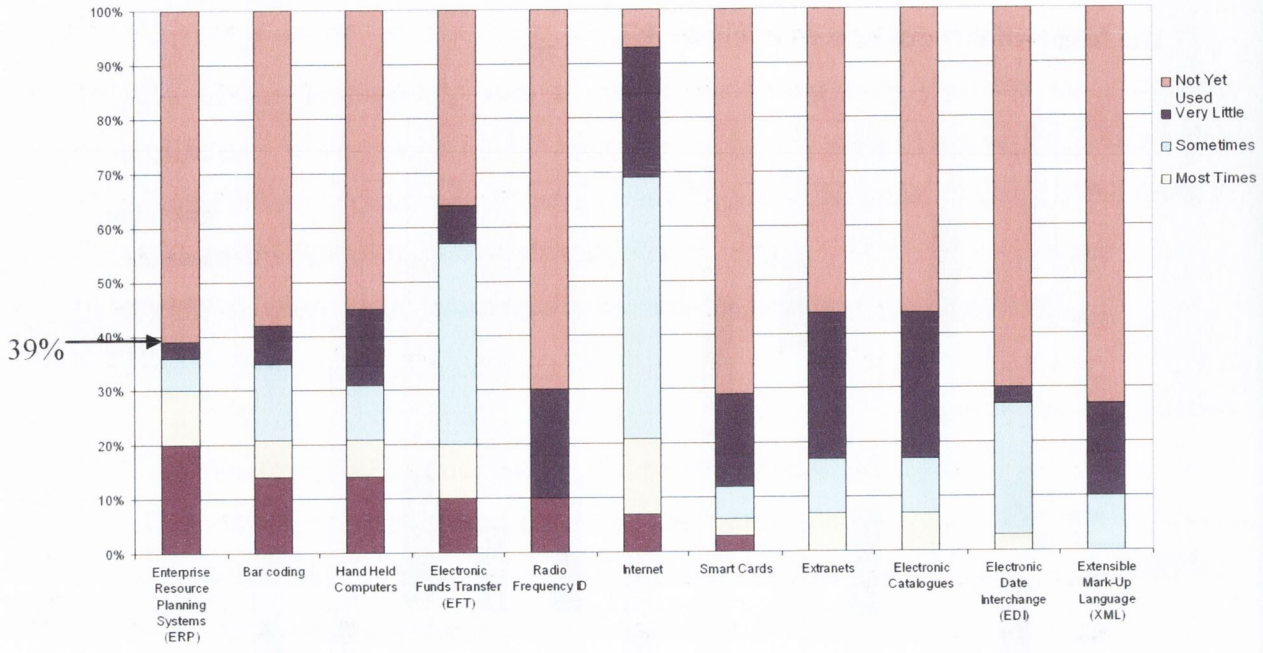


Figure 4.8. Supplier's use of particular technologies in sales of materials

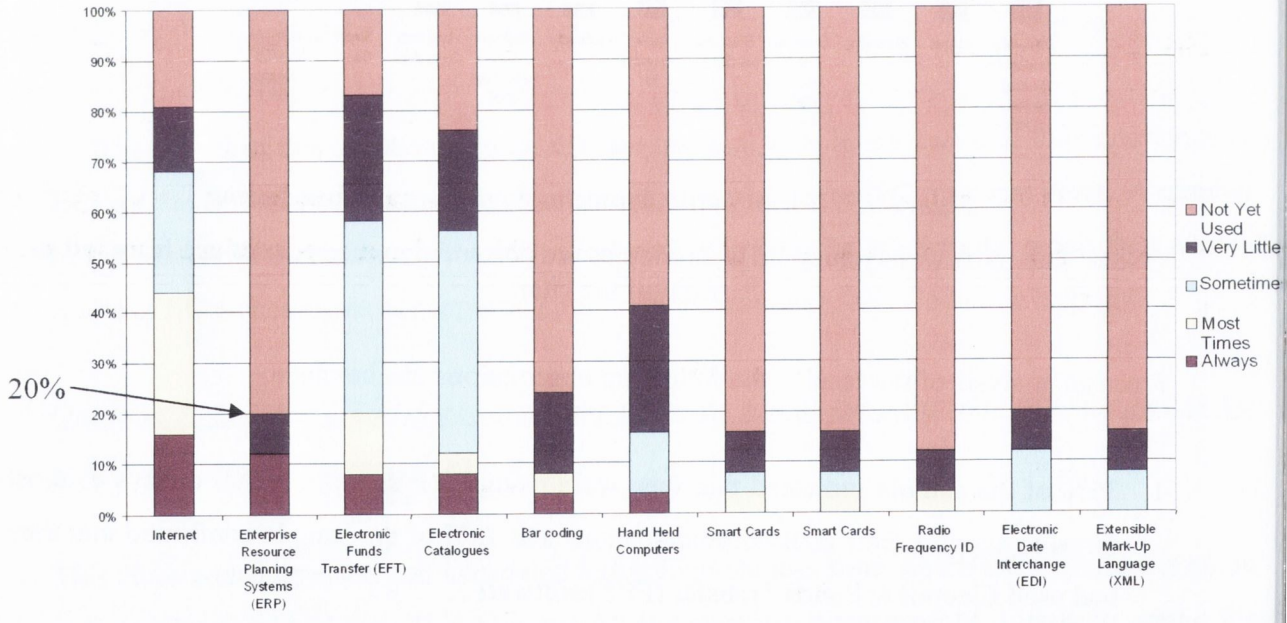


Figure 4.9. Contractor's use of particular technologies in purchasing of materials

3. It can be seen from Figures 4.8 and 4.9 that 39% of the suppliers had an ERP capability, whilst only 20% of contractors confirmed that they had an ERP capability. This is not surprising, as the use of ERP systems by contractors is only a relatively new

development in recent years. Large supplier of materials in Ireland, such as Cement Roadstone Holdings, Heiton Buckley, Brookes Tomas (Wolseley), Grafton Group, Kingspan are established multi-national companies with an established ERP capability for a number of years.

4. The suppliers also used bar coding and hand-held computers extensively to facilitate goods inwards and order entry. Figure 4.9 shows that the contractors' overall level of usage of particular technologies was significantly lower than the suppliers'. Technologies most widely used included the Internet, EFT software and electronic catalogues.
5. The responses to this question suggest that there is more widespread use of sophisticated technologies by suppliers, in comparison to the contractors surveyed, while usage is low overall. Many of the suppliers surveyed did agree that there was a demand for electronic trading within the construction industry and commented that their industrial customers were far more advanced.

Question 8: How is your company's involvement in eBusiness and the use of the Internet expected to change within the next three years?

This close-ended question provided the respondents with an ordered choice of: great increase expected, little increase expected and no increase expected. The results of this can be seen in Figure 4.10.

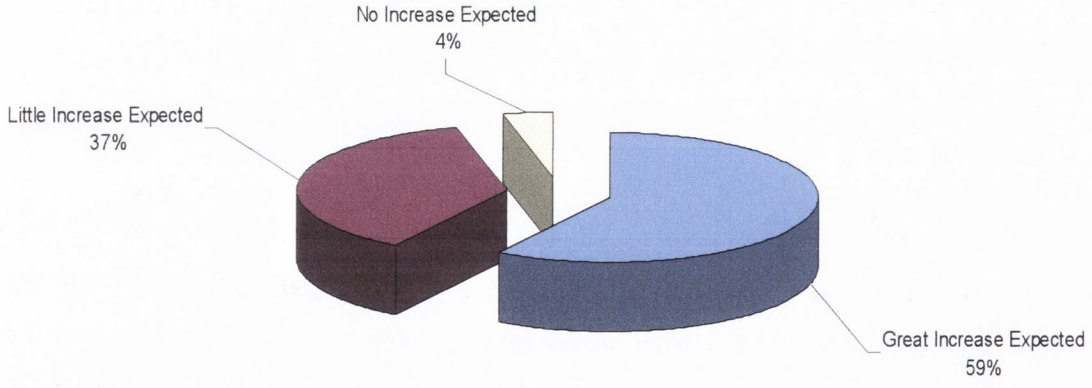


Figure 4.10. Expected level of change in eBusiness over next three years

From an analysis of the results the following observations can be made:

1. 59% of respondents were of the opinion that a great increase in eBusiness and the use of the Internet was expected within the next three years. However, the remaining 41% were not of the opinion that their businesses would be taking an active part in eBusiness within the next three years. The author was surprised that this figure was so high, suggesting a worrying level of apathy among the sample surveyed.
2. It was interesting to compare the results of this question, with those responses received in Question 3, 6 and 8. This comparison is shown in Table 4.7.

Question 3 Current state of awareness of ICT deployment				**Question 6 Increasing significance of eCommerce over next three years**				**Question 8 Company's involvement in eBusiness and Internet over next three years**			
	Contractor	Supplier	Average		Contractor	Supplier	Average		Contractor	Supplier	Average
Not aware	8%	3%	5%	Yes	76%	76%	76%	Great increase	64%	54%	59%
Somewhat aware	36%	41%	39%	No	24%	24%	24%	Little increase	36%	38%	37%
Aware	24%	24%	24%					No increase	0%	8%	4%
Moderately aware	16%	24%	20%								
Very aware	16%	8%	12%								

Table 4.7. Comparison of responses from Questions 3, 6 and 8

The results of Question 6 showed that 76% of the sample predicted a significant increase in EC in the construction industry within the next three years. On further questioning, in response to Question 8, this same group predicted that their own company involvement in eBusiness would significantly increase within the next three years. However, the results of Question 3 show that only 12% of the sample were aware of ICT capabilities to deliver eBusiness (see values circled in Table 4.7).

As may be seen from Table 4.7, 41% (37%+4%) sample expected little or no increase in EC activity in their businesses over the next three years. The author finds it difficult to see how such a large percentage could predict little to no use of the Internet and eBusiness over the next three years. Perhaps there are practical reasons that should be investigated as to why this is the case (see values circled in Table 4.7).

In order to investigate this matter further, the author compared the results of this question to the results obtained from Question 4. Using the statistical technique of cross-tabulation, some interesting observations can be drawn by comparing the results of the samples' willingness to adopt existing technologies against their expectations of their use of such technologies over the next three years. This cross-tabulation is summarised in Table 4.8.

		Q.8 How is your company's involvement in eBusiness and the use of the Internet expected to change within the next 3 yrs?			
				Leading diagonal of values	
		No Increase	**Little Increase**	**Great Increase**	**Total**
Q.4 Please indicate your willingness to consider applying existing technologies in your B2B transactions	**Unwilling**	**0**	**2**	**0**	**2**
	Vertical %	0.0	10.0	0.0	3.7
	Horizontal %	0.0	100.0	0.0	100.0
	Willing	**1**	**15**	**13**	**31**
	Vertical %	50.0	85.0	40.6	57.4
	Horizontal %	3.3	54.8	41.9	100.0
	Applying	**1**	**1**	**19**	**21**
	Vertical %	50.0	5.0	59.4	38.9
	Horizontal %	4.8	4.8	90.4	100.0
	Total	**2**	**20**	**32**	**54**
	Vertical %	100.0	100.0	100.0	100.0
	Horizontal %	3.7	37.0	59.3	100.0

Table 4.8. Cross-tabulation of Question 4 and 8.

The data in Table 4.8 can be analysed in two ways. The vertical percentages show, for example, that of those who are expecting a great increase in the use of the Internet over the next

three years, 40.6% are willing to apply existing technologies in their B2B purchasing transactions, while the remaining 59.4% are already applying these technologies.

The horizontal percentages show that of those who are applying the technologies, 90.4% are expecting an increase in Internet eBusiness usage over the next 3 years. The results suggest that there is quite a high level of willingness to applying existing technologies to support their B2B purchasing transactions in the sample. The results also show that out of the 20 organisations that predicted little increase in their use of the Internet over the next three years, 85% of them remained willing to applying existing technologies to support their B2B purchasing transactions.

Once again Table 4.8 shows a consistency in the responses, as the author would expect a leading diagonal from top left to top right of increased values as shown on Table 4.8.

Question 9: Does your company have concerns over adopting a web-based strategy for future business-to-business purchasing transactions?

This close-ended question provided the respondents with an ordered choice of yes or no. The results of this can be seen in Figure 4.11.

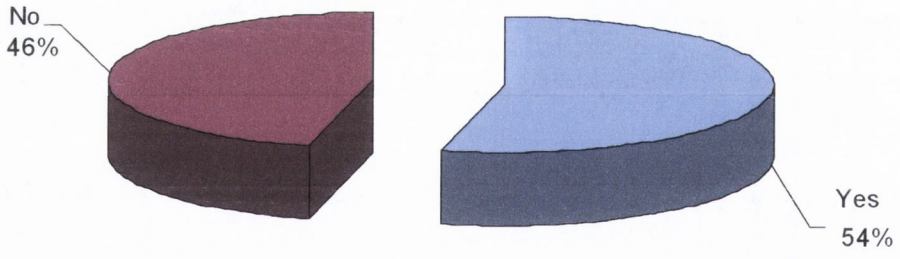


Figure 4.11. Does your company have concerns over adopting a web-based strategy for future business-to-business purchasing transactions?

It is well documented in recent years that there is a great concern among businesses concerning the use of the Internet to trade. This concern is founded on a perception of poor security, high costs, legality and the high costs associated with adopting a web-based purchasing strategy. The research sample were largely divided in their responses, with 54%

indicating that they were concerned about the adoption of a web-based strategy for future B2B purchasing transactions.

Question 10: If Yes to question 9, what are / have been your company's concerns with regard to adopting a web-based strategy for business-to-business purchasing transactions?

This partially close-ended question provided the respondents with an unordered choice of concerns from which they could identify as most concerned; moderately concerned or not concerned. The purpose of this question was to identify specifically the key concerns of the research sample, with respect to the adoption of a web-based strategy.

The results are shown graphically in Figure 4.12.

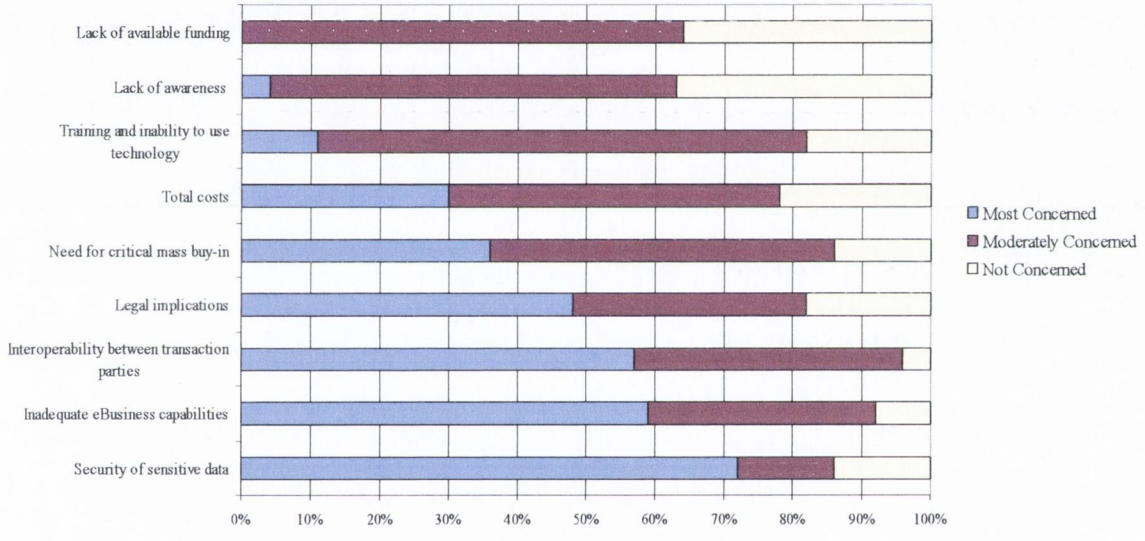


Figure 4.12. Concerns with regard to adopting a web-based strategy for purchasing

From an analysis of the results presented for Question 10, the following observations can be made:

1. It is evident from Figure 4.12 and from Table 4.9, that security of sensitive data, and customers/suppliers not possessing adequate eBusiness capabilities were the main concerns of both groups. Both groups of respondents agreed on the level of concern in respect to security of sensitive data (with 41% for suppliers and 40% for contractors),

however the suppliers appeared to be more concerned (41%) than the contractors (32%) in respect to the adequacy of their supply chain in having an eBusiness capability (see values circled in Table 4.9).

2. A larger proportion of suppliers, in comparison to contractors, were of the opinion that a lack of interoperability between transaction parties was a key concern. The sample was less concerned about a lack of knowledge, availability of funding, training and the need for critical mass buy-in. This would suggest to the author, that the sample was not afraid of change and the costs associated with the web-based strategy. It also suggests that the sample is very conservative in their approach to adopting a web-based strategy.

Concern	**Contractors**			**Suppliers**		
	Most Concerned	Moderately Concerned	Not Concerned	Most Concerned	Moderately Concerned	Not Concerned
Lack of awareness or knowledge of Internet capabilities	8%	24%	24%	3%	34%	17%
Customer / supplier may not possess adequate eBusiness capabilities	32%	20%	4%	41%	10%	3%
Lack of available funding	4%	28%	20%	0%	41%	20%
Total costs	24%	20%	8%	17%	24%	12%
Security of sensitive data	40%	12%	8%	41%	10%	7%
Interoperability between transaction parties	24%	24%	4%	37%	17%	0%
Legal implications	16%	28%	8%	24%	17%	14%
Training and inability to use technology	12%	32%	8%	3%	34%	10%
Need for critical mass buy-in	16%	32%	8%	24%	34%	7%

Table 4.9. Concerns over a web-based strategy

Question 11: *Please rank in order (1-10) the following factors, which attract or are likely to attract your organisations to apply existing technologies in construction purchasing.*

This was a closed-ended question, with unordered choices of drivers, from which the respondents ranked from 1-10 (one is referred to Table 4.10 for choices provided to the respondents).

The overall results of the ranking, together with the unordered choices, are shown in Table 4.10 and Figure 4.13. Appendix B.4 details the calculations of the ranking of the driving forces, within the research sample.

Drivers	Contractors Rank	Suppliers Rank	Overall Ranking
Saving manpower in processing invoices and other information; fewer errors in recording and handling information	4	1	1
Reducing paperwork (orders, invoices and delivery dockets)	1	5	2
Improved accessibility to time and cost data: providing real time information; ability to contribute to data interchange in a national standard format	3	3	3
Fewer errors in recording and handling information	2	4	4
Reduced cost of capturing data	6	2	5
Avoidance of re-keying information into computer systems	5	6	6
Service differentiation from competitors	10	7	7
Clients who may encourage or stipulate the use of ICT in purchasing	8	8	8
Competitor organisations who may have applied ICT in purchasing processes	7	9	9
Ability to contribute to data interchange in a national standard format	9	10	10

Table 4.10. Ranking of driving forces in deployment of EC technologies

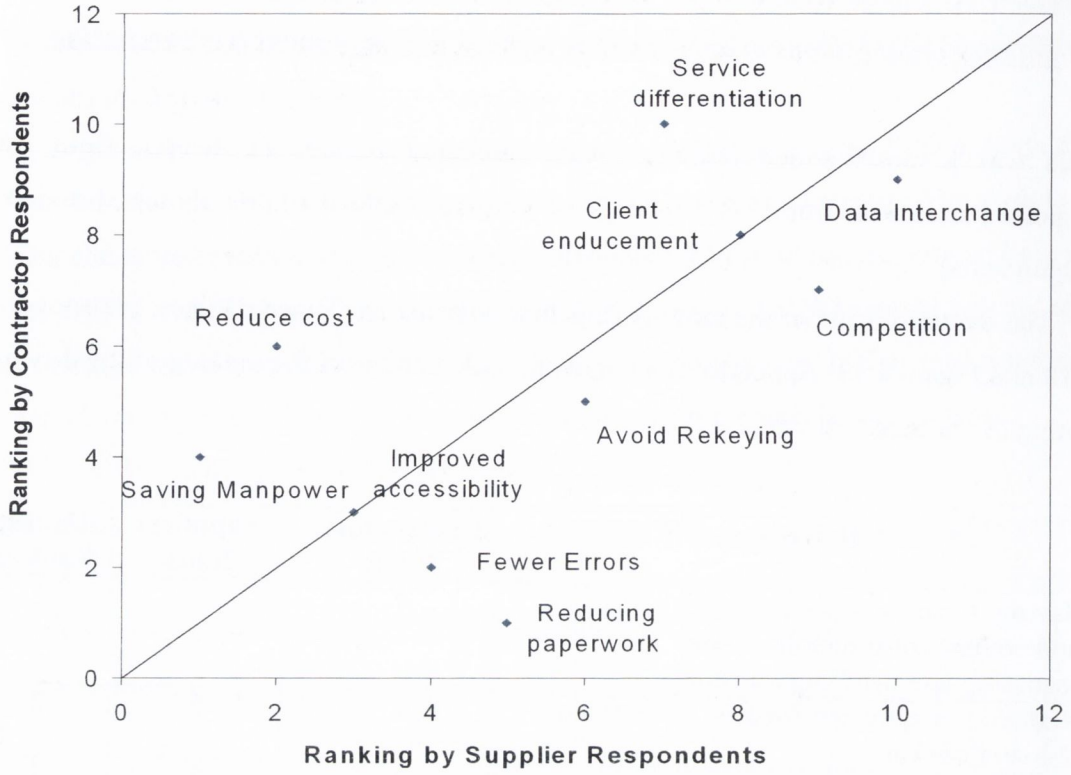


Figure 4.13. Ranking of driving forces in deployment of EC technologies

From an analysis of the results presented for Question 11, the following observations can be made:

1. It is evident from both Table 4.10 and Figure 4.13 that there was a divergence of opinion between the contractors and suppliers, as to the ranking of the driving force choices provided in the Question. In only two instances did the two groups concur on the ranking. However, there were other drivers that both groups closely agreed upon. The degree of ranking correlation is illustrated by use of the scatter diagram shown in Figure 4.13. The nearer the points are to the 45^0 diagonal lines, the greater is the degree of rank correlation between the two groups. It can be seen that quite a few of the driving forces were ranked sufficiently close to the 45° line to conclude that there was broad agreement on the ranking.

2. The degree of correlation can be measured by use of Spearman's Co-efficient of Rank Correlation r. The results of the formula calculated r (in Appendix B.4) as 0.64, where a value of 1.0 would be a perfect correlation. A further statistical calculation to test the sample for reliability, as a measure of the population correlation. This significance value Z provided a value of 1.94, which was sufficiently close to the 95% distribution value of 1.96 to conclude a 95% significance level can be assumed for the responses to this question. The result allows the author to conclude that the level of correlation achieved between the two groups can be statistically relied upon as accurate representations of the groups preferred ranking of drivers to EC deployment.
3. Both groups ranked reduced paperwork, fewer errors, and improved accessibility to information and manpower savings, as the main drivers that would attract their organisations to deploy EC technologies.
4. Client persuasion, perceived threats by competitors and the need for data interchange standards were, surprisingly, not considered to be major driving forces. This is inconsistent with the response to Question 10 that clearly showed security of data as a key concern.
5. The results of this Question indicate that ICT is perceived as a tool for cost reduction, rather than as a strategic issue within the industry. Saving manpower, reducing paperwork, improving accessibility to time and cost data and fewer errors in recording and handling information, were the most significant overall driving forces. However, it is important to recognise that this survey was targeted at IT managers and not senior management therefore strategic driving forces may not be sufficiently representative of the companies in this survey.

Question 12: Please rank in order (1-6) the barriers, which undermine the use of ICT in construction purchasing within your organization

This was a closed-ended question, with unordered choices of barriers, from which the respondents ranked from 1-6 (one is referred to Table 4.11 for choices provided to the respondents).

The overall results of the ranking are shown in Table 4.11 and Figure 4.14. Appendix B.4 details the calculations of the ranking of the driving forces, within the research sample.

Internal Barriers	Contractors Rank	Suppliers Rank	Overall Ranking
Potential benefits of electronic purchasing are not likely to be sufficient to justify investments	2	1	1
Development costs are prohibitive (hardware, software and training)	3	2	2
A lack of awareness of ICT deployment in purchasing	1	4	3
Technology is not yet reliable enough for use in construction environment	4	5	4
Uncertainty about how to measure the costs and benefits of such investments	6	3	5
Employees are likely to resist the introduction of new technologies	5	6	6

Table 4.11. Internal barriers to EC deployment

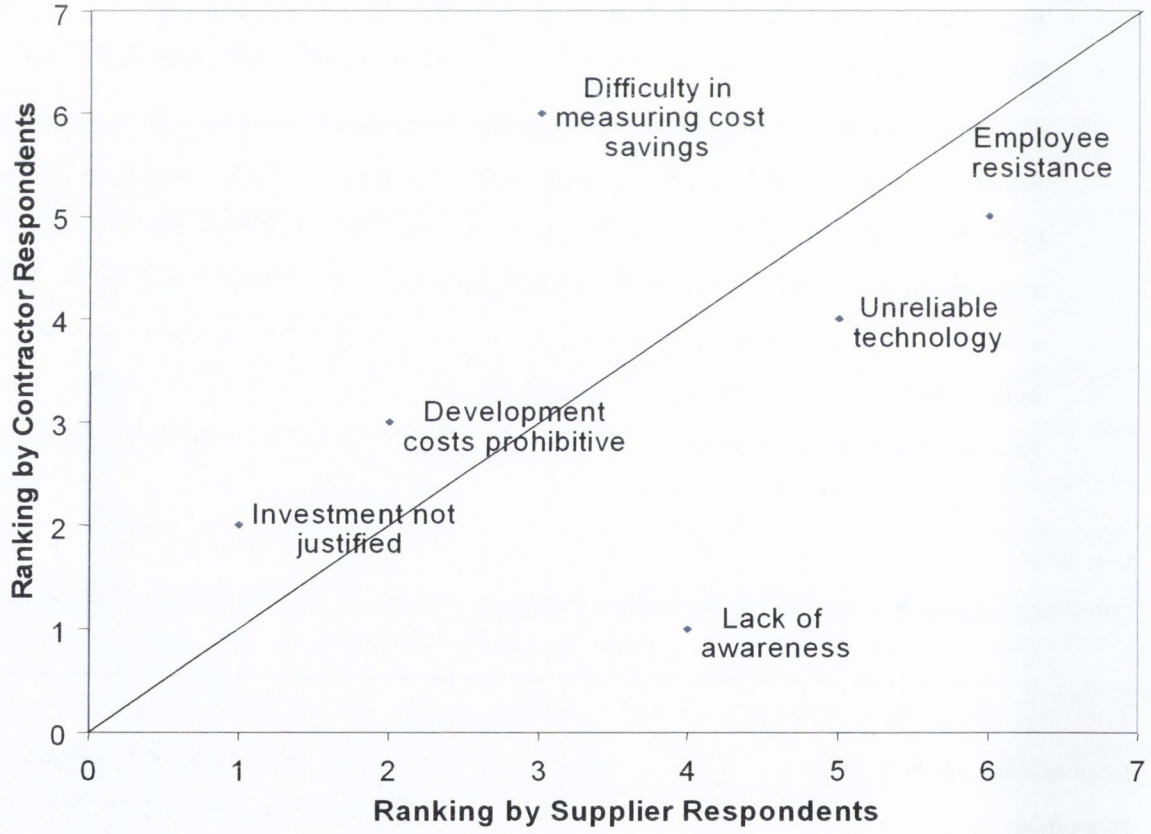


Figure 4.14 Ranking of internal barriers

From an analysis of the results presented for Question 12, the following observations can be made:

1. It is evident from both Table 4.11 and Figure 4.14 that there was some measure of divergence of opinion between the contractors and suppliers, as to the ranking of the internal barriers to electronic purchasing provided in the Question. The degree of ranking correlation is illustrated by use of the scatter diagram shown in Figure 4.14. It can be seen that a number of the driving forces were ranked sufficiently close to the 45° line to conclude that there was broad agreement on the ranking.
2. Spearman's' Co-efficient of Rank Correlation, r was calculated in Appendix B.4 as 0.37. A significance test provided a Z value of 0.83. The Z value of 0.83 is not close to the 95% distribution value of 1.96. There are a relatively small number of factors or choices to be ranked in comparison to question 11 (6 rather than 10). As a direct result of this reduction, it is more difficult to statistically assess with confidence the existence of a correlation in the responses within the population. This does not also disprove the existence of a correlation mathematically. However, when one examines the results in Table 4.11, it would appear that there is a reasonable degree of similarity between the two groups with respect to the ranking of barriers in this question to draw conclusions.
3. It is evident from both Table 4.11 and Figure 4.14, that the main internal barrier in the research sample was that the potential benefits of electronic purchasing were not likely to justify the investment in ICT. The prohibitive cost associated with purchasing hardware and software was selected overall, as the next most important barrier for the research sample.
3. Both groups of respondents did not rank highly the fact that employees are likely to resist the introduction of new technology.

Question 13: Please rank in order (1-6) the barriers which undermine the use of ICT in construction purchasing in the Irish construction industry

This was a closed-ended question, with unordered barriers, which the respondents ranked from 1- 6. The purpose of this question was to identify specifically the external barriers, which prevented organisations adopting ICT in construction purchasing.

The overall results of the ranking are shown in Table 4.12 and Figure 4.15. Appendix B.4 details the calculations of the ranking of the driving forces, within the research sample.

External Barriers	Contractors Rank	Suppliers Rank	Overall Ranking
There is a general lack of awareness of ICT capabilities in construction purchasing and its potential benefits to the Irish construction supply chain	1	2	1
There is a high incidence of technologically conservative organisations in the Irish construction industry	3	3	2
There is no motivation for organisations to apply ICT in construction purchasing when other parties will benefit	6	1	3
The temporary nature of relationships between organisations results in an unwillingness to invest in ICT which may only be short lived	4	4	4
There are too many construction products and components to make the adoption of ICTs in construction purchasing widespread	2	5	5
There is a general lack of leadership from the government to actively promote the use of ICT in construction procurement	5	6	6

Table 4.12. External barriers

From an analysis of the results presented for Table 4.12, the following observations can be made:

1. Respondents were asked to rank the order of importance with respect to the perceived barriers to the adoption of EC within the Irish construction industry. Again, there was common agreement in the survey concerning the general factors in the industry, which undermine the use of ICT in construction purchasing.
2. It is evident from both Table 4.12 and Figure 4.15, that there was more of a divergence of opinion between the contractors and suppliers, as to the ranking of the external barriers to electronic purchasing compared to the ranking of the internal barriers to EC deployment. There was however good correlation between the groups opinions

regarding the existence of technologically conservative industries and the temporary nature of construction business relationships.

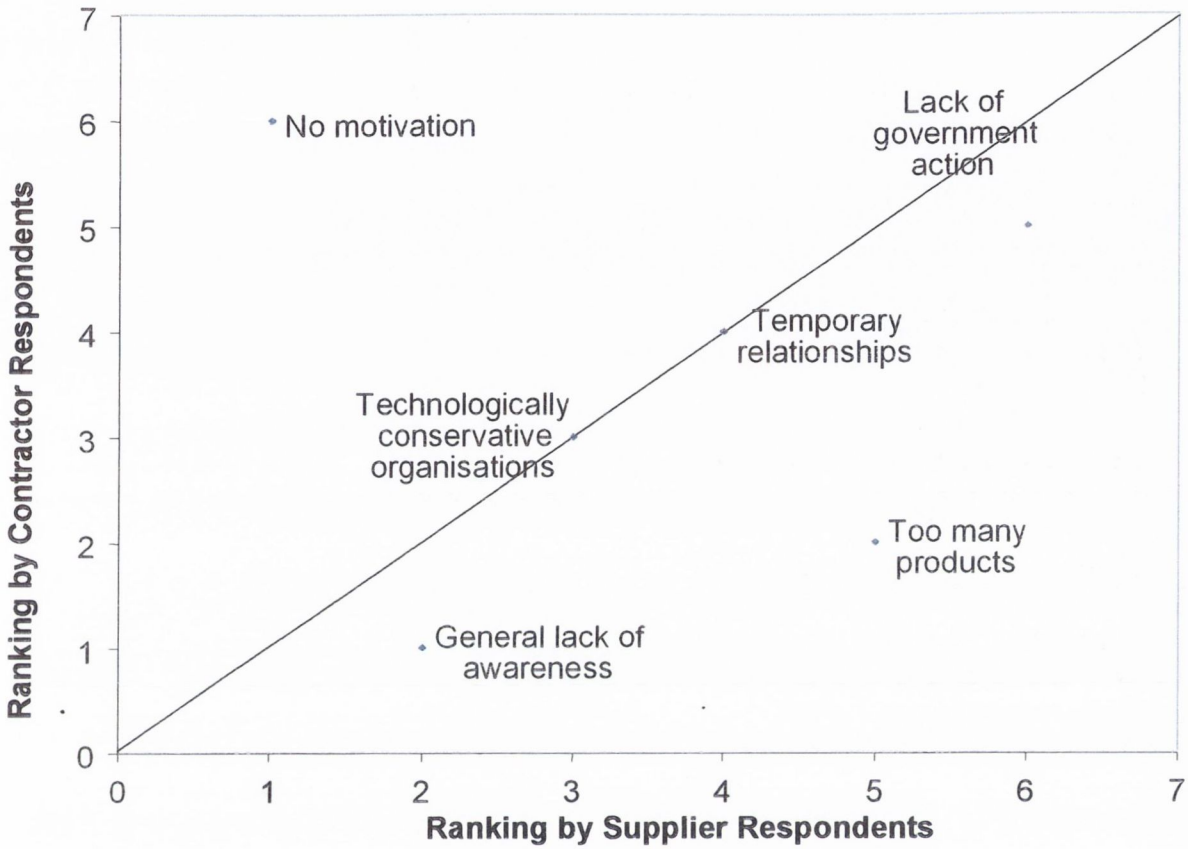


Figure 4.15. Ranking of external barriers

3. Spearman's Co-efficient of Rank Correlation r was calculated in Appendix B.4 as 0.03. A significance test provided a Z value of 0.067. The value of 0.067 is not close to the 95% distribution value of 1.96. As in question 12, there are a relatively small number of factors or choices to be ranked in comparison to question 11 (6 rather than 10). As a direct result of this reduction, it is again more difficult to statistically prove the existence of a correlation of this response within the population. There was perfect correlation on 2 of the external drivers and also a wide divergence of opinion on other barriers as shown in Figure 4.15.

It is evident from both Table 4.12 and Figure 4.15 that the main external barriers were a general lack of awareness of the ICT capabilities and benefits to the Irish

construction supply chain, the high incidence of technologically conservative organisations and an unwillingness to invest to the betterment of others.

4. Respondents tended to disagree with the suggestion that there were too many construction products and components to make the adoption of ICT in construction purchasing widespread. Surprisingly the sample did not feel there was a general lack of leadership from the Irish government to actively promote the use of ICT in construction procurement.
5. The results would suggest that the industry requires education and training in promoting the business benefits of deploying ICT in construction purchasing. This lack of knowledge and awareness is the cause of the high incidence of technologically conservative organisations in the Irish construction industry.

Question 14: Please indicate your position on the following statements:

This part of the survey focused on the respondents' position in regard to statements on the likely future direction of EC in the Irish construction industry. Figure 4.16 summarises the results.

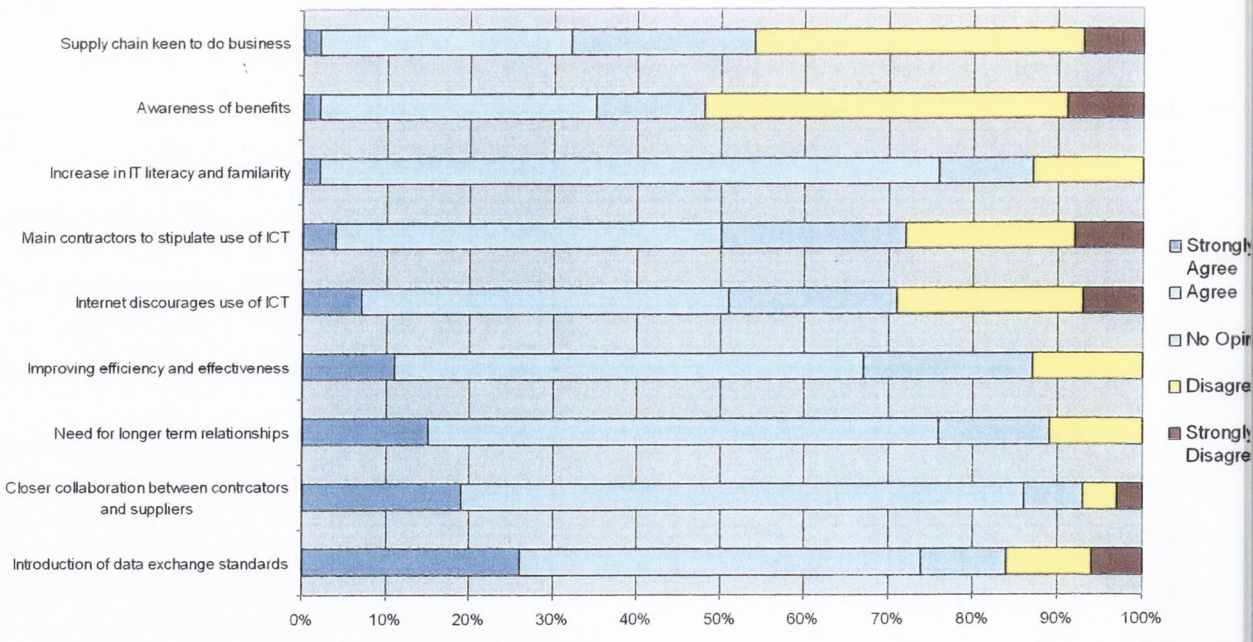


Figure 4.16. Overall importance of future directions for adoption of electronic purchasing

Respondents did not agree with the statements regarding suppliers being keen on doing business via the internet and that there was a general awareness of the benefits of deploying existing technologies in construction purchasing. The importance of the introduction of industry standards for electronic data interchange, closer collaboration between trading partners, the increase of ICT literacy and familiarity with electronic purchasing and the involvement of EC for improving the efficiency and effectiveness of the supply chain were considered to be the highest ranking of the statements presented to the respondents.

4.5 SUMMARY OF FINDINGS

The following is a summary of the main findings from this survey:

1. The current level of ICT take-up in the Irish construction industry is relatively low among the top contractors and suppliers in the Republic of Ireland.
2. The majority of respondents surveyed are adopting some level of ICT in the processing of their B2B purchasing transactions. However, the overall level of sophistication is very low.
3. There was a low level of awareness among the respondents of the technologies currently available to support B2B purchasing transactions.
4. EC did not appear to feature highly in the strategic planning of most respondents surveyed. However, it was noted by the author, that it was mainly IT managers who completed the survey, and as a result they may not be directly involved in strategic planning.
5. The majority of respondents were of the opinion that they expected an increased significance to be placed on EC in the next three years. However, this increase was not expected to materialise into electronic trading within the next three years.
6. The results suggest that there is a higher level of ICT sophistication among the suppliers surveyed in comparison to the contractors.
7. 54% of the respondents were concerned about the adoption of a web-based strategy for electronic purchasing. The main concerns of the sample included security of data and the inadequacy of the eBusiness capability of the construction supply chain.

8. Respondents identified saving manpower and reducing paperwork as the main incentives to the use of EC in the future. This indicated that ICT was perceived more as a tool for cost reduction rather than as a strategic issue within the industry.
9. The main internal barriers to the adoption of EC were that the potential benefits of electronic purchasing were not likely to justify the investment in ICT and the prohibitive cost of the technology.
10. The main external barrier to the adoption of EC was the general lack of awareness of ICT capabilities in construction and the potential benefits to the Irish construction supply chain.
11. Respondents were of the opinion that the introduction of industry standards and closer collaboration between trading partners were very important to the future widespread adoption of EC in the Irish construction industry.

All of these findings provide a number of key challenges for the industry, namely:

- Low level of ICT sophistication in B2B purchasing in construction.
- Lack of awareness in regard to currently available B2B purchasing technology.
- ICT does not form part of the strategic planning of construction businesses.
- Considerable concerns exist with respect to the adoption of a web-based B2B purchasing strategy.
- The business benefits of purchasing electronically must be clearly presented to the industry.
- There is a need to develop standards for electronic purchasing in construction and encourage closer collaboration between businesses in the Irish construction supply chain.

4.6 INTERNATIONAL COMPARISION

Other similar studies that have been carried out in recent years include the following:

1. A study in 2003 by the CPA (2003) in the UK, of the current and future impact of EC on the UK construction industry.

2. IT Construction Forum (2004) survey of IT use in the UK construction industry, undertaken by the Construction Excellence Forum.
3. A study on the impact of ebusiness in UK construction prepared by Davis Langdon Consultancy in January 2002 (DLC, 2002), commissioned by the DTI in the UK and the Construction Industry Directorate (CID).
4. eCommerce in Construction survey carried out by the Construction Industry Institute (CII) in the US, which formed part of a 2002 comprehensive study of the state of practice of eCommerce applications in the US construction industry (CII, 2002b).

There is a limit to the extent of comparison between these different studies, as there is a variation in both the quantities and classification of individuals and firms supplying the data. Of the four publications, the CII survey is the closest to the Irish survey described in this Chapter. Although a direct and exact comparison is not possible, the following sections provide comments that can be made in relation to the current and future use of ICT in construction purchasing by contracting and supplier firms in the Republic of Ireland based on the findings of these publications.

4.6.1 Construction Products Association (2003)

The results of surveys undertaken by the CPA built a picture of UK construction e-business trends, and provided useful indicators of current and likely future uptake. These surveys do not provide any detail of their size and response, so it is not possible to comment on their validity. Results suggest that on average, e-business is used for about 5% of business activities in construction. CPA reported in 2003 that 88% of their members were committed to embracing the benefits of EC. The survey reported however, that only 10% of their members were trading electronically, with over half using EC portals. This was predicted to increase to 22% by 2005.

These results compare to the author's findings that 96% of respondents surveyed were either applying or were willing to apply ICT to support their B2B purchasing transactions (see Figure 4.4). However on average only 19% of respondents indicated that they used ICT regularly to trade electronically (see Figure 4.2).

The CPA 2003 survey reported that increased speed of transactions and reduced costs are seen as the most important advantage of EC by their members. The CPA found that the culture of the construction industry and lack of compatibility of standards and systems were seen as the most significant barriers to the development of EC.

The author's results show that savings in manpower, reducing paperwork, improving accessibility to time and cost data and fewer errors in recording and handling information were considered to be major drivers to the adoption of EC by the respondents (see Figure 4.13).

4.6.2 IT Construction Forum (2004)

A total of 373 firms of all types and sizes responded to this survey. The main purpose of the survey was to provide an up-to-date picture of firms' current use of IT in construction, and their perceptions of its value. The survey reported that most firms use the Internet to source information about construction products. Email was used extensively for communications and, additionally, to order products, materials and services. Just fewer than 50% of firms surveyed reported that they purchased materials or products from suppliers and manufacturers online.

Most firms considered their investment in ICT in recent years to be the same or better than their competitors. This was consistent with the findings of the author's survey, where the respondents viewed that their future investments in ICT was more about keeping ahead of their competitors and keeping pace with their clients, rather than keeping up with their own suppliers.

This survey concluded that firms required independent and pragmatic advice on the costs and pitfalls of investing in ICT, supported by advice on how to assess their ICT needs. Notably, presentations by vendors or consultants were not considered of major importance in influencing decisions on new ways of using ICT. Firms prefer to obtain the relevant information via a website or delivered through a seminar or workshop.

The key drivers to encouraging greater use of ICT included reduction in costs of ICTs, more user-friendly systems and products and training. Setting of standards and costs of technology were viewed as the key barriers preventing firms achieving their business aim.

The author's findings conclude with the Forum's results, as the key drivers identified by the author are also cost related. For example, savings in manpower, reducing paperwork, avoiding

re-keying of information, will all contribute to an overall reduction in the transaction costs of purchasing materials.

The author's findings with respect to key barriers largely concluded with the Forum. The author reported that the main internal barriers to EC adoption were that the potential benefits of electronic purchasing are likely not to justify the investment in ICT and the prohibitive cost associated with purchasing hardware and software. The author's findings also conclude with the Forum findings with respect to the important of setting standards, with 74% of the respondents agreeing that standards are the number one priority for the industry moving forward (see Figure 4.16).

4.6.3 Davis Langdon Consultancy Report (2002)

The DTI in the UK commissioned a report to provide a picture of the current state of play of ebusiness in the UK construction industry and to identify and review likely future developments. DTI and partners undertook a number of studies, which taken together, gave a reasonably good picture of the state of play in the use and penetration of IT and e-business within the UK construction sector. Key work included:

1. Survey of IT usage in the construction team, by the Building Centre Trust (1999).
2. Discussion paper on e-business in construction, prepared by Davis Langdon Consultancy (DLC, 2000).
3. Study of IT integration in construction by the Building Centre Trust (2001).

The Building Centre Trust (1999) was part of a Partners in Innovation (PII) research project. The survey canvassed the views of some 400 practitioners in 80 projects, ranging in value from £10m to above £50m. The study concluded that despite access to IT and the use of dedicated networks, the predominant form of information exchange was paper-based. The electronic exchange of information accounted for no more than 15% of all information exchanged.

The DLC (2000) report identified the key drivers in e-business as:

- Economy and speed of construction – to accelerate order and delivery times, to shorten communication distances and to reduce transaction errors and costs.

- Improved business relationships – clients are increasingly looking to develop longer-term relationships with fewer key suppliers, devoid of adversarial business relationships.
- Business process improvement – closer integration of business processes that will bring considerable savings in costs.
- Technology and entrepreneurship – available technology and the need to exploit it, is seen as a key driver. The development of software tools and communication protocols (for example XML), supported by widely available telecommunications infrastructure, is providing cheaper and more accessible methods of exchanging construction information.

All of the drivers identified by DLC report are reflected in the results of the author's survey. For example, under economy and speed, the major drivers identified by the respondents were savings in manpower, reducing paperwork and fewer errors in recording and handling information, all of which will speed up the purchasing process and drive costs down. With respect to improved business relationships, there was strong agreement in the author's survey that closer collaboration is require between contractors and suppliers and that longer term relationships between supply chain organisations will allow development costs and on-going advantages to be shared.

The author acknowledges that whilst business process improvement and technology and entrepreneurship were not specifically identified by the respondents as key drivers, these matters were ranked very highly by respondents with respect to future directions. The importance of industry standards for electronic data interchange, closer collaboration between trading partners, the increase of ICT literacy and familiarity with electronic purchasing were considered to be the highest ranking issues among all respondents.

The Building Centre Trust (2001) study identified a number of barriers to the adoption of e-business in the UK construction industry, namely:

- Organisational and cultural inertia – the construction industry is highly resistant to change.
- Scale – there are few dominant players in the construction market, and few firms have the resources and influence to successfully re-structure entire supply chains.

- Knowledge of benefits – surveys in recent years have shown that most respondents believe that e-business will be more important in the future, few are aware of the existence of even the more common third party providers.
- Skills – given the general lack of awareness of the business benefits, it is likely that construction firms lack the skills to adopt e-business.
- Perception of cost – many respondents perceive that the anticipated benefits are now out-weighted by the likely cost.
- Legal issues – the legal status of electronic documents is of great concern, and the perceived need to use and retain paper-based documentation for business.
- Standards – there is a lack of widely accepted standards for information exchange.

The author's findings largely conclude with those of the Building Centre Trust. The author found that respondents ranked highly a general lack of awareness of ICT capabilities in construction purchasing and its potential benefits to the Irish construction supply chain, thus concluding with the Trusts finding of knowledge of benefits and lack of ICT skills. The author also found that respondents were concerned about the high incidence of technologically conservative organisations in the Irish construction industry, which concludes with the cultural inertia identified by the Trusts findings. The other barriers of cost, legal issues and standards were not identified by the author as significant barriers to the use ICT in construction purchasing, however they were identified as important drivers in the future implementation of EC in the Irish construction industry.

4.6.4 Construction Industry Institute (2002b)

In 2002, the CII in the US carried out a study to capture the state of EC practice in the US construction industry. Researchers conducted an online survey of a total of 89 CII corporate members. The research sample included public owners (government), private owners (non-government), design/engineering firms, general contractors and manufacturers/suppliers. 49 responses were received in total equating to a 55% response rating, which is similar to the response rate achieved from the author's survey. 16% of the respondents were general contractors and 22% were manufacturers/suppliers.

43% of general contractors and 30% of manufacturers indicated that they had a documented EC strategic plan, which was integrated into their overall business strategic plan. The research found that the private owner sector was leading the drive for EC application. Meanwhile their design, supplier and contracting business partners were more reluctant to experiment with new ways of doing business over the Internet.

These results compare in direct contrast to the author's findings, where almost 75% of respondents disagreed that EC has significantly affected the strategies of construction businesses. The author stated earlier in this Chapter that these results should not be relied upon as the respondents were mostly IT managers and thus would not be actively involved in the strategic planning of their businesses. The author acknowledges that he has no evidence to show how influential the private owner sector is in the Irish construction industry.

The author's findings concur with the CII survey that supplier and contracting firms are more reluctant to experiment in new ways of doing business over the Internet, with the author finding that 54% of respondents having concerns over the adoption of a web-based strategy for future B2B purchasing transactions (see Figure 4.11).

Table 4.13 summaries the top three barriers identified by both the general contractors and the manufacturers/suppliers in the CII survey.

General Contractor	**Manufacturer/Supplier**
Top 3 Barriers	**Top 3 Barriers**
1. Lack of EC software that meets needs of construction industry. 2. Lack of demand from customers/clients. 3. Concerns regarding information exchange standards (for example, XML) and systems integration challenges.	1. Lack of demand from customers/clients. 2. Reluctance or inability of EC among supply chain. 3. Lack of pressure from competitors to engage in EC.

Table 4.13. Barriers identified by business sectors (adapted from CII 2002b report)

For a comparative purposes, Table 4.14 and 4.15 summaries the top three internal and external barriers identified by contractors and suppliers in the author's survey.

Contractor	Supplier
Top 3 Barriers	**Top 3 Barriers**
1. Lack of awareness of ICT deployment. 2. Potential benefits of EC not likely to be sufficient to justify investment. 3. Development costs are prohibitive.	1. Potential benefits of EC not likely to be sufficient to justify investment. 2. Development costs are prohibitive. 3. Uncertainty about how to measure costs and benefits.

Table 4.14. Internal barriers identified by author's survey (see Table 4.11)

Contractor	Supplier
Top 3 Barriers	**Top 3 Barriers**
1. Lack of awareness of ICT capabilities. 2. Too many products to make ePurchasing more widespread. 3. High incidence of technologically conservative organisations.	1. No motivation when other will benefit. 2. Lack of awareness of ICT capabilities. 3. High incidence of technologically conservative organisations.

Table 4.15. External barriers identified by author's survey (see Table 4.12)

In comparing the author's results with those of the CII survey, it is important to appreciate that the choices of barriers provided to the alternative samples by the researchers were quite different and thus it would not be expected that there would be a close correlation between the results.

The contractors' top three barriers differed in their focus. The CII contractors were concerned about the lack of EC software available, a general lack of demand for EC and integration challenges. This differed from the Irish contractors who were more concerned about their lack of knowledge with respect to ICT capabilities, the prohibitive costs associated with EC, the business benefits and the high incidence of technologically conservative organisations in the industry. The author would agree with the CII findings regarding the integration challenges and the importance of embracing XML as a data exchange standard and the lack of EC activity in construction at the present moment. However, the author does not agree that there is a lack of EC software in the market.

In contrast to the contractors' barriers, there was a degree of correlation between the CII and the author's supplier's top three barriers. The theme of motivation and lack of demand was evident throughout the supplier barriers in both samples. The CII suppliers were concerned about the lack of demand for EC from their customers/clients, the inability to use EC among

their supply chain, lack of pressure from their competitors, whilst the author's sample were also frustrated by the number of technologically conservative industries in their supply chain and a lack of motivation to deploy EC when others will benefit. Once again the Irish suppliers were concerned about the business benefits that would accrue from EC and the prohibitive cost of deploying the technology. The results from the CII study are not necessarily representative of the entire construction industry. The sample size and sample population of large CII member organisation, along with the sample distribution size across various industry sub-sectors limits the statistical significance of the results. However, the results provide a good picture of EC trends in the construction industry.

4.6.5 Comparison summary

The results of these various studies largely reflect the findings of the author's survey. Table 4.16 summarises the findings of the drivers and benefits of EC from each of these studies and attempts to compare these to the findings of the author's survey reported in this Chapter.

Findings	**DLC 2002**	**CII 2002**	**CPA 2005**	**IT Construction Forum 2004**	**Author's Findings 2004**
Drivers to EC	Economy and speed. Improved business relations. Business process improvement.	Private owners. Cost savings. System integration.	Reduce costs. Increase speed of transactions.	Reduced cost. More user-friendly systems.	Reduced manpower. Reduced paperwork. Fewer errors. Improved access to data.
Barriers to EC	Culture of the construction industry. Scale of the industry. Knowledge of benefits. Cost of ICT. Legal issues. Lack of standards.	Lack of EC software. Lack of demand. Lack of standards. System integration. Capability of construction supply chain.	Culture of the construction industry. Lack of standards.	Lack of standards. Cost of ICT. Impartial advice on IT investment.	Business case weak. Cost of ICT. Lack of standards. Lack of awareness of ICT capabilities. Capability of construction supply chain.

Table 4.16. Comparison of author's findings with international studies

It can be seen from Table 4.16 that there is a common theme of drivers and barriers reported in all the above studies, including the findings of the author's questionnaire reported in this Chapter. The key drivers common to all studies include a need to reduce the overall cost in administrating the purchasing of materials. This can be achieved by reducing manpower, paperwork and, by implication, reducing errors in data entry. The key barriers include addressing the culture of the construction industry and its reluctance to adopt new ways of working. The lack of data exchange standards, the prohibitive cost of ICT and the poor level of awareness of the business benefits that EC can bring to the industry are other key barriers that need to be addressed.

The author's findings are largely representative of the other international surveys carried out in recent years, with respect to drivers and barriers to EC in the construction industry. The author's results show that there is a serious lack of knowledge within the Irish construction industry with respect to the technologies that are currently available and the capability of such technology to dramatically improve their business purchasing processes.

4.7 CONCLUSION

This Chapter presents the findings of a 2004 questionnaire survey of 54 construction companies in the Republic of Ireland. The objective of the survey was to examine the extent to which Irish construction building suppliers and contractors are currently exploiting electronic purchasing, the drivers and barriers to electronic purchasing and the likely future direction of EC in the Irish construction industry.

The results show that there is a relatively low up-take of ICT to support B2B purchasing transactions. There is limited EC activity within the Irish construction industry, mainly due to a low level of awareness of the benefits of EC. There are a number of reasons hindering the better exploitation of ICT by these firms and the reasons are similar in other construction sectors around the world.

There was considerable concern within the sample with respect to the adoption of a web-based strategy in construction purchasing, due to the perceived lack of security of transaction data and lack of broadband facilities across the country. Statistical tests were carried out on the ranking questions to test the robustness of the results.

Reduced paper volumes, error reduction and manpower savings were ranked as the most important driving forces for applying ICT in construction purchasing. The lack of clarity as to the potential benefits of electronic purchasing and the prohibitive costs associated with implementation of such technology were considered to be the major barriers within organisations to the greater deployment of electronic purchasing. Increased awareness and the introduction of industry standards were seen as the most important future directions, which would encourage the greater use of electronic purchasing. Other important issues included the need for increased ICT literacy skills within the workforce and the fostering of long-term relationships between organisations within the supply chain.

Despite the estimated increase in EC activity in the near future, the majority of respondents do not have an EC strategy and are unlikely to develop and use such a strategy in the near future. This apparent general lack of strategic thinking in relation to EC is both surprising and a major concern for the future investment and use of ICT by these firms and the construction sector in general. On a positive note, there is evidence that the leading firms are prepared to change the way their existing purchasing activities are carried out and take more advantage of ICT.

The EC market is still relatively immature and it is difficult to provide an assessment of the adoption and use of the more construction specific IT solutions. The failure of electronic marketplaces indicates that EC is still evolving in the construction industry (CII, 2002b).

The re-engineered solution will seek to achieve a three-way electronic match of the purchase order, delivery docket and supplier invoice. Chapter 8 will specifically outline the re-engineered solution and address the key barriers identified in this study and similar studies internationally, such as the adoption of a data exchange XML standard, a focus on reduction of administrative costs and the presentation of a robust business case for its widespread adoption.

CHAPTER 5

2004 OBSERVATION STUDY: IMPACT OF ERP IMPLEMENTATION ON CONSTRUCTION MATERIAL PURCHASING PRACTICE IN A LARGE IRISH CONTRACTING ORGANISATION

5.1 INTRODUCTION

This Chapter reports on an independent observation study carried out in 2004, on the material purchasing procedures adopted within a large contracting organisation, following the introduction of the COINS ERP system to support the company's business processes. Data was gathered from the COINS product manuals, interviews and by direct observation of the procedures over a defined period.

The first observation study of this company was reported in Chapter 3. At the time of the first observation study, the COINS system had not been implemented and the purchasing system relied heavily on a manual paper-based procedure. Two of the suppliers observed in the first observation study were similarly reviewed in this observation study. The third supplier selected was a different supplier due to a change in the concrete supplier selected by the company.

5.1.1 Purpose of Study

The purpose this study is to report on the relative inefficiencies of the material purchasing procedure in the observed company, following the implementation of the COINS system. The author carried out a similar first observation study in late 2002 in the same company prior to the COINS implementation, that is reported in Chapter 3. This Chapter will compare the results of this study with the results reported in Chapter 3.

5.1.2 Methodology

The methodology adopted in this study broadly involved four core stages, namely :

Stage 1 – Reading company literature on the material purchasing procedures. Documentation consulted included reference to the COINS operating manual.

Stage 2 – Interviewing of key staff. This involved carrying out structured interviews with purchasing, accounts payable and a selection of site staff. The purpose of these interviews was primarily to identify the perceived weakness of the material purchasing function.

Stage 3 – Selection of a suitable case study project. The Stocking Lane case study project was selected following advice from the company purchasing manager.

Stage 4 – Identification and monitoring of particular supplier transactions for a defined period. Three suppliers were selected to reflect a range of material types, namely: -

- Supplier A – Supplier of specialist concrete fixing products.
- Supplier B – Supplier of ready mix concrete.
- Supplier C – Supplier of general building materials.

The selection of the supplier types ensured that there was an opportunity to benchmark the results of this study against the results obtained in the first observation. Supplier transactions over a three-month period were investigated from purchase order stage to final payment. Chapter 3 reported on the company's purchasing procedures in 2002 and referred extensively to company manuals. At the time of writing this Chapter, the observed company had not made any further amendments to company procedures, notwithstanding the fact that the procedures were radically altered due to the implementation of the COINS system.

5.2 PROCUREMENT OF ERP SOFTWARE

In 2003, the observed company commissioned Deloitte and Touche to carry out a review of ICT systems and processes in their organisation. A report was produced by Deloitte and Touche presenting a proposal for the future structure of ICT systems in the company (Deloitte and Touche, 2003). Interviews were conducted by them with personnel from each department to review their current business processes and the systems used to conduct these processes. Problems relating to these processes were identified, along with solutions provided by the proposed ICT system. The main problems and solutions identified by Deloitte and Touche are summarised in Table 5.1 below, together with the author's commentary on their implementation during the observation study.

PROBLEMS	DELIOTTE & TOUCHE RECOMMENDATIONS	AUTHOR'S OBSERVATIONS
Each region had a separate process for materials ordering and receipt.	Adoption of a centralised purchasing function across all regions of the company.	Achieved through the COINS system, in all regions. Southern region no longer maintained their tradition of creating the purchase order on site.
Supplier information was not centralised, with little or no view of supplier details and performance history.	COINS purchasing module would provide a complete view of supplier details and performance history.	Whilst supplier's details were readily viewable on the system, the system relied on manual input of price up-dates etc.
Purchase requisitions were completed by site staff manually.	Requisitions can be completed on site, using the COINS central Address Book (Supplier List) and the Item Master (Product/Price List).	The requisitioning function of the COINS system was not utilised by the company. Site personnel continued to prepare requisitions manually on duplicate booklets.
Re-keying of purchase order into the IT system.	Purchase Orders can be created directly from the Requisition without the need to re-enter data.	Purchase orders were re-entered into the COINS system, following receipt of the paper requisition form from site.
No central view of materials on order, received or overdue.	Interrogate the system to provide supplier performance, open orders, blanket orders, receipts and overdue orders.	Variety of reports available from system. Example of a Material Delivery report is included in Appendix D.
No central view on material pricing.	Interrogate the system to obtain central view of material prices.	Whilst there was a central view of prices, they were largely out-dated requiring updating.
Manual two and three way matching process in Accounts Payable.	Receipt of materials on site against the purchase order and invoices.	There will remain an over dependency on manually matching the core purchasing documents.
There is no integration between transactional and valuation systems.	Record costs at the appropriate level and integrate with estimation/valuation systems.	There was no integration between purchasing and valuation systems.

Table 5.1. Author's observations on Deloitte and Touche 2003 recommendations

As is evident in Table 5.1, the consultants suggested solutions that were not fully realised on observation. The main reason for this failure was the resistance of many departments to change. For example, the decision to maintain the traditional process of creating the requisition manually was due to practical problems at site level. The process of re-keying information into the system on receipt of the paper requisition form was maintained, causing the requisitioning functionality of the COINS system not to be utilised. This matter was raised by the author in Chapter 3, where the contractor felt very

strongly that the purchase requisition stage should be retained. The contractor chose not to utilise the requisition functionality of the COINS system, as it was felt that the COINS system was not user friendly and thus they decided to retain the manually prepared requisition forms.

Whilst there was a centralised view of supplier details and prices, this information in many instances was out-dated. There did not appear, on observation, to be any particular rigour applied to supplier prices. By keying-in the supplier's name, it was possible to retrieve a list of material prices on the system, which were previously inputted. Whilst the buyers could invariably select the correct material on the system, to create the purchase order they normally confirmed the prices on the purchase order by phone, prior to dispatching the purchase order by post or by fax.

The COINS system allowed for the receipt of materials on site to be manually matched against the purchase order and the supplier invoices. The software necessitated the need for various departments to interrogate the system and input details of purchase order, delivery notes and supplier invoice. The functionality however, depended on attention to detail in the creation of the purchase order and on inputting the GRN onto the COINS system on site. Whilst discrepancies remained, the main advantage of the COINS system was the central view of the information, which negated the need to retrieve the paper documentation. It will be evident that the incidence of the successful three-way match had improved from that achieved in the 2002 observation study. However, there remained a great deal of time and effort into manually inputting the data, in order to achieve a successful match of purchase order, delivery notes and supplier invoices.

The COINS system provided the functionality to link the purchasing system to the valuation system, in order to support the creation of cost reports and external valuations for payment. It was felt at the time that the system adopted by the quantity surveyors was superior to the COINS system and thus they decided not to integrate their reporting mechanisms into the COINS system. This was another example of the company working outside the system and thus, not embracing the essence of a fully integrated ERP system.

The proposed solution recommended by the consultant involved the integration of three core modules, as illustrated in Figure 5.1. At the core of the proposed solution is the purchasing function of the COINS system.

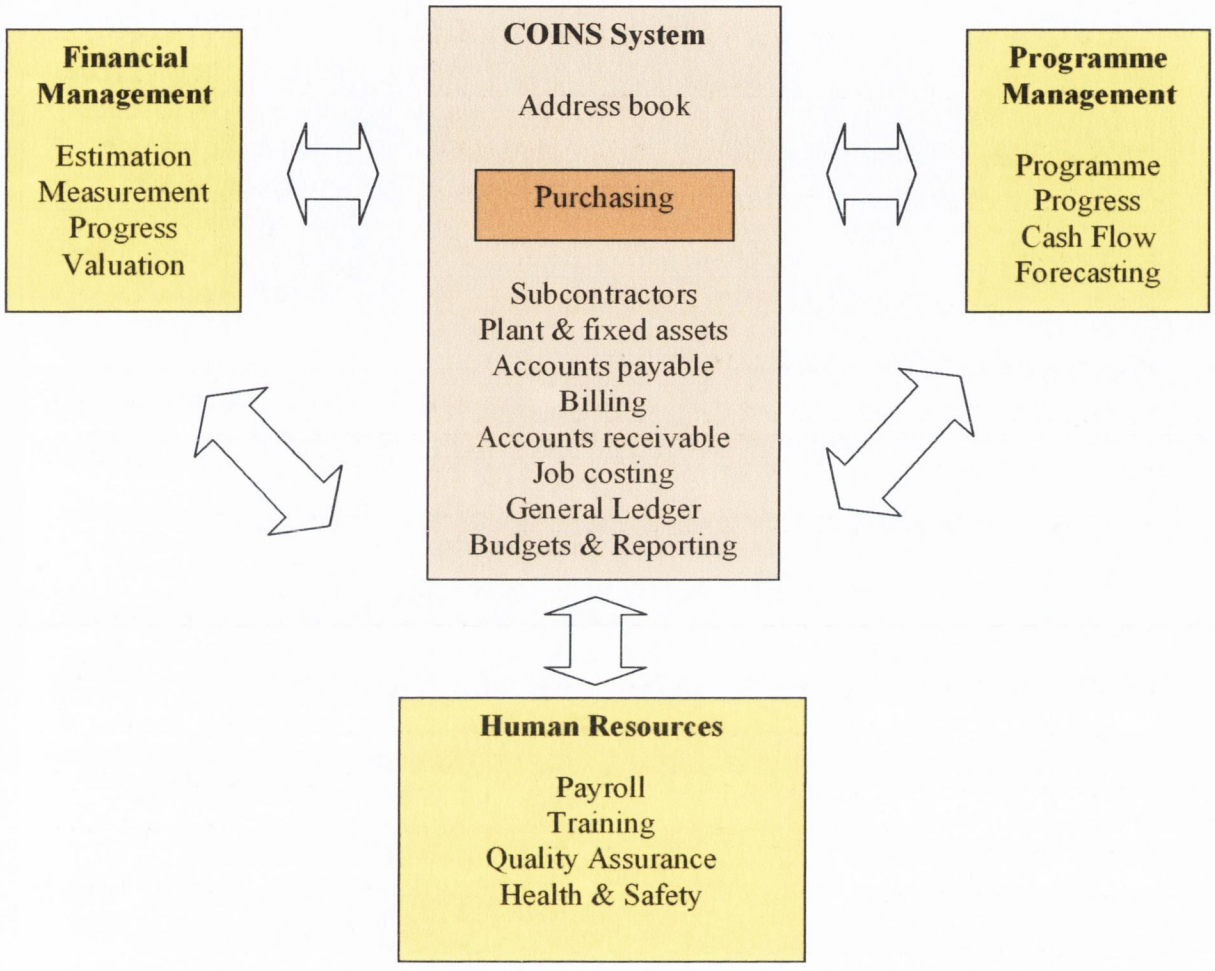


Figure 5.1. The COINS System (Source Deloitte and Touche 2003 Review)

The recommendation by Deloitte and Touche in their report to procure the ERP software was the correct advice, as it was essential that a centralised solution was employed in order to connect the different facets of the company's business. As described in Chapter 2, COINS software removes the barriers between and among departments, allowing for a sharing of centralised data. It will be seen however on observation, that full functionality of the integrated software was not utilised by the observed company.

Deloitte and Touche identified five key areas that required attention prior to the successful implementation of the COINS system. Table 5.2 summaries the consultant's observations with respect to these areas, together with the author's observation on the implementation of this advice by the company observed.

KEY AREAS	DELIOTTE AND TOUCHE 2003 OBSERVATIONS	AUTHOR'S OBSERVATION
Training	The level of training of staff even in the most basic Micro Office functionality was low. Further training was required in ICT skills	There was evidence that an IT training programme was implemented.
Personal computer access	Access to personal computers at remote sites was poor. Many quantity surveyors and contracts managers required laptops.	Laptops were procured for key staff.
Data security	The head office data was backed up regularly, regional and site data was not backed up on a regular basis. Floppy disks were used as the basic means for data backup. While there were no incidents of data loss reported, the lack of security of data was a major issue.	The company now maintained a robust server and back-up system on a daily basis.
Communication	Both internal and external communications was mostly conducted via manual means (post, courier, and fax). Fax software was not used to send and receive faxes, when documents were produced electronically; they were printed and faxed, rather than printed from the source. The use of e-mail throughout was low.	A high incidence of printing and faxing documentation remained. The use of email was widespread and available to all staff.
Documentation control	Due to the manual communications of information and the lack of integrated systems, large amounts of paperwork were stored in various locations.	There remained a high dependency on large volumes of paperwork.

Table 5.2. Author's observations on Deloitte and Touche 2003 recommendations

5.3 COINS ERP SYSTEM

Construction Industry Sofware Solutions (COINS) is an integrated software ERP system that can be accessed from various locations. The main objective of the system was to allow site users to access information for the purpose of transacting business and

generating information to allow improved contract performance. COINS was promoted by its vendors as a solution that integrates the purchasing process from requisition to accounts payable. Figure 5.2 summarises the main features of the COINS system available to the company, together with observations on the take-up of these features to support the material purchasing process in the observed company.

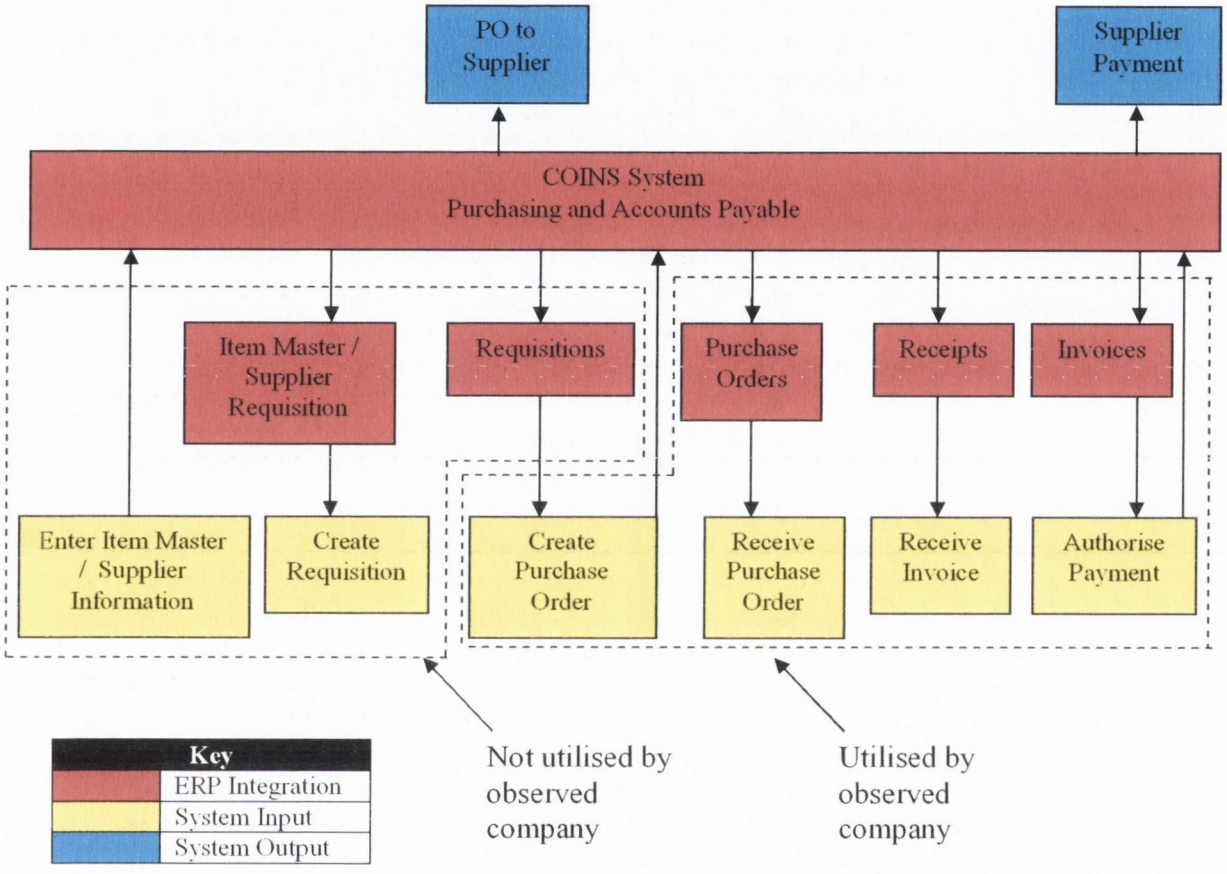


Figure 5.2. The COINS purchasing system observed by author (Adapted from Deliotte and Touche 2003 review)

It can be seen in Figure 5.3 that the observed company did not fully utilise the suite of modules available. The reasoning for the non-use of the requisitioning function was discussed earlier in this Chapter. Observations on the main features of the COINS system are described in more detail in Table 5.3.

ERP Feature	COINS DESCRIPTION OF FEATURE	AUTHOR'S OBSERVATION
Item Master	The COINS Item Master includes all details about an item that is purchased or available to purchase. This includes the item's supplier(s), current price and price history.	These features were not utilised by the company, as requisitions were prepared manually on duplicate booklets and faxed to head office.
Requisition	When a requisition was entered onto the system, the user had the choice of all the items in the item master. The user can select the item and the supplier and enter the quantity requested.	
Purchase order	Once the requisition was entered, the order can go through an approval process. If the requisition did not include all details of price and the supplier, then the relevant purchasing department could update this. Once the purchase order was complete, the system printed a purchase order, or alternatively it could automatically fax or email the purchase order to the supplier.	Purchase order prepared in the COINS system following receipt of paper copy of requisition. Purchase order was printed and posted to supplier.
Blanket orders	Many of the purchase orders raised were blanket orders, where a total order quantity and rate were agreed for items that required multiple deliveries. As each delivery was called-off, the original blanket order quantity was reduced each time. In each case the price was checked against the original blanket order.	This was the principal technique adopted for the supply of materials such as bar reinforcement and in-situ concrete.
Receipts	When the item was received, the system was immediately updated by inputting the details of the goods received. This involved the first stage of the 3-way matching process, matching the purchase order to the delivery docket for quantity received. Once receipt was confirmed on the system, this allowed accounts to authorise payment when the invoice was received.	Materials received on site were entered into the COINS system (commonly referred to as a GRN). This allowed accounts payable to check this against any invoices received.

Table 5.3 – Author's observations on the main features of the COINS system (Adapted from www.coins-global.com)

5.4 BUSINESS PROCESSES

A detail review of the current business processes operating prior to the implementation of the COINS system in the ordering, delivery and payment of building materials was comprehensively reported in Chapter 3. The following reports on the purchasing business

processes following the implementation of the COINS system, utilising the same methodology.

A process map key is included in Table 5.4.

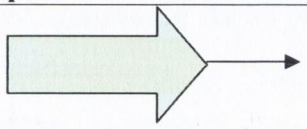
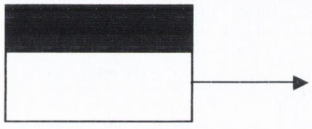
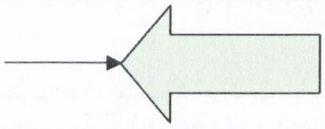
Process Map Key	
Purchasing Materials: **Material Requisition & Order**	**Process Category** **Process Name**
	**Start of Process** This may follow from another process.
	**Process** The black box contains the name of the department undertaking the process. This lower box will be coloured to the system used to conduct the process (e.g. white is a manual process, yellow is the COINS system).
	**End of Process** This may lead to another process.
Key Manual Process | COINS	**Systems Key** This key shows the colour of each system used for the process boxes.

Table 5.4. Process flow key

5.4.1 Material Requisitioning and Ordering Process Mapping

The procedures for material requisitioning following the implementation of the COINS system did not alter. It was reported in Chapter 3 that materials were either purchased centrally or negotiated at site level. The procurement of bar reinforcement, in-situ concrete and backfilling materials were normally negotiated and administrated by the quantity surveyor, who obtained quotes for the materials. Once the supplier was selected, the quantity surveyor raised a requisition (traditional paper copy) for the materials, including information about the items to be ordered, the quantity required, the supplier

and the negotiated price. Purchasing checked the requisition and, if complete, raised a purchase order on COINS and send it by fax to the supplier (with original copy in the post). If the materials required multiple deliveries, the requisition included only the total order value. These details were in turn inputted into the COINS system by the purchasing department.

With respect to centrally purchased materials, the authorised members of the contract team would prepare a site requisition and fax this to the purchasing department. This included the item description and the quantities required. The purchasing department would then check the requisitions for completeness and authority. If the item was not on an existing price list, then the order would be raised in the COINS system against the current negotiated supplier price. If the item did not appear on the price list, then the purchasing department obtained quotes for that material. Once the supplier and details were negotiated, the purchase order was raised in COINS and sent to the supplier in the traditional paper-based methods reported in Chapter 3.

One of the major improvements to the process was that there was no longer a necessity to send a paper copy of the order to accounts, as the details were readily available on COINS for accounts to retrieve.

It was necessary to enter the current supplier price list onto the system. Price lists were updated by printing an existing price list from the system and faxing/posting this to the supplier in order that they could update their price lists. This proved to be very cumbersome as the prices on the COINS system, in many instances, were not used in the creation of the purchase order, as they were out-of-date.

The process flow chart for requisitioning and ordering of materials is shown in Figure 5.3. The process shows a total of 16 tasks in the creation of a purchase order, as compared to 18 tasks identified in Figure 3.5 in Chapter 3 (prior to COINS implementation). The most widely adopted observed route for processing the purchase orders is indicated in red and involved a minimum of 11 tasks, which is only 2 less than that observed in Table 3.5 in Chapter 3 (prior to the COINS implementation).

The author observed that the process remained largely inefficient, with the preparation of material requisitions by hand, the manual checking of the requisitions, extensive

photocopying and the manual re-keying of information to create the purchase orders. Table 5.5 summarises the tasks that are carried out manually rather than electronically in the material requisition process. The introduction of the COINS system did not in any way reduce the number of tasks involved in the creation of the purchase order. The direct result of the COINS system simply involved replacing the inputting of the order details into the Binary System in the first observation, to the inputting of the order details into the COINS system.

	Tasks	Manual/ Handwriting	Photocopy/ Printing	Manual keying of Info.
1	Check if materials are centrally purchased	√		
2	Prepare material requisition	√		
3	Send requisition to Purchasing	√	√	
4	Check material requisition for correctness	√		
5	Check if materials are centrally purchased	√		
6	Check if item on price list	√		
7	If item is on price list, check if up-to-date.	√		
8	Up-date price list on COINS			√
9	Select supplier on COINS			√
10	Enter order and price on COINS.			√
11	Post / print out purchase order on COINS	√	√	
	Total	8	2	3
	Observation study 1 comparison	11	4	3
	Incremental improvement	(-3)	(-2)	(0)

Table 5.5 - Tasks carried out manually rather than electronically in the material requisitioning and ordering process (Post COINS implementation)

It can be seen from both Figure 5.3 and Table 5.5 that there was an incremental improvement only in the performance of this process. It can be seen in Table 5.5 that 3 manual handwriting tasks and 2 photocopy/printing tasks were removed from the process. There was no overall improvement in the manual keying of information required in preparing the purchase order. The main reasoning for this was the decision to retain the manual requisitioning of materials.

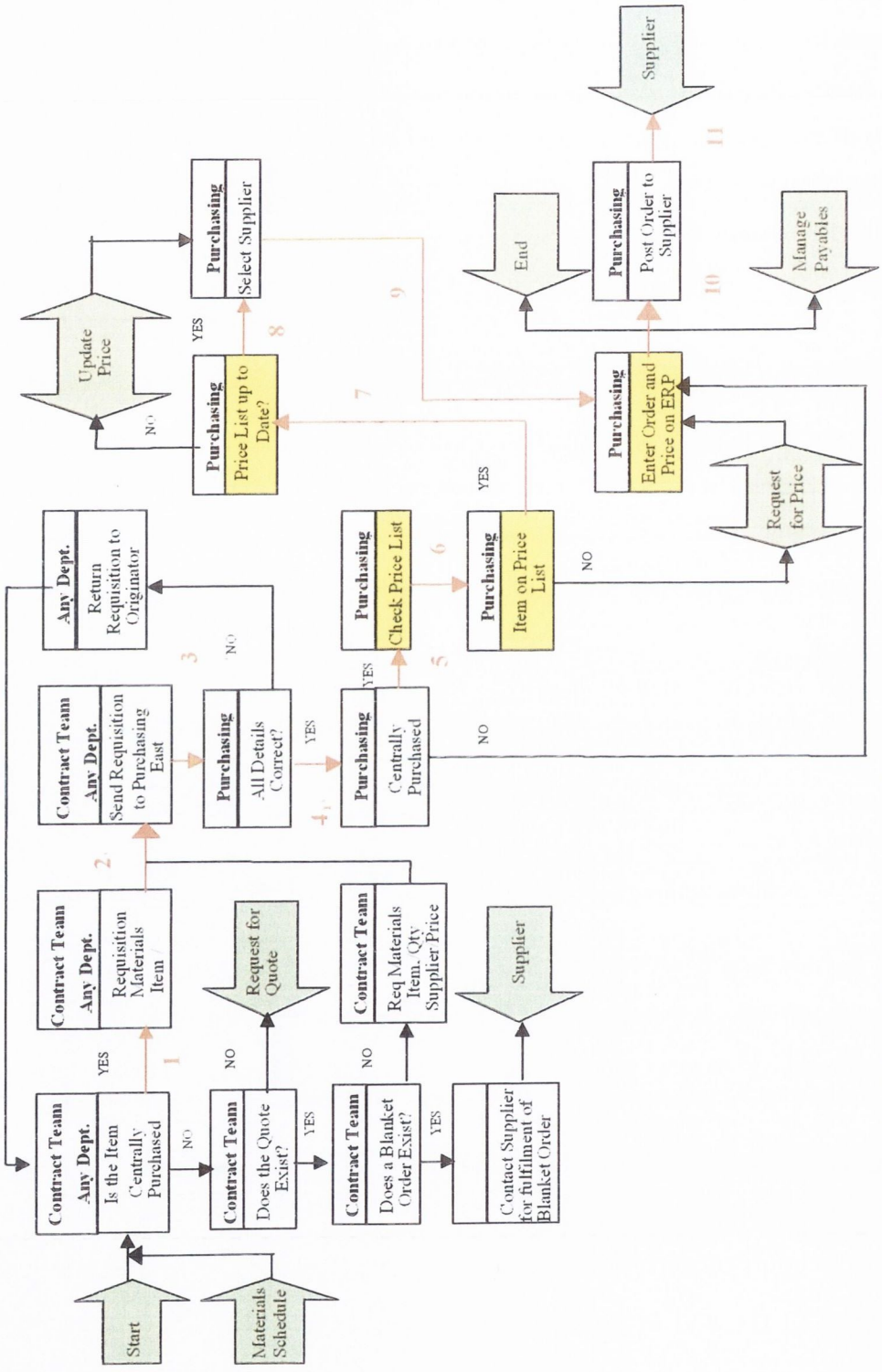


Figure 5.3. Material requisitioning and ordering process map – Post COINS implementation

5.4.2 Receiving Materials Process Mapping

The procedures for receiving materials differed considerably from the first observation study. It was a policy of the company that all projects were to be networked to cater for the COINS system on site. As a direct result, all materials received were logged on the COINS system as a GRN.

The process flow chart for receiving materials is shown in Figure 5.4. The process shows a total of six individual tasks in the creation of the GRN, as compared to 7 tasks identified in Figure 3.6 in Chapter 3 (prior to the COINS implementation). The most widely adopted observed route for processing the delivery notes is indicated in red and involved a minimum of 5 tasks, which was only 1 less in comparison to that observed in Table 3.6 in Chapter 3. The author observed an improved process, with the all delivery docket information re-keyed manually directly into COINS as a GRN. Table 5.6 summarises the tasks that are carried out manually rather than electronically in the receiving material delivery process.

	Tasks	Manual/ Handwriting	Photocopy/ Printing	Manual keying of Info.
1	Nominate receiving personnel	√		
2	Receive materials	√		
3	Inspect material against delivery dockets	√		
4	Sign delivery dockets	√		
5	Record receipt of materials on COINS		√	√
	Total	4	1	1
	Observation study 1 comparison	6	1	1
	Incremental improvement	(-2)	0	0

Table 5.6 - Tasks carried out manually rather than electronically in the receiving materials process (Post COINS implementation)

Table 5.6 only shows an overall reduction in 2 manual handwriting tasks. Whilst the introduction of the COINS system did not reduce significantly the number of tasks involved in the processing of the delivery dockets, the impact of the COINS system had improved the process.

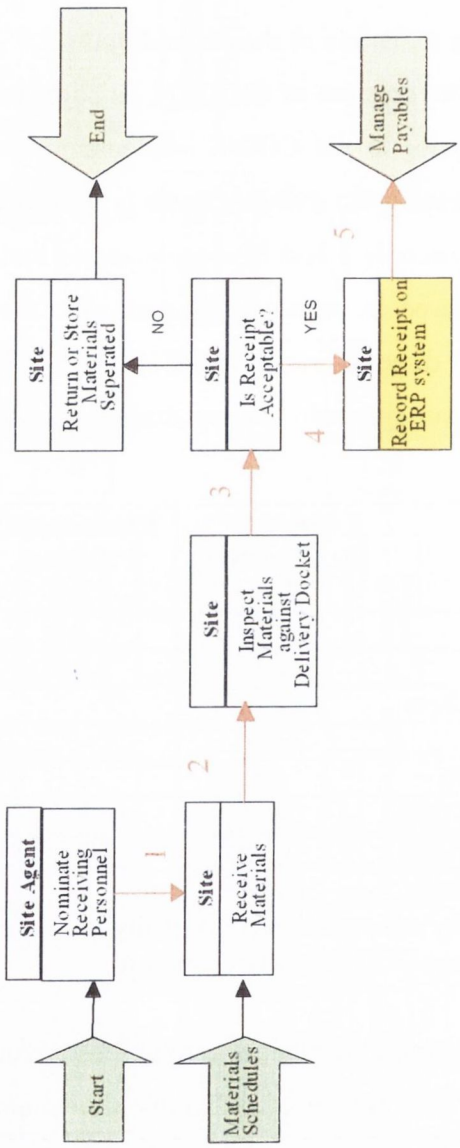


Figure 5.4. Receiving material process map (Post COINS implementation)

5.4.3 Manage Payables Process Mapping

The introduction of the COINS system enabled the matching of purchase orders, GRNs and invoices to be a much improved process. Invoices were received in the traditional manner from suppliers and the details were entered into the COINS system direct by the accounts department. Each invoice was given a unique registration number, similar to the procedure reported prior to the implementation of the COINS system, reported in Chapter 3. The invoice details were in turn checked against the GRN and purchase order entries on the COINS system, as part of the three-way matching process.

The process flow chart for managing payables of materials is shown in Figure 5.5. The process shows a total of 16 individual tasks in the management of the payables process, as compared to 20 tasks identified in Figure 3.7 in Chapter 3 (prior to the COINS implementation). The most widely adopted observed route for processing the delivery notes is indicated in red and involved a minimum of 7 tasks, as compared to 11 tasks identified in Table 3.7 in Chapter 3 (prior to the COINS implementation).

Table 5.7 summarises the tasks that are carried out manually rather than electronically in managing the payables process. It can be seen that a number of the inefficiencies identified in Tale 5.7 were removed from the process. For example the necessity to photocopy invoices and to re-key invoice information were removed from the process.

	Tasks	Manual/ Handwriting	Photocopy/ Printing	Manual keying of Info.
1	Receive invoice	√		
2	Determine matching process	√		
3	Enter details onto ERP system			√
4	Release payment		√	√
5	Print cheque and remittance advice		√	√
6	Collate cheque and remittance	√		
7	Post to the supplier	√	√	
	Total	4	3	3
	Observation study 1 comparison	7	3	3
	Incremental improvement	(-3)	0	0

Table 5.7 - Tasks carried out manually rather than electronically in the managing payables process (Post COINS implementation)

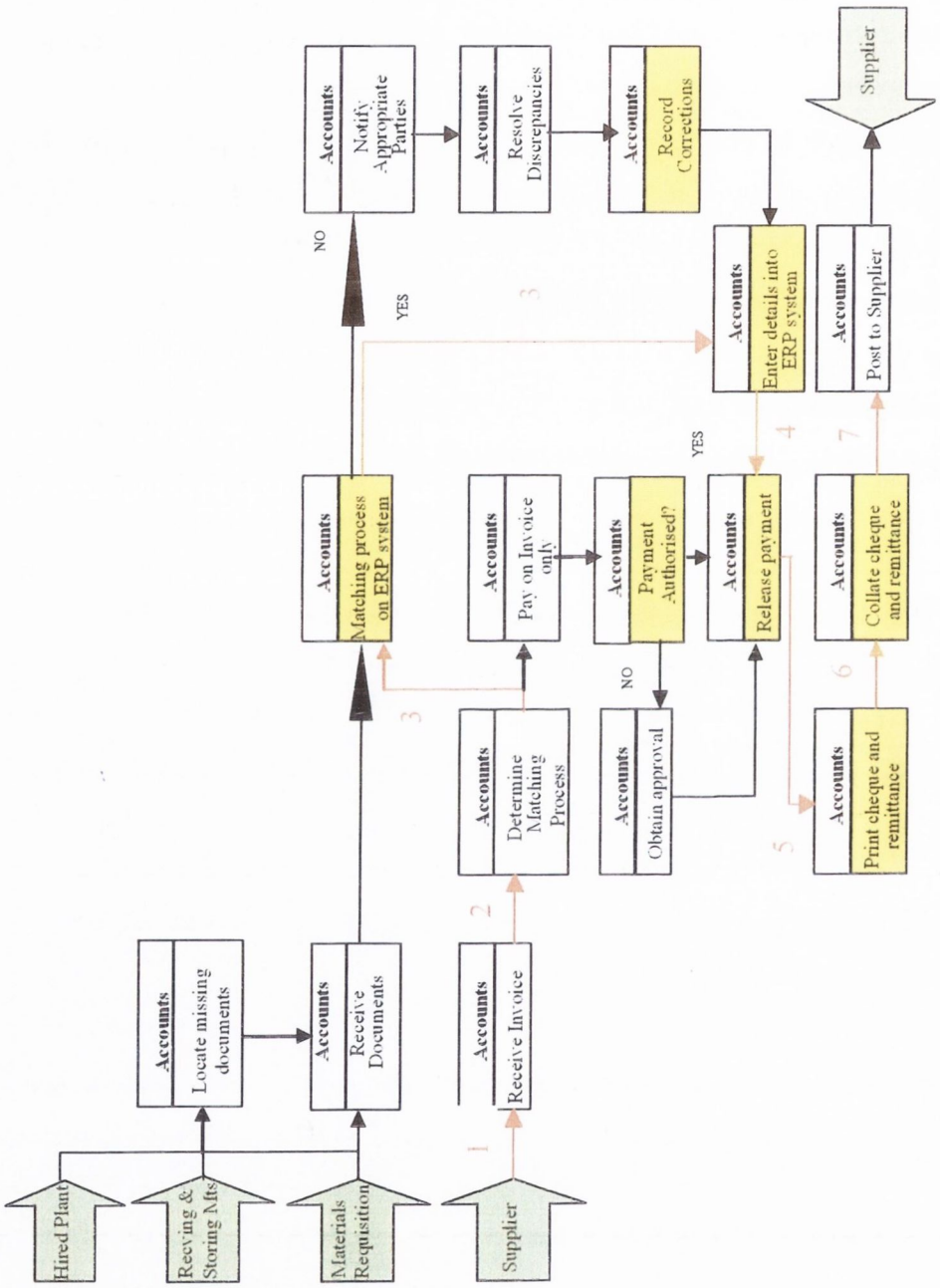


Figure 5.5. Managing payable process map (Post COINS implementation)

It can be readily seen that the introduction of the COINS system only incrementally improved the purchasing process. In order to achieve a re-engineering of the process, there should have been evidence of a dramatic improvement in the business processes. Table 5.8 summarises how the overall material purchasing process has been improved by the introduction of the COINS system. The figures are extracted from Tables 5.5, 5.6 and 5.7.

Business Process	**Manual/ Handwriting**		**Photocopy/ Printing**		**Manual keying of Info.**	
	Pre	**Post**	**Pre**	**Post**	**Pre**	**Post**
Material Requisitioning & Order Processing	11	8	4	2	3	3
Receiving and storing materials	6	4	1	1	1	1
Managing payables	7	4	3	3	3	3
Total	24	16	8	6	7	7

Table 5.8 – Incremental improvements achieved following introduction of COINS software

On observation the material requisitioning and order processing did not achieve any significant improvement following the introduction of the COINS system, with only a limited reduction in manual tasks. The introduction of the system simply replaced the Binary system with that of the COINS system when inputting the order details. The manual production of the purchase requisition remained and the dispatch of the purchase order by printing, fax and by post was maintained by the company.

Whilst the process of receiving materials improved due to the fact that site staff were no longer required to complete the manual GRN documentation and dispatch all delivery notes to the accounts payable for processing, the overall number of tasks had not reduced significantly. The inputting of the material delivery details into COINS directly by site staff meant that accounts payable had a ready proof of delivery on the system. The accounts payable procedures had not changed to any considerable extent, other than by the fact that they no longer had to input the delivery details onto the system. It was still necessary for all invoice details to be re-keyed into COINS, in order to create a three-way manual match, between the purchase order, delivery note and the invoice. The stand

alone COINS systems has no capability of automatically electronically matching the purchase order, delivery docket and supplier invoice, as it was necessary at each stage of the process to manually input the information to create the match.

5.5 STOCKING LANE CASE STUDY

The overall purpose of this case study was to focus on particular supplier transactions over a defined period on a specific project case study and record the performance of the purchasing procedures adopted by the observed company following the introduction of the COINS system.

The project case study selected was a nursing home incorporating a central nursing facility and separate self-contained low-rise independent living units. The strategy adopted in the observation study was identical to that strategy adopted in Chapter 3, namely: -

- Select particular supplier accounts to observe.
- Observe and record particular supplier account transactions over a defined period.
- Analyse and interpret the data.

It was decided that three supplier accounts would be observed. Table 5.9 summaries the mixture of materials types investigated. The author adopted a similar rationale with respect to the supplier type selected and period of observation, as adopted in Chapter 3.

Suppliers Selected for Observation	**Nature of Materials Supplied**	**Period of Observation**	**Number of Invoices**
Supplier A	Multiple low volume transactions for specialist fixings for concrete and blockwork.	February 2004 to April 2004	17
Supplier B	Bulk supplies of in-situ concrete of varying specifications	February 2004 to April 2004	11
Supplier C	Mixture of low and high volume general building materials	February 2004 to April 2004	40

Table 5.9. Summary of Supplier Accounts investigated

It was important that the author achieved the right mix of supplier types when investigating the performance of the purchasing process. Suppliers of multiple product types, such as in the case of Supplier A and C, are more of a challenge than single product type suppliers, such as Supplier B. The reason for this challenge is that the matching process is complicated by the fact that in any one delivery it may be necessary to match multiple products types, within a single delivery. This is a challenge that the author will address in the final re-engineered solution.

The methodology adopted in retrieving the data was not as complex or time consuming as experienced by the author in the first observation study, outlined in Chapter 3. The principal reason for this was due to the fact that the vast bulk of data was readily retrievable from the COINS software database.

This observation study, unlike the 2002 study, did not analyse the discrepancies between purchase requisitions and purchase orders, as in the first observation, because the process had not changed. As stated earlier in this Chapter, the contractor had made it very clear to the author that they did not intend changing their site requisitioning procedures at the time of this observation study. Therefore, it was assumed that inefficiencies remained in the process.

The modes of communication adopted in this observation study changed from a mainly paper-based system in the first observation, to the use of a centralised COINS software solution. All requisitions, however, were created by hand on duplicated requisition forms, which were in turn filed in the purchasing department under a particular job number. Site requisitions were filed in date order and were easy to retrieve. Staff in the purchasing department inserted the purchase order number against the relevant item(s) on the paper site requisition sheet. Once all the appropriate site requisition forms were located, it was then necessary to locate the matching purchase order. This information was readily available and easily retrievable on the COINS system, unlike the first observation when paper copies had to be located.

The matching of the purchase order to the delivery note and invoice was made a lot easier, as this information had previously been inputted onto the COINS system by both site and accounts payable respectively. The company maintained the procedure of

allocating each invoice received a unique registration number, which one could use to locate the invoice details on the COINS system. There was no necessity for site to send in copies of all the delivery dockets to head office, as all delivery dockets were retained by site and inputted into the COINS system as GRNs by site personnel. Similarly on receipt of the invoices at head office, this information was in turn inputted and matched against the appropriate purchase order and delivery note.

It was seen earlier in this Chapter that the overall process had improved considerable for the contractor, the overall requirement for manual matching of the documents by accounts payable was simplified by the fact that they no longer needed to retrieve hardcopy purchase orders and delivery notes, as this information was previously inputted into the COINS system, prior to the receipt of the supplier invoice.

5.5.1 Observation Results

The results of the study are based primarily on the matching/mismatching of particular documents. The two core issues that are examined include :

- Payment period of invoices –v- Supplier credit periods.
- Discrepancies between purchase orders and supplier invoices.

Payment period of invoices –v- Supplier credit periods

The payment periods were observed, as they were in the first study. Figures 5.6, 5.7 and 5.8 below summarise the periods of payment from receipt of invoice to payment, as compared to the particular supplier credit period for each supplier observed. Tables summarising the periods of payment from receipt of invoice to payment, for each supplier are presented in Appendix C.1

With respect to Supplier A, there was an improvement in the payment periods observed in 2002. No invoices were withheld during the observed period for queries. The average payment period achieved was 64 days, in comparison to 62 days reported in the first observation study. Figure 5.6 illustrates the payment periods achieved for Supplier A during the observed period. It can be readily seen that the contractor is paying all invoices

within a definite payment cheque run cycle. It can also be seen that the erratic payment periods achieved in the 2002 study, as shown in Figure 3.9 of Chapter 3, were not evident during the 2004 study. In comparison to the first observation study there were relatively few problems in clearing the invoices.

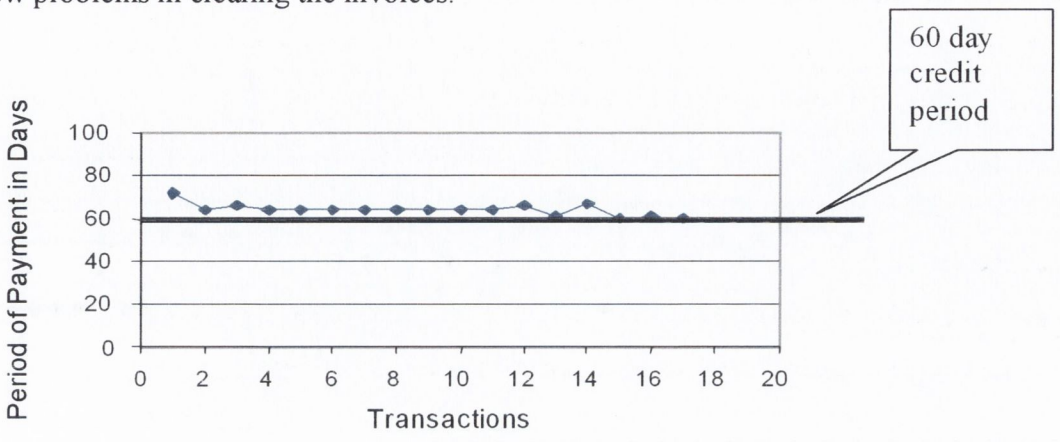


Figure 5.6. Observed payment periods for Supplier A

In the case of Supplier B the average payment period was 68 days in comparison to 66 days reported in the first observation study. Figure 5.7 summaries the payment periods for Supplier B. Due to the relatively few queries raised on the Supplier B invoices, both in 2002 and 2004, it can be seen that the supplier was paid on a definitive payment cycle.

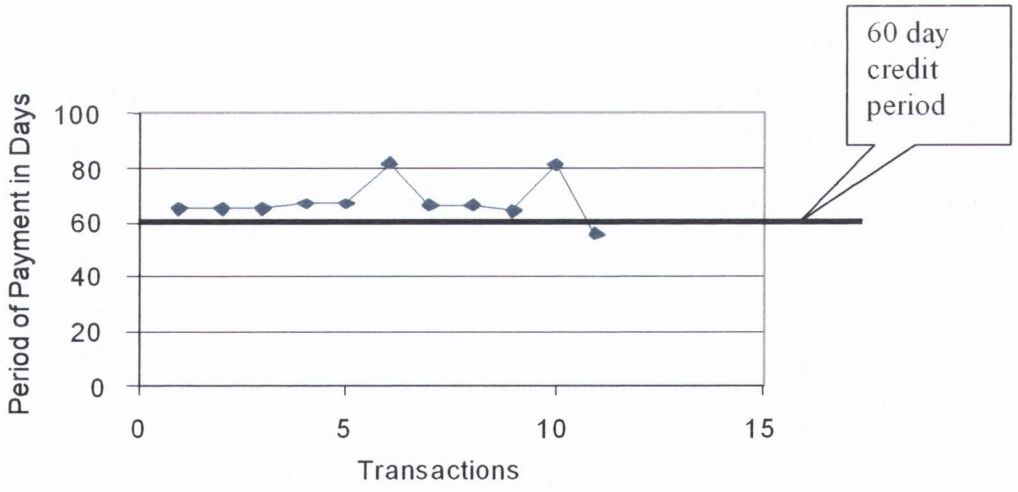


Figure 5.7. Observed payment periods for Supplier B

Figure 5.8 summarises the payment periods for Supplier C. The average payment period achieved was 57 days in comparison to 113 days observed in the 2002 observation. The significance of the 57 days was once more due to the cheque run payment cycle and a significant reduction on invoice queries.

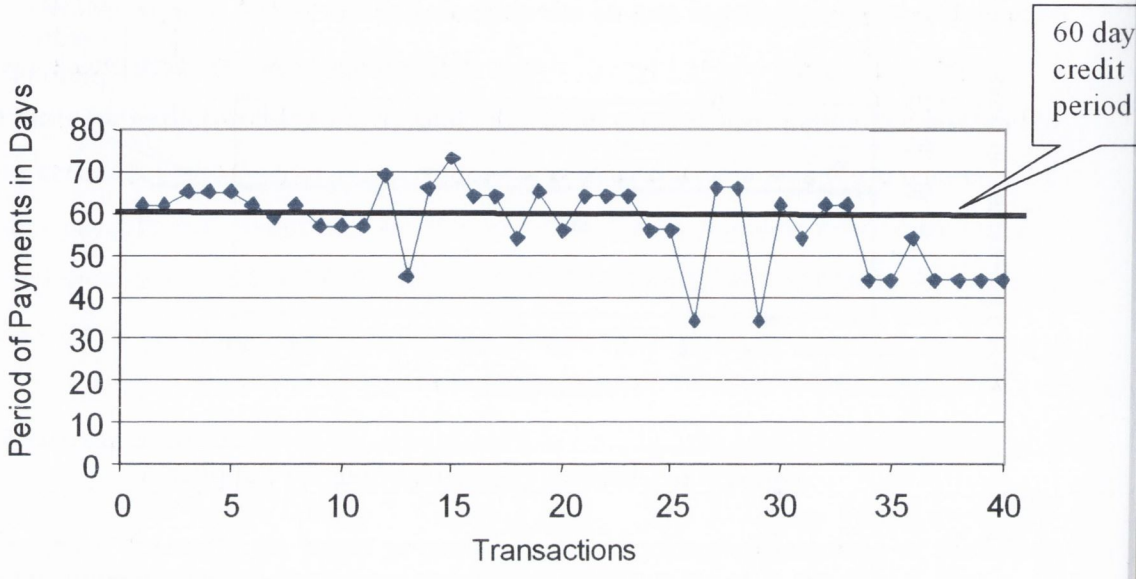


Figure 5.8 Observed payment periods for Supplier C

This dramatic improvement in the payment periods for Supplier C's account was a direct result of the availability of the purchase order and GRN information on the COINS system. Unlike the first observation, with the introduction of the COINS system, accounts personnel were no longer required to manually match the paper documentation. This improvement made the matching of the invoices more efficient.

It was surprising that the company were, however, paying the supplier, in many instances, less than the credit terms agreed of 60 days. On further investigation, no satisfactory reason was given by the contractor as to why these invoices were paid early.

Discrepancies between purchase orders, delivery dockets and supplier invoices

The exercise of matching purchase orders, delivery dockets and supplier invoices did not prove to be as onerous a task in comparison to the first observation, as all the data was

readily retrievable from the COINS system. The extent of matching of purchase order prices and supplier invoice prices is included in Appendix C.2. At no point was it necessary to retrieve paper copies of the documents. The COINS system provided for user-friendly reports to be printed, such as material delivery and invoice matching reports: an example of these reports is included in Appendix C.3.

Table 5.10 compares the level of three-way matching of purchase orders, delivery dockets and supplier invoices, achieved in both the 2002 and 2004 observation studies.

Supplier	2002 Observation Study	2004 Observation Study
A	17%	65%
B	95%	90%
C	4%	70%

Table 5.10. Relative success of three-way matching for Supplier A, B and C in 2002 and 2004 observation studies

It can be seen that there was an improvement in the extent of matching achieved in both the cases of Suppliers A and C. This was mainly due to the fact that site personnel were inputting the details into the COINS system directly, as opposed to furnishing paper copies of delivery notes to head office. Whilst the author acknowledges this dramatic improvement in the matching process, this matching was not achieved electronically, as it involved a great deal of re-keying of information into the COINS system by both site personnel and the accounts department.

In the case of Supplier B, the extent of matching was below that achieved in the 2002 study. The reason for this was due to the fact that the supplier was supplying a variety of products, such as in-situ mortar, blockwork and in-situ concrete, unlike in the first observation, where the supplier was solely delivering in-situ concrete, under an open order system.

5.6 CONCLUSION

It can be seen that the introduction of the COINS system has improved the material purchasing process within the observed company. Whilst improvement had been made,

many of the traditional inefficiencies remain in the system, such as the dependency on manual processes including form filling by hand, photocopying and re-keying of information. The prolonged payment periods reported in the first observation study, did not materialise in this study, as the information was readily available in the COINS system. The matching of purchase orders, delivery notes and invoices, albeit on a largely manual basis, had dramatically improved the process in comparison to the 2002 observation study results.

It can be concluded that the introduction of an ERP system is a necessary ingredient in achieving a re-engineered material purchasing process in construction. The author highlighted that the contractors did not fully utilise the modules available and were insistent that the manual material requisitioning system be maintained.

This observation study confirms that the introduction of the ERP system alone does not remove many of the inefficiencies in the traditional paper-based system. What is required is the adoption of an ICT infrastructure, which includes an ERP capability, that will eliminate the need for manual input, printing, re-keying of information etc. and lead to the successful re-engineering of the material purchasing process in the Irish construction industry.

CHAPTER 6

2004 SURVEY: A SURVEY OF ELECTRONIC PURCHASING PRACTICE IN IRELAND: A PERSPECTIVE FOR THE IRISH CONSTRUCTION INDUSTRY

6.1 INTRODUCTION

This Chapter seeks to examine how the Irish construction industry can learn from the experiences of other industries. A survey of the top Irish companies was necessary in order to gauge attitudes from the various business sectors to the adoption of EC technologies into their B2B purchasing transactions.

The author acknowledges that the applicability of the results must be put in context when presented, as respondents will be mainly drawn from large organisations, operating within particular business sectors, which are traditionally very innovative. A methodology was adopted which involved the design and distribution of an online questionnaire to over 75 Irish businesses in late 2004. The aim of the survey was to examine the extent to which the top Irish companies are currently exploiting electronic purchasing, the drivers and barriers to electronic purchasing and the likely future direction of EC in particular Irish business sectors. It was also an objective to see how the construction industry compared with other sectors, and what lessons can be learnt from this.

The author will explicitly compare the results of this survey with the findings of the early 2004 Irish construction industry survey reported in Chapter 4. The author will also compare the key findings of this survey with similar surveys carried out internationally in recent years. The findings of this survey were presented at a conference in the UK in April 2005 (Hore and West 2005b).

6.2 THE SURVEY

The methodology adopted was very similar to the technique adopted in the early 2004 survey reported in Chapter 4. It involved two core stages, namely, the planning phase and an implementation phase.

6.2.1 Planning Phase

The planning phase of this survey was simplified by the fact that most of the early 2004 survey design could be reused in this survey. This phase involved focusing on three aspects, namely, research questions, presentation of questionnaire and sample selection and size.

Research Questions

The core task of deciding on the wording of the questions was completed in the first survey reported in Chapter 4. Initially the order, wording and the four key areas identified in the first survey were maintained, namely :

(i) The current level of ICT take-up by Ireland's top companies in B2B purchasing transactions.

(ii) The driving forces which attract organisations to adopt electronic purchasing.

(iii) The barriers preventing organisations from applying these technologies.

(iv) The future developments, which would encourage higher usage of electronic purchasing within Irish business.

Presentation of Questionnaire

The strategy of adopting an online questionnaire was maintained as in first survey. The survey sample was accessed by the recipients via a website link, which included a statement as to the background to the survey and detailed explanations as to how to complete the survey. Once completed, the responses were returned instantaneously to the author. A copy of the online questionnaire is included in Appendix D.1.

Sample selection and size

It was decided to target the top 100 Irish companies in Ireland. This was sourced from the Business and Finance (2004) report of the top 1000 companies in Ireland, published in

association with Stephen Fry Solicitors. Companies were telephoned to identify the individual IT managers in the respective companies and to secure their contact details, including their email addresses. A total of 75 companies agreed to partake in the survey, which included companies within the Airline, Warehousing and Distribution, Food and Drink Processing, Construction, Information Technology and Manufacturing industries. With respect to particular characteristics of the sample, companies were only asked to provide information on their annual turnover and basic contact information.

Table 6.1 shows the distribution of the research sample. Unlike the author's first survey, all of the companies who partook in this survey were very large companies, with an annual turnover in excess of €40 million. As stated in the introduction, the author acknowledges this restriction, however when comparing the results the author will be comparing them with the results from construction companies who operate a similar turnover annually in excess of €40 million.

Business Sector	**Total Number (%)**
Airline	3 (4%)
Warehousing and Distribution	13 (17%)
Food and Drink Processing	17 (23%)
Construction	9 (12%)
Information Technology	14 (19%)
Manufacturing	18 (24%)
Other	1 (1%)
Total companies surveyed	75

Table 6.1. Distribution of research sample

It is evident in Table 6.1 that the research sample represented a wide cross-section of Irish business, with the larger proportion of companies representing the food and drink processing (23%), and manufacturing (24%) sectors.

6.2.2 Implementation Phase

The implementation phase of the questionnaire focused on two aspects, namely, a pilot questionnaire and the distribution and return of the questionnaire.

Pilot Questionnaire

A pilot questionnaire was carried out, similar to the first survey reported in Chapter 4. Table 6.2 identifies the questions and the responses received from two companies when asked to comment on the pilot questionnaire.

	Question	**Summary of Responses**
1.	How long did it take to complete?	On average between 10 minutes.
2.	Were the instructions clear?	It was suggested the number of questions be reduced.
3.	Were any of the questions unclear or ambiguous? If so, which questions and why?	Question 3 on 'current state of awareness of ICT deployment' and Question 6 on 'significance of eCommerce over next 3 years' should be omitted.
4.	Did you object to answering any of the questions?	There was no objection to any of the questions asked, other than the removal of particular questions.
5.	In your opinion, has any major topic been omitted?	No omissions noted.
6.	Was the layout of the questionnaire clear/attractive?	All respondents were satisfied with the layout.
7.	Any further comments?	It was suggested that Questions 9 and 10 detailing 'concerns with respect to a web-based strategy' and the 'identification of those concerns' should be combined into one question.

Table 6.2. Summary of responses to pilot questionnaire

The responses enabled the author to revise the questionnaire, such that it was ready for main distribution. The recipients to the pilot survey suggested that the calibre of companies surveyed would be very aware of the EC technologies currently on the market and of the significant impact that EC will make to their businesses within the next three years. It is for this reason that Questions 3 and 6 were omitted from the circulated survey.

Distribution and return of questionnaires

The surveys were distributed by hosting initially the questionnaire on the Construction IT Alliance website (www.cita.ie) then emailing the sample of 75 companies. The questionnaire was accessed by clicking on a URL link to the survey and completing the same online. Once completed, the survey was sent back to the author's email address for analysis. A date was fixed for completion of the survey, however the author extended the

completion date by three weeks and regularly telephoned the non-respondents to encourage a good response rate. A list of the recipients and respondents of the questionnaire is included in Appendix D.2.

Table 6.3 summarises the research sample response rate achieved. A total of 38 responses were received. This represented an overall response rate of 51%.

Sectors	Questionnaires Issued	Responses (%)	Responses (%)
Airline	3	3 (8%)	100
Warehousing and Distribution	13	9 (24%)	69
Food and Drink Processing	17	8 (21%)	47
Construction	9	5 (13%)	56
Information Technology	14	4 (10%)	29
Manufacturing	18	9 (24%)	50
Other	1	0 (0%)	0
Total	75	38	51

Table 6.3. Research sample: rate of responses by sector

It can be seen from Table 6.3 that the distribution of responses closely mirrored the distribution of the research sample. It can, therefore, be concluded that the results of this survey are reasonably representative of the larger companies in their industries.

6.3 QUESTION SELECTION

It is not necessary to discuss the rationale to the wording of the questions in this Chapter, as the questions selected and the rationale with respect to their wording was largely similar to those adopted in the earlier 2004 survey discussed in detail in Chapter 4.

6.4 ANALYSIS OF RESULTS

6.4.1 Error Structure

It was stated in Chapter 4, that it is important to clarify that the outcomes of sample surveys, such as this one, are not precise, as this type of survey produces only estimates of people's opinion (Salant and Dillman, 1994). Since the survey was confined to a relatively small number of companies in each sector, the results are only valid for that

proportion of the industry. Therefore, inferences made from the sample response relate only to very large Irish companies. The survey was not targeted at the smaller to medium sized companies, thus no informed conclusions can be drawn about the use of ICT in these companies. As the sample aimed for full coverage of the defined population, no random sampling, was therefore, required.

The author described earlier that the defined population was confined to the top 75 companies in Ireland. A total of 49% of the research sample declined to participate, notwithstanding their initial indications that they would participate. A total response rate of 51% was achieved overall. However, on further analysis (see Table 6.3), it can be seen that there was a reasonably balanced distribution of responses received from the various business sectors, with the main contribution coming from the warehousing/distribution, food/drink processing and manufacturing sectors.

6.4.2 Method of Analysis

The method of analysis adopted for this survey is very similar, but not as detailed, as that adopted for the first survey reported in Chapter 4. The author will report on the overall levels of ICT take-up, the perceived driving forces and barriers to EC and the likely future direction of EC, as indicate by particular business sectors. Rather than report on the overall ranking of barriers and drivers to EC by each business sector, the author has chosen to concentrate on the top and bottom three barriers reported in each instance.

Due to the relative complexity of the sample and the wide range of comparative variables possible, the author has not utilised the statistical technique of cross tabulation in reporting on the results. The results of this survey are presented in detail in Appendix D.3 using standard bar charts, pie charts etc.

6.4.3 Analysis of the Results

The author adopted an alternative method of analysing the results in comparison to that adopted in Chapter 4. Rather than go through each question in turn, the author choose to concentrate on the four core themes of the survey, namely :

- ICT Take-up;
- Drivers to EC adoption;
- Barriers to EC adoption and
- Future directions of EC

6.5 ICT TAKE-UP

The purpose of this section of the survey was to measure the overall level of ICT sophistication present in the sample. For the purpose of the survey, ICT was defined as any computer hardware or software that collects, processes, stores, analyses, and disseminates information for a specific business purpose.

6.5.1 Current Level of ICT Usage

By implication of the nature of the research sample, the author would expect a relatively high level of ICT usage among the sample. Figure 6.1 illustrates that most of the business sectors (with the exception of construction), report a high level of usage. It is important to remember that these results are subjective, as they relate to the respondents own view of their level of ICT usage.

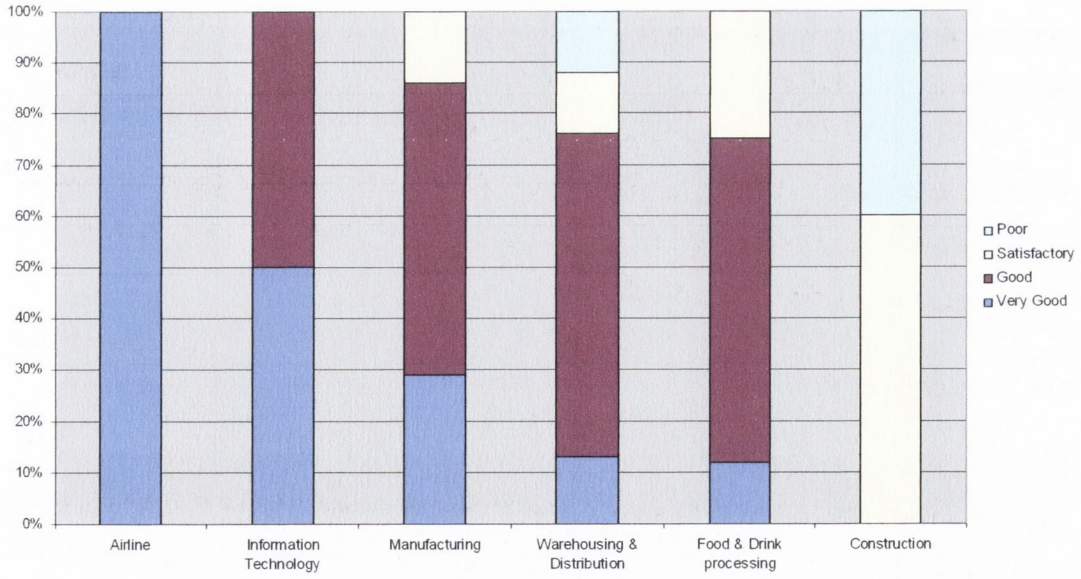


Figure 6.1. Current level of ICT usage

In particular, the airline companies, such as Aer Lingus and Ryan Air reported a very high level of usage of ICT, right across their businesses. Both commented that they operated a profitable dot com business. This level of usage is evident with the almost widespread deployment of online flight bookings. It was also predictable that the IT companies, by implication of their business, would report a very high level of usage. It can be seen from Figure 6.2 that the construction sector lags significantly behind the other sectors with respect to ICT usage. Commentary from the non-construction sectors provided a picture of sophistication in the use of ICT by large Irish companies. Some of the more interesting comments included:

- 'our sector extensively uses ERP systems'.
- 'ICT is an integral part of our business, we depend on it'.

6.5.2 Current Level of ICT Usage in B2B Purchasing Transactions

Respondents were asked about the current level of ICT usage in their B2B purchasing transactions. A summary of the responses is shown in Figure 6.2.

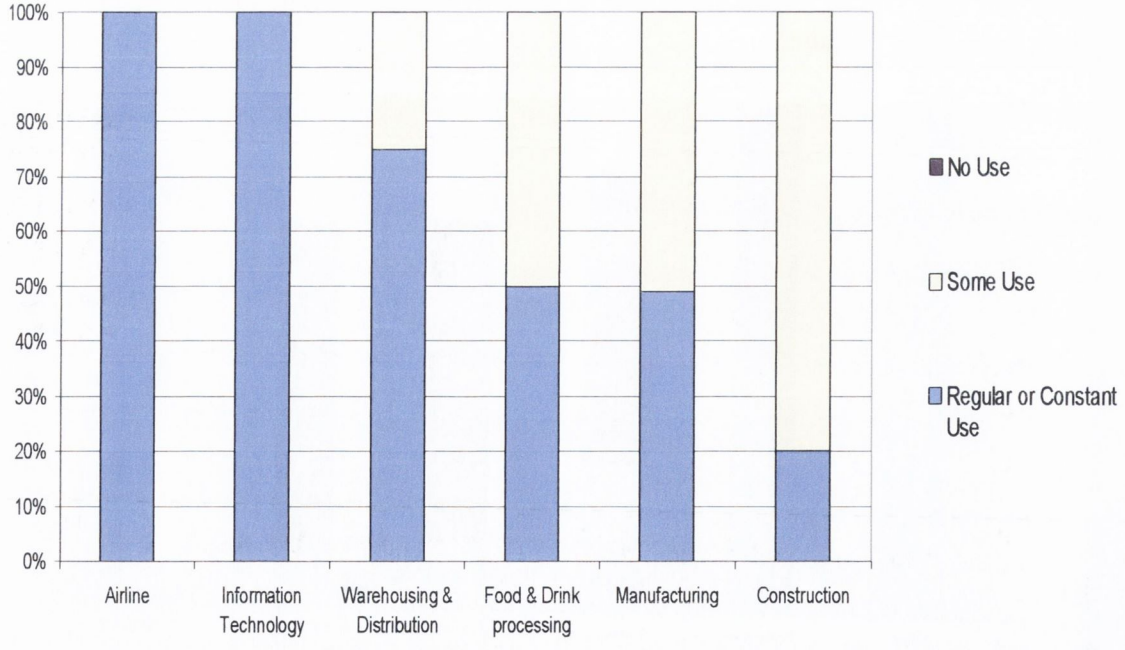


Figure 6.3. Current level of ICT usage in B2B purchasing transactions

The airline and IT respondents reported a 100% usage of ICT to support their B2B purchasing transactions. However on further analysis, commentary from these sectors suggest that whilst their communications with their customers was largely electronic, their suppliers ICT eBusiness capability was reported as poor. The results show clearly the 'gap' that is evident between the construction industry and other industries with respect to level of ICT usage in B2B purchasing transactions. The results shows also a "gap" between those construction companies in the sample that use ICT a lot and the rest that only use very little ICT in B2B purchasing transactions.

6.5.3 Willingness to Consider Applying Existing Technologies

Respondents were asked about their willingness to adopt existing technologies. Figure 6.3 illustrates that on reflection this question was not necessary, as businesses of the calibre surveyed would be expected either to be adopting existing technologies or were willing to adopt such technologies.

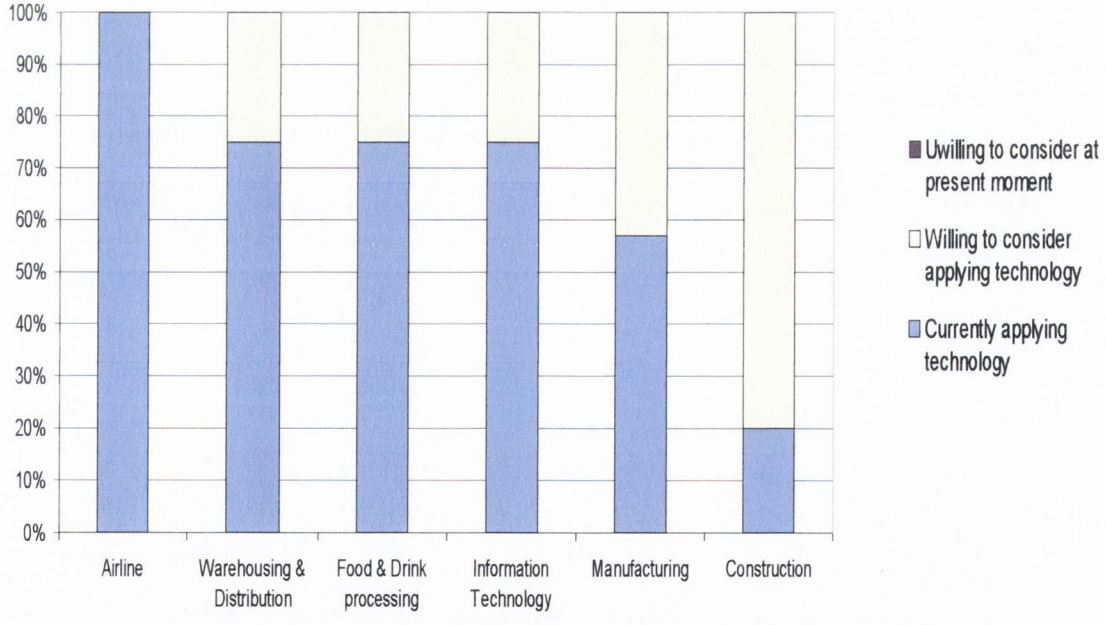


Figure 6.3. Willingness to consider applying existing technologies

Commentary suggested that many of the non-construction sectors were currently looking beyond existing technologies to new technologies, in order to gain competitive advantage or to generate increased efficiencies. Examples of commentary included :

- 'we typically extend our business systems to third parties over a secure link. If they are sophisticated enough we will deal with them on eMarket places.'
- 'extensive use of ERP, EFT, EDI and XML will eventually lead to online catalogs and eTendering, but this will depend on the up-take of the technologies from our suppliers. We would go ahead if they could participate'.

The results in Figure 6.3 show once again that the construction sector lags behind the other sectors surveyed. Only 20% of the contractors surveyed indicated that they were currently applying ICT to support their B2B purchasing transactions, in comparison to the nearest other sector manufacturing, where 57% of respondents indicated that they were currently deploying this ICT. Given that all of these construction companies turnover in excess of €40m, it is surprising that they are so far behind other sectors, with respect to ICT take-up. In Chapter 2, the author referred to the nature of the construction industry as been different to other industries, such as the manufacturing or the retail sector, where processes and the working environment are well defined and controlled (Gann, 1996). The temporary nature and uniqueness of construction projects is reflected in one-off design solutions and one-off project teams, which leads to a very fragmented industry. This is perhaps the reasoning for this relatively low level of ICT investments in construction.

6.5.4 Impact of eCommerce on Business Strategies

Respondents were asked whether they agreed that EC significantly affected their current business strategies. Figure 6.4 illustrates, as expected, that the airline and IT business sectors were 100% in agreement, whilst all other sectors were predominantly in agreement. The construction sector scored the lowest percentage with 60% in agreement.

The results obtained from the construction respondents' in this survey differed dramatically from the overall results obtained by the author in his first 2004 survey of the Irish construction sector, reported in Chapter 4. In the first survey, almost three quarters of the respondents disagreed that EC had significantly affected the strategies of construction businesses. It was explained by the author that the main reasoning for this result was the fact that the first survey was targeted at IT managers rather than executives. Whilst the author chose to use the same target strategy in the second survey, it must be remembered that only 5 construction companies responded to this survey. In contrast, 54 construction organisations with varying turnover levels, responded to the first survey. The overall result of 60% was not surprising, as the results reflect the position of the top five construction companies in Ireland only.

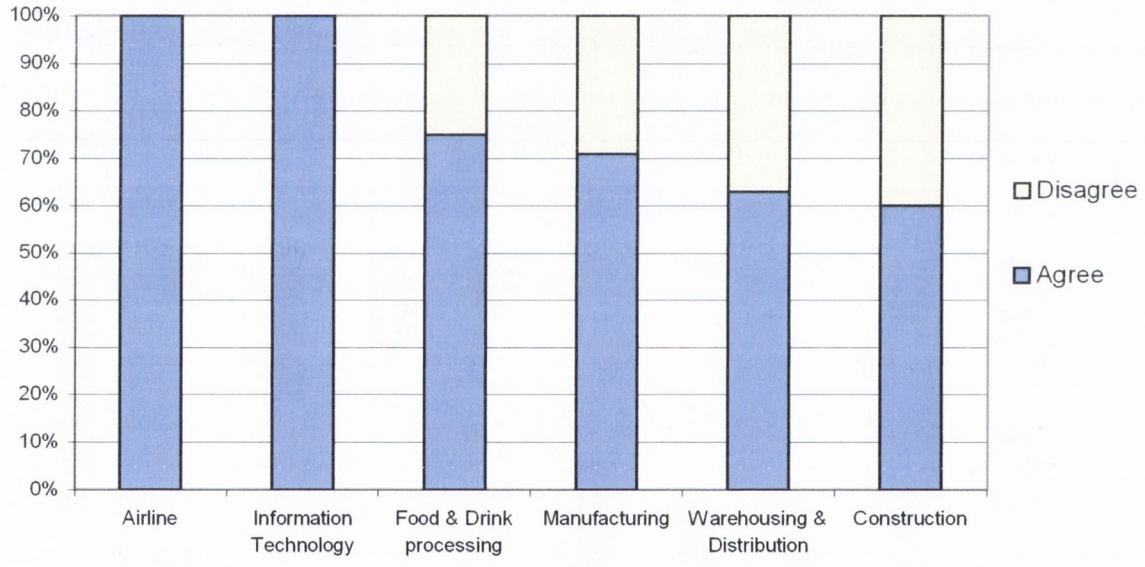


Figure 6.4. Impact of eCommerce on business strategies

Quite a degree of commentary was provided by the respondents. There was a very strong feeling from a large number of the respondents that EC will have a significant impact on business strategies. This is in sharp contrast to the results obtained from the medium to large companies reported in the first survey in Chapter 4. The following is a sample of the commentary provided :

- 'yes, it brings efficiencies and reduces the impact of country boundaries'.
- 'eCommerce reduces costs and improves reach internationally. It allows us to focus on our core business. Really its about close-knit outsourcing'.
- 'for an island nation eCommerce is a god-send'.

6.5.5 Overall Use of Technologies in Sales/Purchasing

Respondents were asked to confirm the extent to which they adopted particular technologies, such as bar coding, ERP systems, RFID technologies etc. The purpose of this question was identical to that of the first survey. Firstly to gauge the extent of use of particular technologies, and to see which technologies were the most widely adopted by the research sample. Secondly, to capture the samples' experiences with the use of such technologies. Figure 6.5 summaries the overall extent of usage of particular technologies by the research sample. It should be noted that, in the case of many industries, it was expected that the use of specific technology might not be relevant for that industry.

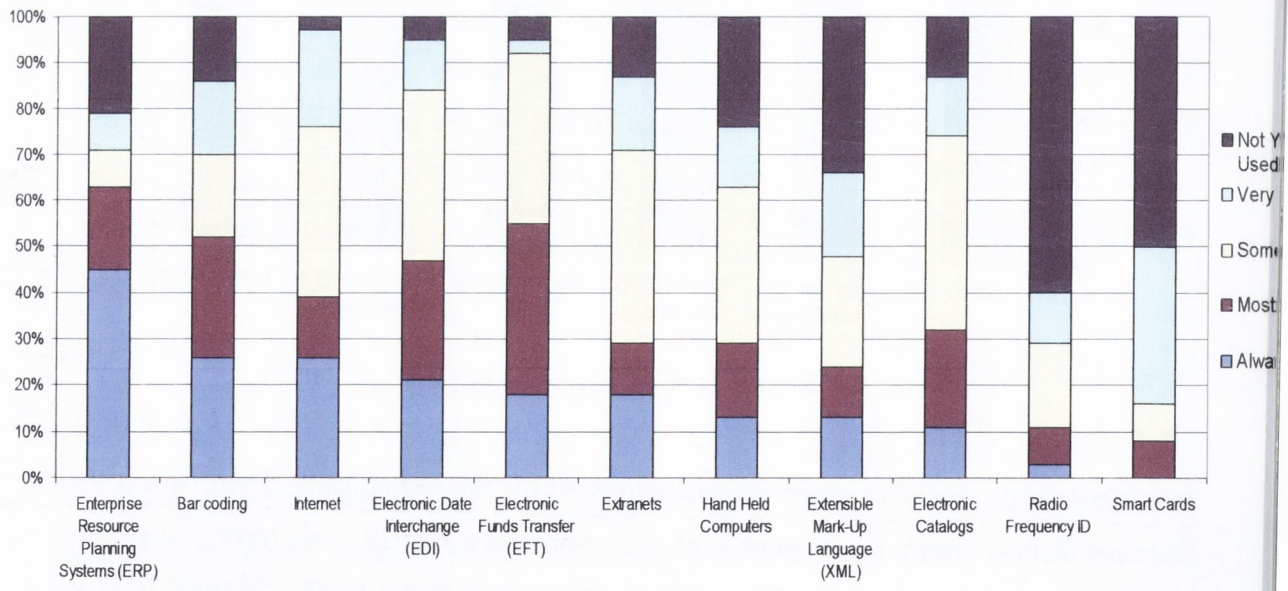


Figure 6.5. Overall use of technologies in sales/purchasing

Not surprisingly, the results show that ERP systems were the most widely adopted technology by the recipients. Also bar coding, the Internet, EDI and EFT were reported as having been widely adopted among the top Irish companies. It is perhaps surprising to observe that XML did not figure widely among the sample. On further analysis of the commentary, it appears that a number of companies have an XML capability but only adopted it when requested to do so by their customers or major suppliers.

It was felt by a large number of respondents that EFT had a negative impact on cash flow and a number of them have avoided it unless suppliers changed their payment terms. Also, there was a strong indication from the sample that RFID technologies were not mature at the present moment and that it could take 10 years or more before consumer electronic tags are commonplace.

6.5.6 Increased Use of the Internet within the Next 3 Years

Respondents were asked how their involvement in eBusiness and the use of the Internet was expected to change within the next 3 years. Figure 6.6 shows that there was a strong feeling among the respondents that EC would have a significant impact on their businesses in the short term.

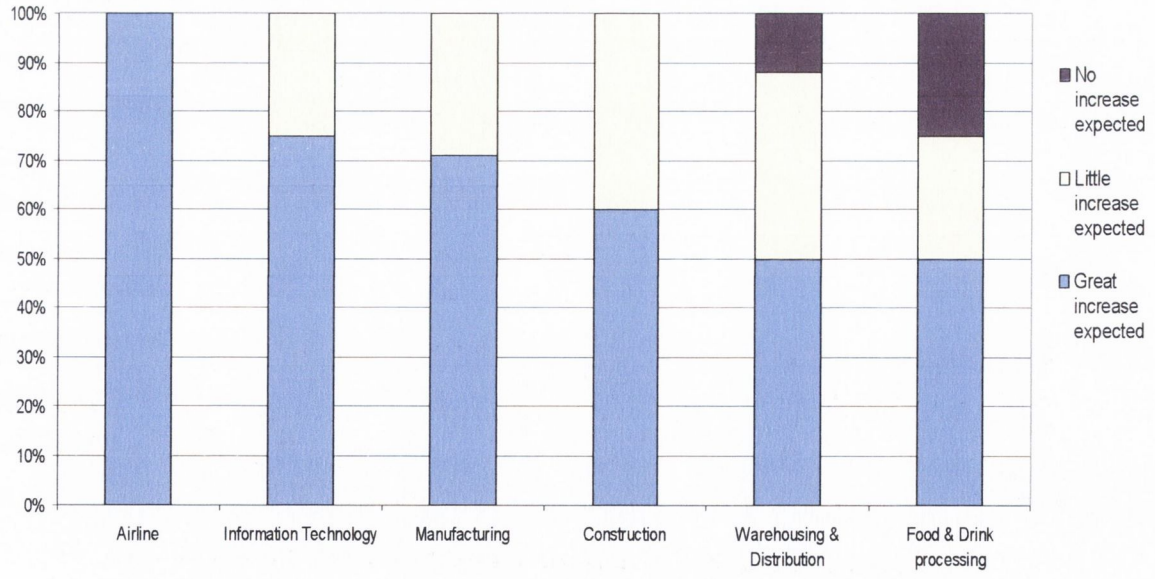


Figure 6.6. Increased use of the Internet within the next 3 years

It is worth noting that, as the construction industry has a much lower starting base than other sectors, it is not surprising that it does not rank as low as its does in other areas.

6.5.7 Concerns over a Web-based Strategy

Respondents were asked whether they had concerns over a web-based strategy for their B2B purchasing transactions. The results are shown in Figure 6.7.

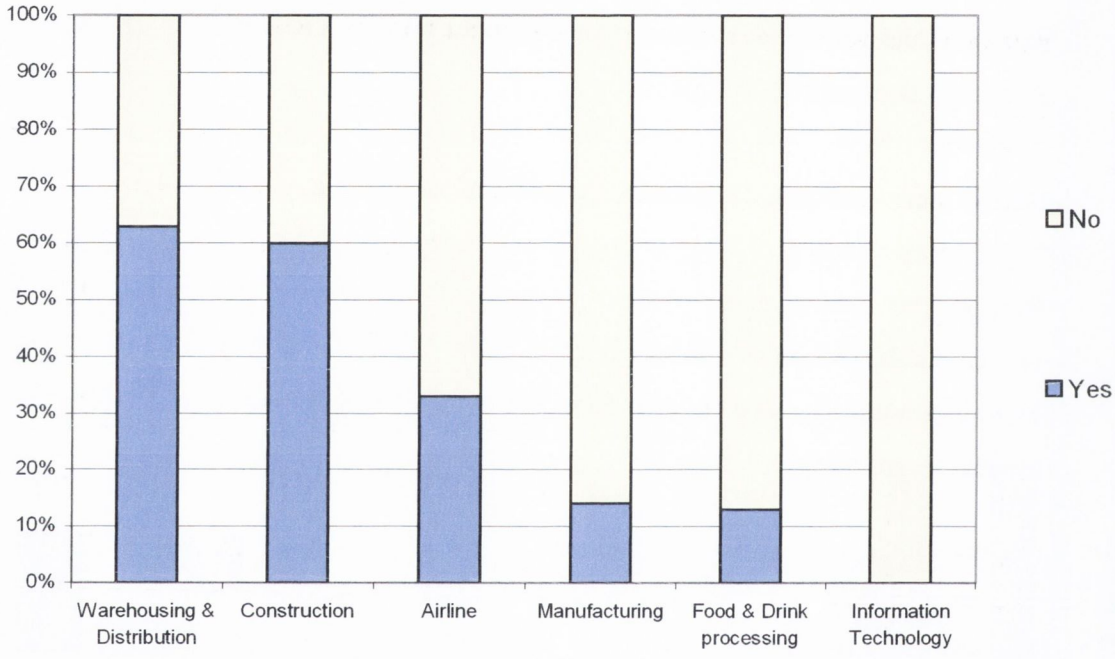


Figure 6.7. Concerns over a web-based for B2B purchasing transactions

It was not surprising, that the IT industry had no concern about a web-based B2B purchasing strategy, as this is the nature of their business. The manufacturing, food/drink processing and airline sectors had little concern about adopting a web-based strategy, whilst the manufacturing and construction sectors had significant concerns. The concerns of the construction industry were discussed in great detail in Chapter 4. On further analysis of the manufacturing responses, it was found that there was a sense among this sector that it was not best suited to conduct business trading on the Internet, as there is a

great deal of price sensitive issues in trading between companies. This issue of price sensitivity was also a significant factor in the insecurity felt by the construction sector.

As a corollary to this, sectors such as the airline industry, manufacturing and food/drink processing are typically highly organised and competitive industries, where there are relatively few dominant players, who have, in effect, forced others to follow a web-based strategy. A profound example of this can be seen in the Musgrave Group, operating in the food/drink-processing sector, where a very large portion of the supply chain is trading on the Internet.

Figure 6.8 displays the degree of concern that the overall sample had with the adoption of a web-based strategy for B2B purchasing transactions.

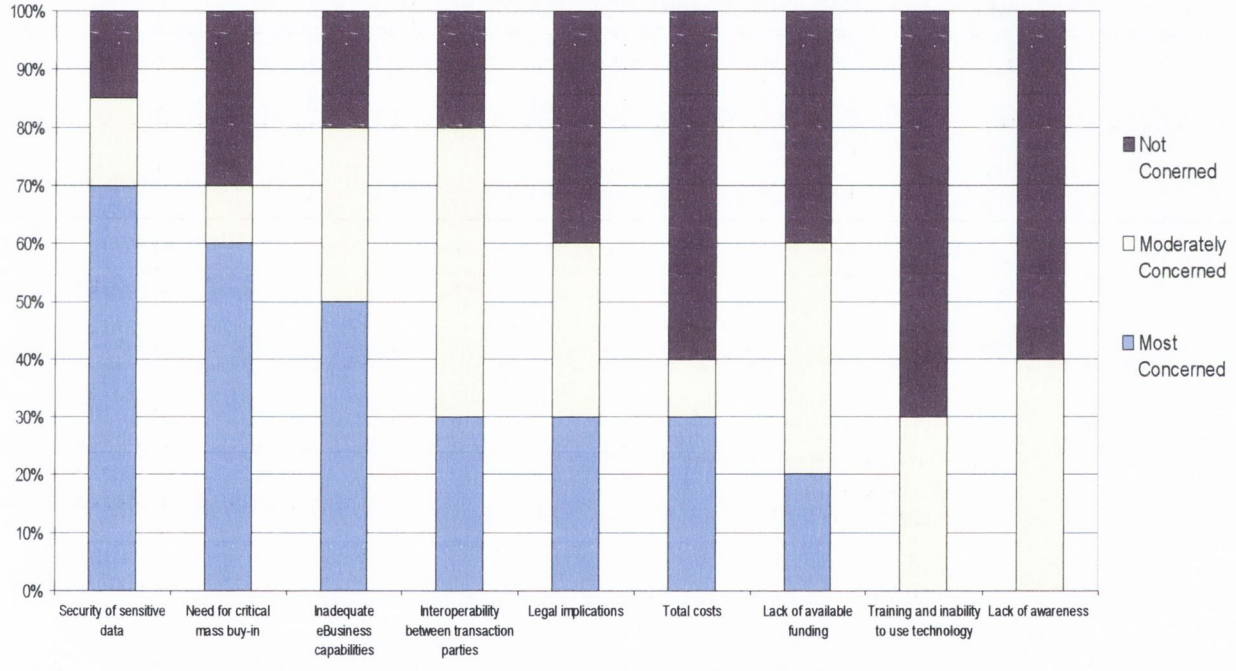


Figure 6.8. Specific concerns over a web-based purchasing strategy

It is evident that the matter of sensitive data, as mentioned earlier, is of the most concern to the respondents. There was also a feeling among the most concerned that there was a need for more of a critical mass buy-in to web-based trading and that it will take the main players, in each sector, to adopt such a strategy, and it is only then that others within the supply chain will be forced to react. The author has mentioned several times in

this Chapter, that the respondents were particularly concerned about the lack of ICT take-up by their suppliers.

The results of this survey show that there is a great deal of concern about the adoption of a web-based trading strategy. This level of concern was also reflected in the results of the first survey reported in Chapter 4. Table 6.4 summaries the top three concerns in both the author's surveys.

Early 2004 Survey – Top three concerns	**Late 2004 Survey – Top three concerns**
Security of sensitive data	Security of sensitive data
Inadequate eBusiness capabilities	Need for critical mass buy-in
Interoperability between transaction parties	Inadequate eBusiness capabilities

Table 6.4. Top Three Concerns with respect to the adoption of a Web-based Purchasing Strategy

It is clearly evident that the construction industry are not on their own, with respect to their concerns about the security of price sensitive data. In this survey 85% of respondent's were concerned about security. In the first survey, interoperability issues between trading partners and inadequate eBusiness capabilities, also ranked highly as compared to this survey. The issue of critical mass buy-in was not ranked as highly by the respondents of the first survey, as the author suspects there were more immediate concerns about the readiness of the construction sector to trade electronically with their trading a partners, rather than be concerned about the wider industry participation.

6.6 DRIVING FORCES

The participants were asked to evaluate 10 possible drivers, which would attract or were likely to attract their organisations to apply existing technologies in B2B purchasing. As these larger companies are generally adopting such technologies, the question sought to give an insight into the areas of EC where companies are finding the most success. The overall results are summarised in Table 6.5.

Industry Sector	Reduced paperwork	Avoid re-keying	Saving manpower	Fewer errors	Reduced costs	Improved Accessibility	Data standards	Service differential	Client inducement	Competition
Airline	1	2	3	4	5	6	10	8	7	9
Warehousing and Distribution	5	3	2	4	1	6	9	7	8	10
Food and Drink Processing	2	6	3	5	1	8	7	4	10	9
Construction	9	5	2	1	3	4	7	8	6	10
Information Technology	3	7	4	2	1	5	10	6	9	8
Manufacturing	2	4	1	3	5	6	8	9	7	10
Overall ranking	6	4	1	2	3	5	8	7	9	10
Ranking of Other Sectors not including Construction	6	5	1	3	2	4	8	7	9	10

Table 6.5. Overall ranking of driving forces to adoption of ICT

The results shown in Table 6.5 provide some interesting results. It is surprising that the construction respondents ranked the reduction in paperwork and the influence of clients so low. On further analysis of the commentary provided by the respondents, it was evident that paper is not seen as a major cost to construction companies. They were more concerned about people costs, such as, reducing errors, savings on manpower and overall reduction on costs of processing purchasing documentation.

6.6.1 Top Three Drivers Overall

The top three drivers overall were savings in manpower, fewer errors and reduce costs. The results suggest that the respondents perceive ICT as a tool for cost reduction, in additional to having a strategic importance to the business. It will be commented on later, that these top three drivers, were not the same top three drivers selected by the construction respondents and reported in Chapter 4.

6.6.2 Bottom Three Drivers Overall

The respondents identified competition, client inducement and data standards, as their bottom three drivers to apply ICT in their purchasing function and there was good consensus on this. As a whole, the respondents were not driven by the need to keep up-to-date with their competitors. It was, perhaps, surprising that the need for data standards and client driven implementation did not rank more highly. On further reflection, whilst these factors were of importance to the respondents, they were more concerned and driven by the need to reduce overall costs and become a more efficient business, as opposed to being concerned about external influences.

6.6.3 Drivers by Industry Sectors

To demonstrate the different challenges being faced by different sectors of Irish business, the top three and bottom three barriers of each sector are listed in Table 6.6.

Industry Sector	**Top Three Drivers**	**Bottom Three Drivers**
Airline	Reduced paperwork Avoid re-keying Saving manpower	Service differential Competition Data exchange standards
Warehousing and Distribution	Reduced cost Saving manpower Avoid re-keying	Competition Data exchange standards Client driven
Food and Drink Processing	Reduce cost Reduced paperwork Saving manpower	Competition Client driven Accessible data
Construction	Fewer errors Saving manpower Reduce cost	Service differential Competition Reduced paperwork
Information Technology	Reduce cost Fewer errors Reduce paperwork	Competition Data exchange standards Client driven
Manufacturing	Saving manpower Reduce paperwork Fewer errors	Service differential Competition Data exchange standards

Table 6.6. Top and bottom drivers identified in particular sectors

It is evident from Table 6.6, that there was a great deal of agreement between the different sectors, with respect to the top and bottom drivers. Almost all sectors agreed that savings in manpower, reduced paperwork, avoid re-keying and fewer errors were the main driving forces to the use of ICT in business purchasing. Respondent were not particularly concerned about data standards and competition. It is, perhaps, surprising that sectors such as construction, airline and manufacturing were not driven by the need to have competitive advantage (service differential).

The construction sector can learn a great deal from the results of this question. All respondents agreed largely that the driving forces are primarily focused around reducing overall administration costs, reducing paperwork, avoiding re-keying of information, saving on manpower and producing fewer errors.

What is surprising is that the construction respondents identified the same driving forces as other sectors, but still perform very poorly in comparison to other sectors (see Section 6.5.). It is the author's opinion that the larger construction companies must lead the way in showing the wider construction industry how ICT can be deployed successfully to drive out the unnecessary processing costs in conducting B2B purchasing transactions.

6.7 BARRIERS TO ADOPTION OF ELECTRONIC PURCHASING

This part of the survey concentrated on ranking the perceived barriers to electronic purchasing that undermines the use of ICT, both within business organisations and within their overall particular business sector. It is important to note that not all business sectors are starting from the same base level, therefore it is expected that a lesser degree of correlation will be evident in the results of this section of the survey.

6.7.1 Organisational Barriers

The participants were asked to evaluate six inter-organisational barriers, which would which undermine the use of ICT in business purchasing in their sector. The overall results are summarised in Table 6.7.

Industry Sector	Lack of awareness	Development cost prohibitive	Unreliable technology	Investment not justified	Difficulty in measuring cost savings	Employee resistance
Airline	-	-	-	-	-	-
Warehousing and Distribution	4	3	6	1	2	5
Food and Drink Processing	2	1	5	3	4	6
Construction	3	1	5	4	2	6
Information Technology	4	1	6	3	2	5
Manufacturing	6	1	4	2	3	5
Overall ranking	5	1	4	2	3	6
Ranking of Other Sectors not including Construction	5	2	4	1	3	6

Table 6.7. Overall ranking of inter-organisational barriers to adoption of ICT

The top three barriers identified overall include prohibitive development costs in deploying ICT, the potential benefits of EC are not sufficient to justify investment and uncertainty about how to measure cost and benefits of ICT investments. It is evident that what mostly concerned the respondents overall was the return on investment for ICT spend. Table 6.7 shows that the respondents were less concerned about the reliability of the technology and the level of awareness of ICT in purchasing and employee resistance. Large organisations, such as those surveyed by the author, are confident about what ICT solutions are currently in the market. They have confidence in the technology (other than RFID as discussed earlier in this Chapter) and experience little to no resistance to change from their employees.

It is perhaps, interesting to note that in Figure 6.9 earlier, respondents did not rank total costs associated with adopting a web-based strategy very highly among their concerns. It important, however, to appreciate that although there appears to be inconsistency in the respondents' feedback, these are two different questions. The cost of adopting a web-based strategy is only one component of the ICT investment needed to adopt electronic purchasing.

To demonstrate the different challenges being faced by different sectors of Irish business, the top and bottom internal barriers of each sector are summarised in Table 6.8.

Industry Sector	**Top Three Barriers**	**Bottom Three Barriers**
Airline	No barriers reported	No barriers reported
Warehousing and Distribution	Investment not justified Difficulty in measuring cost savings Development cost prohibitive	Lack of awareness Employee resistance Unreliable technology
Food and Drink Processing	Development cost prohibitive Lack of awareness Investment not justified	Difficulty in measuring cost savings Unreliable technology Employee resistance
Construction	Development cost prohibitive Difficulty in measuring cost savings Lack of awareness	Employee resistance Unreliable technology Investment not justified
Information Technology	Development cost prohibitive Difficulty in measuring cost savings Investment not justified	Lack of awareness Employee resistance Unreliable technology
Manufacturing	Development cost prohibitive Investment not justified Difficulty in measuring cost savings	Unreliable technology Employee resistance Lack of awareness

Table 6.8. Top and bottom organisation barriers overall

Airline companies such as Aer Lingus and Ryan Air, run very profitable dot com EC businesses and were very explicit in highlighting that no internal barriers existed in their organisation.

The remaining industry sectors broadly agreed that prohibitive development costs, difficulties in measuring cost savings, and justification of investment were the top three internal organisational barriers. It is not surprising that the construction industry barriers are similar to other, more electronically developed, industries. However, the construction sector was the only sector to identify lack of awareness as one of the top three barriers.

Most of the sectors agreed that lack of awareness, employee resistance and unreliable technologies were their bottom barriers.

Additional barriers not mentioned in the questionnaire were identified by the respondents, such as: lack of competing resources, higher priority projects with greater returns on investment, suppliers not technologically advanced and a lack of B2B marketplaces.

6.7.2 Industry Barriers

The participants were asked to evaluate 6 industry-wide barriers, which would which undermine the use of ICT in business purchasing in their sector. The overall results are summarised in Table 6.9.

Industry Sector	Lack of awareness	Technologically conservative organisations	Temporary relationships	No motivation	Too many products	Lack of government action
Airline	-	-	-	-	-	-
Warehousing and Distribution	4	3	2	1	6	5
Food and Drink Processing	1	5	6	3	4	2
Construction	4	2	3	1	5	6
Information Technology	6	-	-	-	4	5
Manufacturing	4	1	3	2	5	6
Overall ranking	4	2	3	1	6	5
Ranking of Other Sectors not including Construction	4	3	2	1	5	6

Table 6.9. Overall ranking of industry barriers to adoption of ICT

The top three industry barriers identified included no motivation for organisations to apply ICT in purchasing when others would benefit, technologically conservative suppliers and the temporary relationship between organisations resulting in an

unwillingness to invest in ICT. The recurring message of poor ICT deployment by the supply chain, once again arose in the response to this question. In particular, the multinational companies were concerned that their foreign suppliers were more technologically advanced. The temporary relationship barrier result was surprising as most modern businesses thrive on forging partnerships for more long-term relationships. The respondents were less concerned about a lack of awareness of ICT, the large number of products in the marketplace and the lack of government action.

To demonstrate the different challenges being faced by different sectors of Irish business, the top and bottom barriers of each sector listed in Table 6.10.

Industry Sector	**Top Three Barriers**	**Bottom Three Barriers**
Airline	No barriers reported	No barriers reported
Warehousing and Distribution	No motivation Temporary relationships Technologically conservative organisations	Lack of awareness Lack of government action Too many products
Food and Drink Processing	Lack of awareness Lack of government action No motivation	Too many products Technologically conservative organisations Temporary relationships
Construction	No motivation Technologically conservative organisations Temporary relationships	Lack of awareness Lack of government action Too many products
Information Technology	No barriers reported	No barriers reported
Manufacturing	No motivation Temporary relationships Technologically conservative organisations	Lack of awareness Lack of government action Too many products

Table 6.10. Top and bottom industry barriers overall

The airline sector was once again confident that there were no external barriers to ICT deployment in their industry. This sector is dominated in Ireland by two companies who dictate the pace of change and the ICT to be deployed by their suppliers. The IT sector also did not report any external barriers. These companies are at the forefront of EC implementation and, thus, see little by way of obstacles in promoting EC to their customers and suppliers.

The remaining sectors were broadly in agreement in the top three and bottom three external barriers. They were concerned about technologically conservative suppliers, and the overall lack of motivation by their industry to adopt ICT in B2B purchasing. These sectors were less concerned about the level of awareness of ICT, lack of government action and the large volumes of products on the market.

It is very interesting to see the level of similarity between the top and bottom three barriers identified by the construction, manufacturing and warehousing/distribution respondents. It is perhaps, surprising that the barriers did not differ more clearly between these sectors. However on reflection, the external barriers reported affect all large businesses in Ireland (in this instance, with perhaps the exception of the airline and IT sector). In any industry, there are those companies which are readily able to adopt electronic purchasing, however there also many which are not and which are, by implication, technologically conservative. One of the main barriers that all large companies experience, notwithstanding the sector in which they operate, is the lack of motivation from within that sector generally. The other barrier of temporary relationships is a fact of business life, where it can be difficult to form strategic partnership to ensure longevity of business relationships. The author therefore is, of the opinion that the external barriers identified by the contractors respondents' are indicative of what large companies are faced with in modern business.

6.8 FUTURE DIRECTIONS

This part of the survey focused on the respondents' positions in regard to statements as to the likely future direction of EC in Irish business. The results are summarised in Figure 6.9.

The results reveal either agreement or strong agreement with almost all the statement choices provided by the author. The top three statements overall identified by the respondents included :

1. There is a general awareness in the company of the benefit of deploying existing technologies in purchasing processes.

2. A standard should be introduced for the electronic data interchange in B2B transactions in our business sector.
3. There is an increase in IT literacy and familiarity of electronic purchasing in the company.

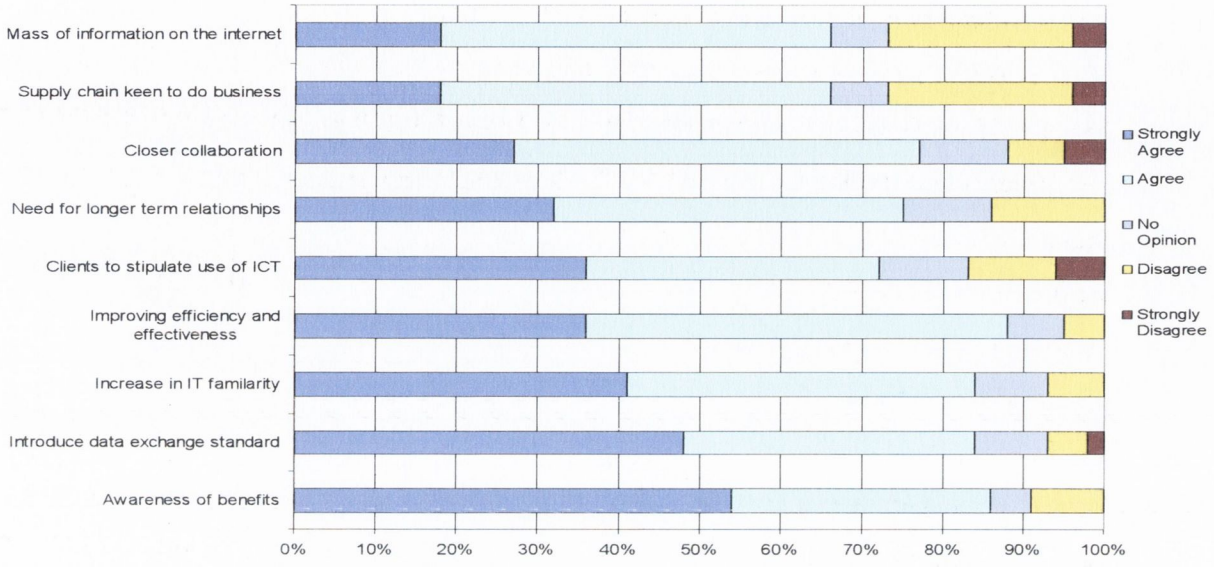


Figure 6.9. Future directions of EC

The message coming through in the responses to this question is one of a very healthy attitude among the larger Irish businesses to the benefits of EC. Many of the companies surveyed referred to their research and development strategy and to their dedicated teams, whose role is to research new technologies, in order that they may see if these technologies can bring future efficiencies to their businesses.

It is understandable that the importance of being aware of the benefits of deploying existing ICT in their B2B purchasing processes is the number one priority for the respondents of this survey in the future development of their business. It is perhaps surprising, that the respondents of the first survey did not rank this as highly (see Figure 4.16 in Chapter 4). The author can only conclude that there were other priorities that the Irish construction industry generally needs to address, such as closer collaboration and development of industry standards, in order that there can be a greater appreciation of the wider business benefits in investing in ICT to support its B2B purchasing transactions.

It was refreshing that there was broad agreement among the sample about the need for industry standards for data exchange, such as XML. This matter will figure in the re-engineering solution, which is discussed in Chapter 8. The important of the development of an XML standard was also ranked number one by the respondents in the Irish construction survey reported in Chapter 4.

6.9 ELECTRONIC PURCHASING PRACTICE IN IRELAND: A PERSPECTIVE FOR THE IRISH CONSTRUCTION INDUSTRY

Technology use, such as ERP systems, RFID, EDI, EFT and bar coding, has become widespread within manufacturing, airlines and the food/drink industries. However, the rate of adoption in other business sectors, such as the construction industry, has been very slow and piecemeal (Hore and West, 2005b), as the first survey showed with regard to the construction industry.

6.9.1 Overall ICT Take-Up

It was clearly evident from the results of this survey that the construction sector was lagging significantly behind all other sectors with respect to ICT take-up. The following is a summary of the extent of this lag.

- Overall level of usage of ICT was reported by the construction sector as mainly satisfactory. This compare to the airline and IT sectors who all reported a very good rating.
- Overall level of use in B2B purchasing was reported by 60% of the construction sector as little use. Again this compares to 100% regular/constant usage reported by the airline and IT sectors.
- 20% of construction sector respondents are already using ICT with the balance of 80% willing to consider ICT for construction purchasing at the present moment, whilst the vast majority of all the other business sectors surveyed were currently applying ICT in their B2B purchasing business.

There appears to be little substantive evidence that the construction industry is actively using existing ICT to carry out B2B purchasing transactions. The construction industry respondents of this survey appear to be paying no more than lip service that they are willing to consider applying existing ICT to support their purchasing processes. The author concluded earlier that this lack of ICT take-up is typical of a fragmented construction industry, where there a one-off projects, one-off project teams etc.

6.9.2 Driving Forces to ICT Adoption

There was broad agreement among all the respondents of the main drivers, which were likely to attract organisations to apply existing technologies in purchasing. Figure 6.10 illustrates by use of a scatter diagram, the degree of correlation between the views of the construction respondents and the other business sectors surveyed regarding the ranking of the driving forces for ICT adoption.

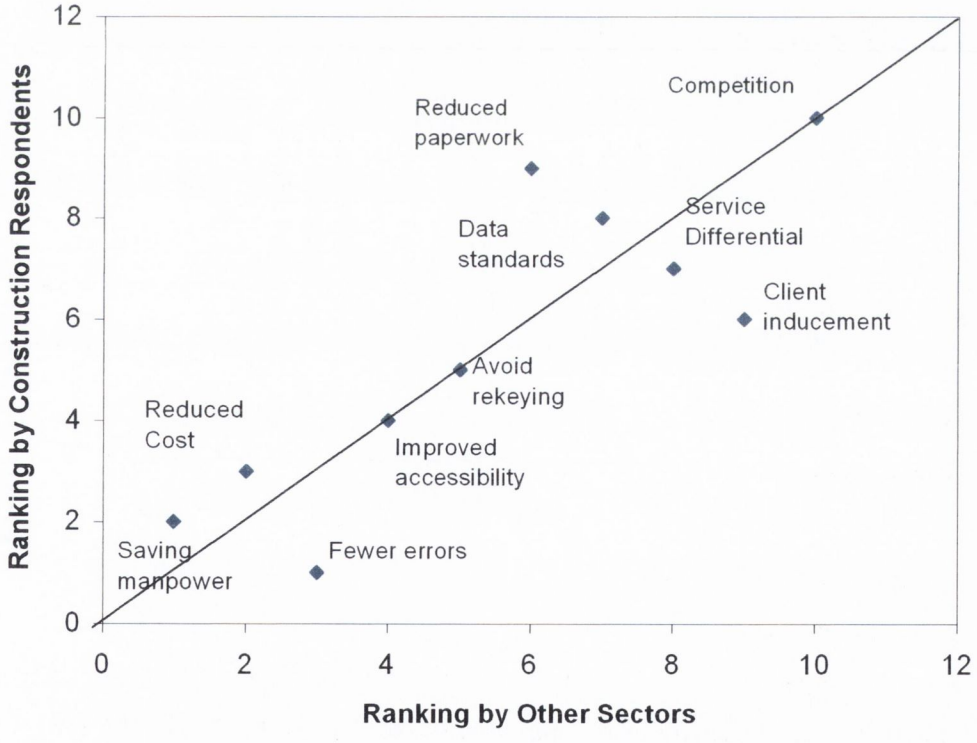


Figure 6.10. Ranking of driving forces in the adoption of ICT in B2B purchasing for construction and other sectors

It was stated earlier in this Chapter that there was a great deal of agreement between the different sectors, with respect to the top and bottom drivers. This can be readily seen in Figure 6.10. This consensus or acknowledgement of the driving forces is not reflected by the business practices of the larger contracting organisations. The contractors acknowledge that savings in manpower, reduced costs and fewer errors were the main driving forces for the use of ICT in business purchasing. But it is the author's opinion that this is nothing more than lip service. The larger construction companies must target these driving forces when conducting future B2B purchasing transactions.

6.9.3 Organisational barriers

All respondents concurred on the top three organisational barriers. Figure 6.11 illustrates the degree of correlation between the rankings to the barriers given by construction sector and the other sectors surveyed on this question.

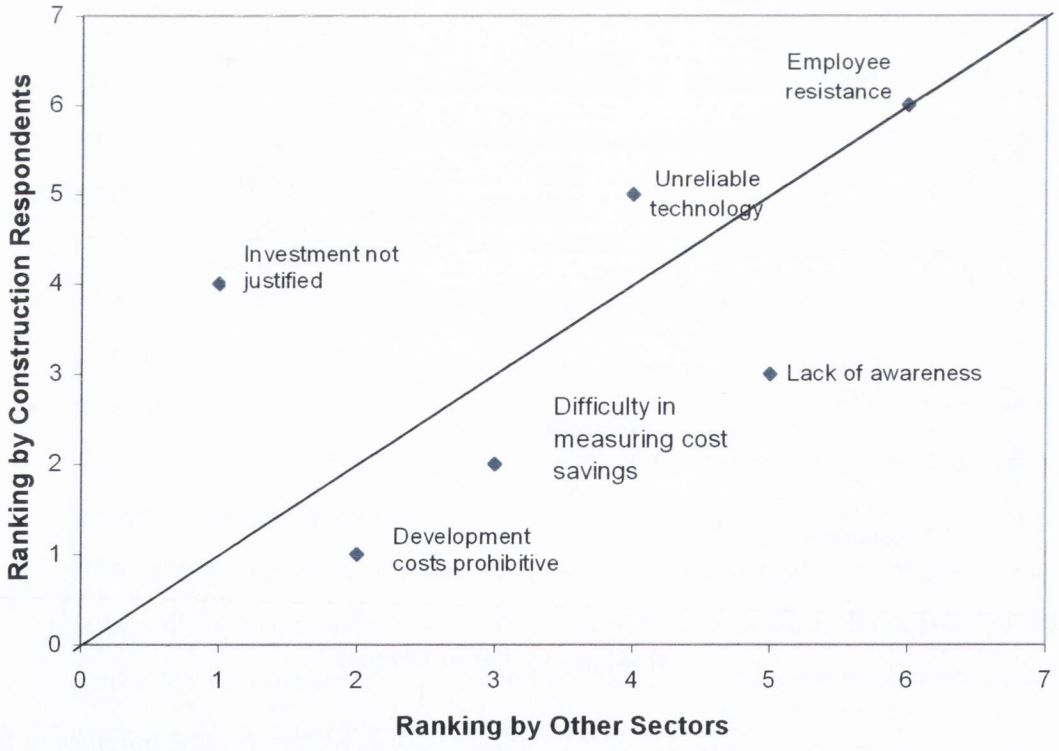


Figure 6.11. Ranking of inter-organisational barriers to the adoption of ICT

As stated earlier, the construction industry was the only sector to identify lack of awareness, as one of the top three barriers. The industry, by implication, is acknowledging a deficiency in their understanding of the capabilities that ICT can bring to their business processes. The author is convinced that these inter-organisational barriers need to be tackled head-on, by demonstrating to the industry that there are significant business benefits (and by implication cost savings) associated with deploying ICT solutions to support their B2B purchasing transactions.

6.9.4 Industry Barriers

All industry sectors surveyed largely concurred on the barriers, which undermined the use of ICT in their sector. An illustration of the degree of correlation between the ranking of the barriers given by construction sector and the other business sectors surveyed is shown in Figure 6.12.

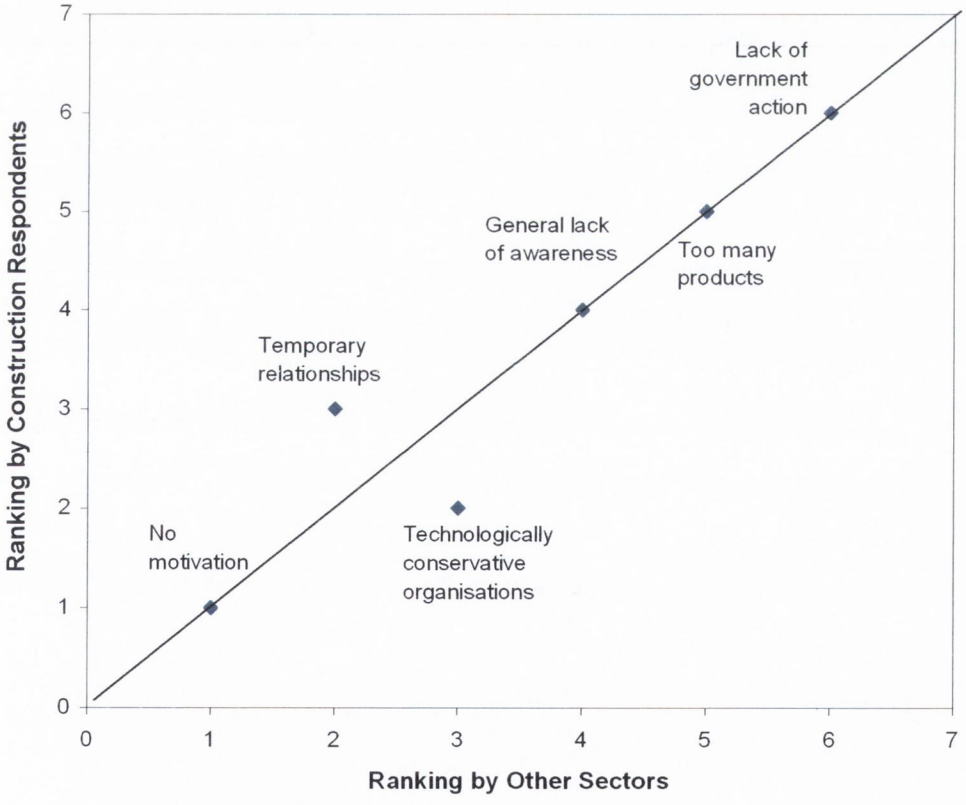


Figure 6.12. Ranking of industry barriers to the adoption of ICTs

The top three industry barriers identified overall, included no motivation for organisations to apply ICT in purchasing when others would benefit, technologically conservative suppliers and the temporary relationship between organisations resulting in an unwillingness to invest in ICT. With respect to the bottom three barriers, there was 100% correlation between the rankings provided by the respondents. Despite this strong correlation on barriers, large firms in the construction industry have :

- Not got over these barriers, as other industries have and
- Surprisingly, have no special unique barriers despite their relative poor position.

As stated earlier, by the author, the external barriers reported affect all large businesses in Ireland, notwithstanding the sector in which they operate their businesses. The construction industry appears to be the only industry that has not yet and is not willing to breakdown these barriers.

6.9.5 Future Direction of eCommerce

All respondents strongly agreed as to the necessity for the introduction of industry standards for exchange in the future. Overall respondents were generally aware of the benefits of deploying existing technologies in purchasing processes and experienced an increase in IT literacy and familiarity of electronic purchasing in their organisations in recent years.

The construction sector was of the opinion that there needed to be closer collaboration between business partners in construction and longer-term relationships between supply chain organisations in order to allow ICT development costs and other advantages to be shared. Closer collaboration or partnership is not as widespread in the construction industry in Ireland compared to in the other sectors surveyed.

6.10 SUMMARY OF FINDINGS

The following is a summary of the main findings from this survey.

1. The current level of ICT take-up reported by the top Irish companies was generally very good. In particular, the airline, IT and manufacturing industries reported very high levels of usage in supporting B2B purchasing transactions.
2. Many of the non-construction sectors were currently looking beyond existing technologies, in order to gain competitive advantage or to increase their business efficiencies.
3. It was evident from the results of this survey that the construction sector lagged significantly behind other sectors in many of the issues addressed in the questionnaire. Despite this, strangely, this sector's driving forces and barriers are similar to other industries'.
4. All sectors agreed that EC was having a significant impact on their business strategy.
5. ERP software was reported as the most widely adopted technology by the respondents in supporting B2B purchasing transactions. Also bar coding, the Internet, EDI and EFT were commonplace technologies. A large number of companies were concerned that EFT technology had a negative impact on their cash flow. Also it was felt that RFID technology was currently under-deployed and could take up to 10 years to be more commonplace.
6. The majority of respondents were of the opinion that they expected an increased significance to be placed on EC over the next three years.
7. The manufacturing and construction sectors, in particular, were concerned about the adoption of a web-based strategy for B2B purchasing transactions. Price sensitivity was a significant factor of concern reported by construction respondents. There was also the sense that there was a need for more of a critical mass buy-in to web-based trading and that it would take the main players in each sector to adopt such a strategy.
8. Almost all the sectors agreed that the top three driving forces to the adoption of ICT in supporting purchasing, were savings in manpower, reduced costs and fewer errors. This result suggested that the respondents perceived ICT as a tool for cost reduction, in addition to having a strategic importance to the business. The

respondents were less concerned about client inducement, data standards and competition. The results of this survey were very similar to the results of the author's first survey.

9. There was broad agreement that the top three organisational barriers included prohibitive development costs in deploying ICT, a belief that that ICT investment was not justified and uncertainty about how to measure the cost and benefits of ICT investment. The respondents were less concerned about the reliability of the technology, the level of awareness of ICT and employee resistance. The airline companies reported no barriers.
10. The top three industry barriers identified included no motivation to apply ICT in purchasing when others would benefit, technologically conservative suppliers and temporary relationships between organisations resulting in an unwillingness to deploy ICT.
11. Respondents were of the opinion that the introduction of industry standards, a clear understanding of the benefits of ICT and an increased familiarity with electronic purchasing were very important to the future widespread adoption of EC in the Irish business.
12. The larger construction companies appear to be giving nothing more than lip services with respect to a willingness to adopt greater use of ICT in B2B purchasing transactions because there is little evidence of this happening on the ground.
13. The internal and external barriers to this deployment of ICT are broadly similar, however other sectors seem to have bypassed these barriers, and are successfully in the deployment of ICT to support their purchasing processes.
14. What is required is a clear demonstration of the business benefits accruing to the industry as a direct result of deploying ICT in construction purchasing. The author will seek to achieve this by re-engineering the purchasing process in construction by the use of a fully integrated ICT solution, which will demonstrate the cost savings achievable and thus educate the industry as to the benefits of ICT investment in construction purchasing communications.

6.11 OTHER eCOMMERCE SURVEYS

There have been a number of similar surveys carried out in recent years, which are worthy of mention.

6.11.1 Central Statistics Office eCommerce Survey 2004

The Central Statistics Office (CSO) in Ireland carried out an EC survey in 2004 for the Department of Enterprise, Trade and Employment (DETE 2004). The survey measures the extent to which Irish businesses use EC and ICT. Over 8,000 enterprises were surveyed in 2004. The CSO figures show that Irish enterprises use the Internet more as a tool for ordering goods and services rather than for selling. Larger firms use the Internet more frequently than smaller firms.

The CSO found that 30% of enterprises surveyed sold goods by EC, with sales accounting for up to 25% of turnover. EDI accounted for half of these sales. Almost half of all the businesses surveyed purchased some goods or services using EC, but the percentage overall was very small. The exception was the retail and wholesale sectors, where 9% of purchases are made by EDI.

The CSO survey asked enterprises what they perceived as the main barriers to EC. While the emphasis was different depending on whether the companies were selling or buying, security problems about payments and uncertainty concerning the legal framework for EC were identified as the main barriers. The other key barriers identified in the survey were that customers not ready for EC and their own products/services were not suitable for EC.

6.11.2 Eurostat eCommerce survey 2004

In 2002 the European Commission set up Eurostat, which worked with the statistical authorities of the EU member states and candidate countries, and in co-ordination with the OECD, worked on developing a standard to measure ICT usage and EC activity. The Eurostat (2004) survey found that Ireland was well established with respect to EC

activity, particularly in transport and commodity services. The survey revealed that Irish companies tended to engage actively in Internet EC, as both suppliers and buyers, and that this level of activity was far above the EU average. Some 46% of enterprises surveyed were reported to be active in eProcurement, as compared to the EU average of 30%. Similarly 26% of Internet connected businesses had received orders via the Internet, which was twice the EU average.

However, most of the Irish EC activity was with clients outside of Ireland. In fact only 10% of Internet sales were domestic sales, which was the lowest reported among the other EU member states.

6.11.3 The European e-Business Report 2003

A European eBusiness Report (2003) focusing on the development of EC in the European Union assessed the maturity of EC in the EU. The report concluded that eProcurement has shown a rapid development since the late 1990's. It was reported that one in three enterprises of the seven sectors surveyed, made online purchases of MRO goods or direct production goods.

More than 50% of the enterprises from the seven sectors surveyed said that e-business constituted a 'significant part' or 'some part' of the way they operated. On the other hand, companies were not enthusiastic about the adoption of EC, mainly due to the perceived immaturity of the technology and the lack of up-take in certain sectors, such as in the construction industry.

6.12 CONCLUSION

The results of this survey show that there is a healthy up-take of ICT to support B2B purchasing transactions in Irish business. There is, however, limited EC activity within the Irish construction industry, mainly due to a low level of awareness of the benefits of EC. There was considerable concern within the construction and manufacturing sectors with respect to the adoption of a web-based strategy in purchasing, in particular, they were concerned about the sensitivity of publishing price data on the web. Almost all

sectors agreed that savings in manpower, reduced paperwork, avoidance of re-keying and fewer errors were the main driving forces to the use of ICT in business purchasing. The prohibitive development costs in deploying ICT, the difficulty of justifying investment and the uncertainty about how to measure the costs and benefits of ICT investment were considered to be the major barriers within the research sample. Increased familiarity with ICT and the introduction of industry standards were seen as the most important future developments, which would encourage the greater use of electronic purchasing.

The larger construction companies appear to be giving nothing more than lip services with respect to a willingness to adopt greater use of ICT in B2B purchasing transactions because there is little evidence of this happening in practice. Lessons can be learned by the construction industry, where other sectors have addressed many of the industry barriers. The key to unlocking the greater potential of ICT in construction purchasing is to demonstrate that significant business benefits can accrue to construction companies by investing in appropriate technologies.

Current CSO figures suggest that Irish businesses mainly use EC technologies to order goods and services, rather than sell goods. CSO research shows that security about payments and uncertainty about the legal framework for EC are the main barriers to more widespread EC activity in Ireland. Eurostat figures confirm that EC activity in Ireland overall is far above the EU average, however only 10% of Internet Sales were domestic. This is the lowest reported among the other EU member states. The most recent European e-Business report reported that respondents were not enthusiastic about EC and were quite downbeat about the role of e-business in the future.

The process of comparison between construction and other industries is useful because they are so different. Sectors differ hugely in terms of their institutional context, structure and technological intensity. Industries such as the airline industry, manufacturing and food/drink industries have experienced extensive consolidation in recent years and are dominated by a small number of global companies. Many of the large Irish companies who partook in this survey operate within complex business networks of global inter-dependency, such that collaborative working is a commercial imperative.

In contrast, the construction sector remains highly fragmented and is characterised by a continued reliance on small firms and multiple suppliers. The re-engineered solution presented by the author in Chapter 8 should help to resolve these issues, by enabling the industry to utilise readily available technology to re-engineer the purchasing process in the Irish construction industry.

CHAPTER 7

2004 PILOT PROJECT: ELECTRONIC PROOF OF DELIVERY IN THE IRISH CONSTRUCTION INDUSTRY

7.1 INTRODUCTION

The author identified in earlier Chapters the opportunities to electronically support the construction purchasing process. One of the core opportunities identified was the extent of mislaid documentation in the process and how appropriate ICT tools can be deployed to ensure information is retained securely. The author discussed how handheld computers, in particular, can record and distribute information more speedily and securely. Many industries use handheld devices to record the electronic transaction data, for example couriers, restaurants, postal services etc. (Coble and Kilbert, 1994).

The author reported in Chapter 4 a very low level of handheld computer usage among the top companies in the Irish construction industry. The author's findings in Chapter 6 showed that almost 30% of the top Irish companies always or most times used handheld computers in supporting the processing of information in their purchasing procedures (see Figure 6.6 Chapter 6).

This Chapter will demonstrate that the use of handheld computers with an Electronic Proof of Delivery (ePOD) functionality is an essential ingredient to successfully achieving a re-engineered purchasing process. ePODs will bring about savings in manpower, reduced paperwork, avoid re-keying of information and cause fewer overall errors in the process of deliveries, all of which were the main driving forces identified in the author's survey findings reported in Chapter 4 and 6.

7.2 BACKGROUND TO ePOD PILOT PROJECT

In May 2001, the author, along with academic colleagues, formed the Construction Information Technology Alliance (CITA). CITA was founded to provide independent and active leadership to the Irish Construction Industry in the application of current and emerging ICTs throughout the entire construction process. The organisation is subscription-based, open to all stakeholders in the Irish construction industry (clients, architects, contractors, engineers, quantity surveyors, suppliers, government departments,

IT companies, third level colleges, universities, etc.). Currently CITA has in excess of 110 corporate members.[1]

The main barometer of the organisation's success is based on the progress of its Special Interest Group (SIG) network (Thomas and Hore, 2003). The first group formed by the author in 2001 was SIG 1, which focused on Electronic Purchasing in the Irish construction industry. The group, consisting of a number of main contractors, suppliers and ICT vendors, aimed to use ICT to minimise the cost of administrating the ordering, delivering and invoicing of construction materials.

It was accepted by the group that building materials account for up to 50% of all construction costs. In the field of construction B2B interactions, there was huge untapped potential for productivity gains. This group saw ICT as the main driver that will enable companies to embrace EC B2B in construction purchasing transactions. It quickly became apparent that the technology behind EC was not the problem. The problem was getting the committment from all parties concerned. It was reported in a CITA member meeting in November 2004 that the biggest savings from eBusiness can be achieved from exchanging orders, delivery notes and invoices electronically. The group, which is chaired by the author, believe that an increased awareness of the capability of EC within the Irish construction industry is likely to be the key factor in encouraging wider uptake of EC technologies. The author carried out an ePOD pilot project in 2004, under the auspices and with the co-operation of the SIG.

7.3 AIM AND OBJECTIVES OF ePOD PILOT PROJECT

The overall aim of this pilot project was to prove that delivery data could be recorded electronically and be acceptable as a Proof of Delivery (POD) for the construction industry.

The underlying objectives of the pilot project included: -

- To ensure that delivery information is made available on the handheld device.
- To record electronically a site signature.

[1] www.cita.ie

- To test and confirm that completed PODs, with signatures, could be made available online.
- To ensure that the drivers making the deliveries were satisfied with the functionality and ease of use of the technology available.
- To confirm productivity improvements and potential savings, as a direct result of this pilot, for both the contractor and the supplier.

7.4 METHODOLOGY

The methodology adopted for the pilot project included 4 inter-related steps (Figure 7.1), involving: -

1. The scope of the pilot project,
2. proof of concept,
3. pilot project execution,
4. pilot project evaluation.

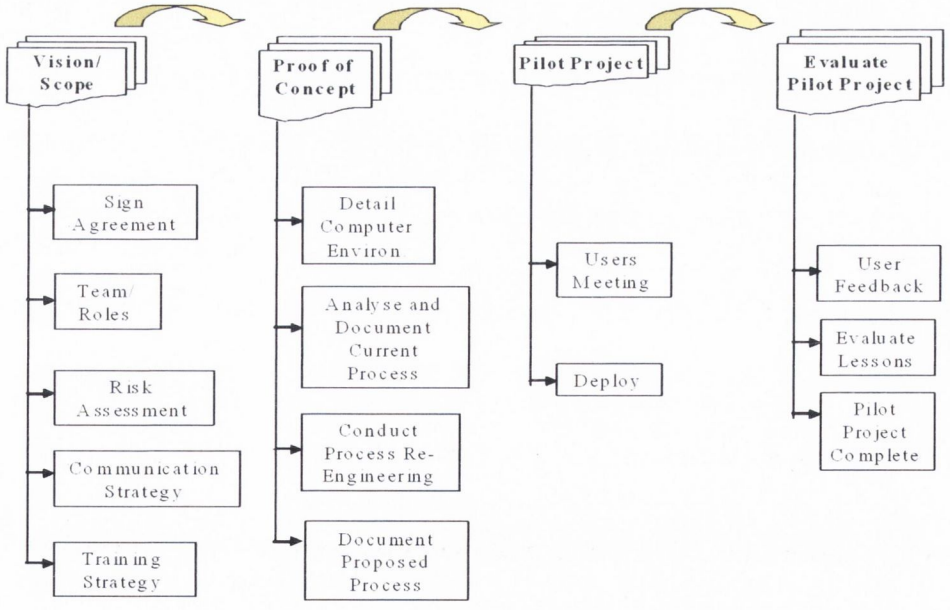


Figure 7.1. CITA pilot project methodology

The strategy initially involved reaching agreement on the scope of the pilot project. A document was prepared by the author, which identified the roles and responsibilities of each party involved in the pilot project. Once agreement was reached on the scope, it was necessary to document the current business processes. As this pilot project did not involve re-engineered the entire business process, it was possible to move quickly to the start of the pilot project. On completion of the pilot project, the data was collated and an evaluation was carried out.

7.5 PILOT PROJECT TEAM

The pilot project team members consisted of the author, acting as the team leader and the project manager, a main contractor (Ascon), a building supplier (Kilsaran Concrete), an independent management consultant (Team BDS) and the ICT providers (Sentrio and O_2). Figure 7.2 illustrates the relationship between pilot project participants. The role of the consultant was to independently verify the business benefits accruing from the performance of the pilot project.

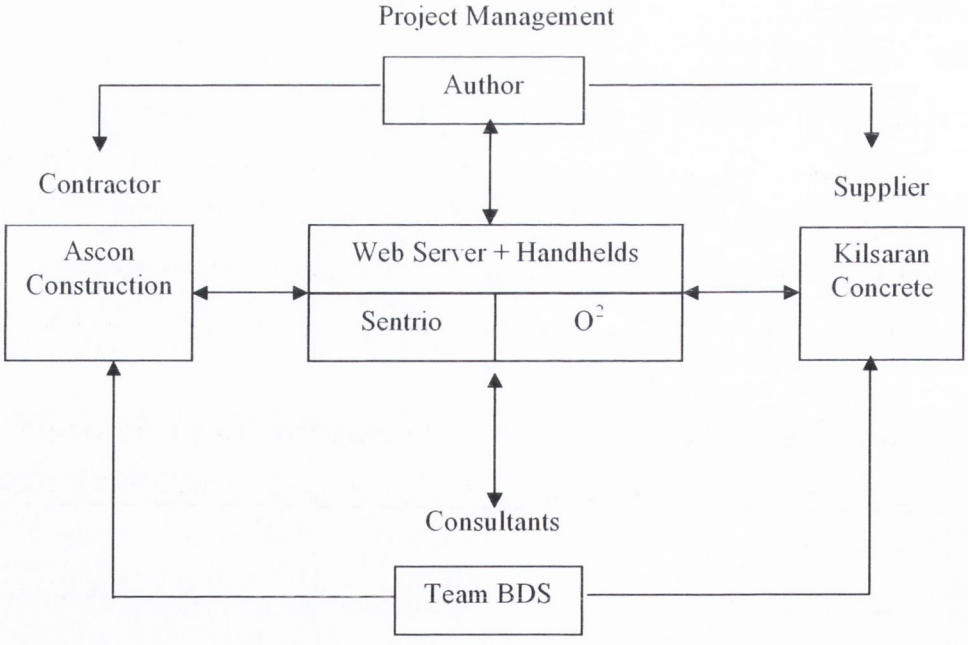


Figure 7.2. CITA pilot project team

7.6 PROBLEMS TO BE ADDRESSED BY THE PILOT PROJECT TEAM

The main problems encountered by the contractor and the supplier included; very large volumes of paper generated in their purchasing processes; a significant amount of time spent in carrying out repetitive tasks such as scanning, photocopying, matching documents; inaccuracies in the ordering and delivery process and the degree of mislaid delivery dockets, all of which led to delays in payment and, in many cases, non-payment. Table 7.1 documents the estimated volume of documentation that was created annually within the contractor and supplier organisations.

Pilot Project Contractor	Pilot Project Supplier
78,000 invoices per annum with an average of 5 lines per invoice	31,000 invoices per annum with an average of 20 lines per invoice
390,000 GRNs per annum	1,250 invoice queries per annum
20,000 missing documents per annum	375,000 delivery dockets for scanning per annum
10,000 order amendments	

Table 7.1. Estimates of purchasing documentation created by contractor and supplier

This pilot project sought to address the electronic recovery of the POD. When goods were delivered to a site, a number of issues arose, namely :

- If an authorised signatory was unavailable, the delivery docket was unsigned and a process of trying to get a signatory to sign the dockets manually after the event took place. This wasted time for both the supplier and the customer.
- If the delivery details had to be changed, a manual adjustment had to be made on the docket, which then had to be retrieved by head office staff in both the supplier and contractor organisations.
- A copy of the docket had to be returned by the authorised site signatory to the site administration office, and from there, it had to be inputted into the contractor's ICT system by way of a GRN.
- A copy of the docket had to be returned by the driver to the supplier's office, so that the supplier could raise an invoice.

- With copies of the docket needing to be sent to the administration within both the supplier's and the contractor's organisations, the potential for loss/misplacement of dockets was very obvious. 'Dockets-in-pockets' was a term often used by the contracting representatives on the pilot project team.
- When there were issues with delivery dockets or returns, it was normal for copies of dockets to be requested by the contractor. The supplier had invested in scanning technology to scan all dockets received, but this incurred costs for scanning equipment, scanning software, and labour costs to physically scan dockets. While scan rates were reasonably accurate, there was often manual intervention required to process torn, poor quality or damaged dockets. When scanning was not used, copies of delivery dockets were retrieved, photocopied and faxed to the contractor.

The net results of the above problems were the imposition of unnecessary administrative overheads, delays in payments to suppliers, inefficient distribution activity, and wasted time.

7.7 SCOPE OF PILOT PROJECT

The scope of the pilot project sought only to address the POD aspect of the purchasing process, as illustrated in Figure 7.3.

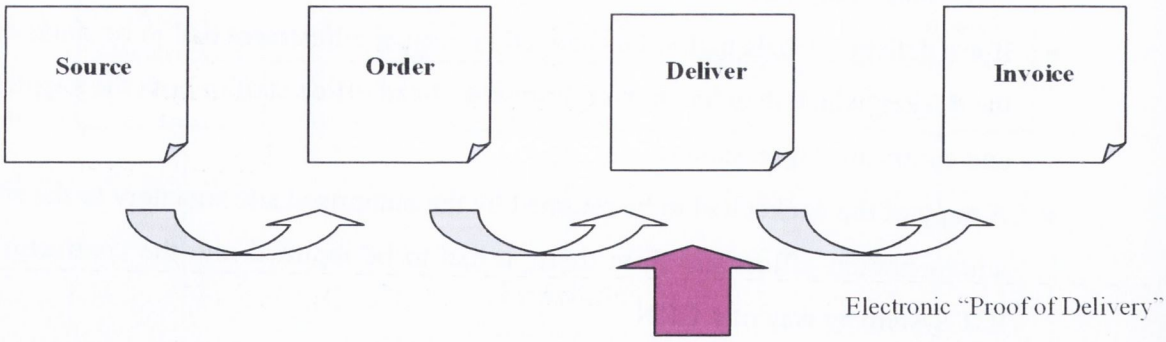


Figure 7.3. Focus of pilot project

7.8 PILOT PROJECT PROCESS

A high level illustration of the pilot process is shown in Figure 7.4. The pilot project process commenced with the contractor requisitioning material by a phone call and confirming their request by use of facsimile. The supplier, in turn, generated the order details in their ICT document management system and simultaneously onto the central web repository. Order details were then transferred to a handheld device, which, on delivery of goods to the site, were presented in an electronic format for signature on the device. Once signed, the POD was instantaneously sent back to the central repository. This allowed both companies to check the delivery information and customer signature online. It also enabled the parties to query delivery information using the central web application.

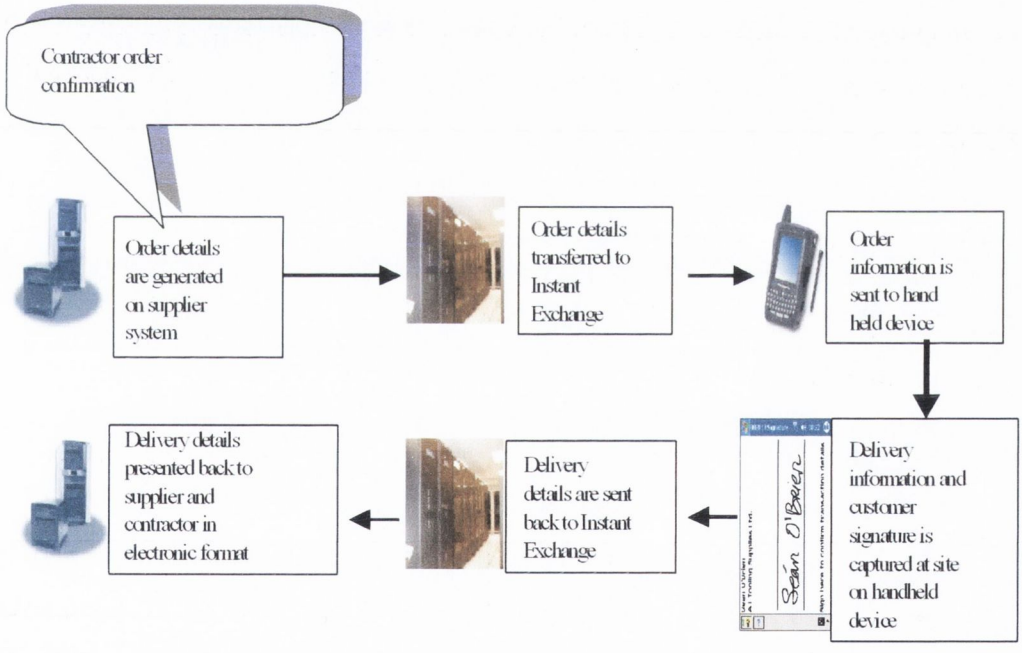


Figure 7.4. High level illustration of the POD pilot project

For the purposes of the pilot project, an order was recorded on the supplier's ICT system in the normal manner. ePODs were captured on the handheld device and

subsequently transmitted to the supplier's ICT system for invoice processing and to the contractor's system for inclusion in the purchase ledger. Once deliveries were reconciled against orders, downstream activities such as invoicing and payment processing should proceed smoothly. Figure 7.5 shows an image of one of the actual web page queries that site personnel used to verify the receipt of ePODs during the pilot project.

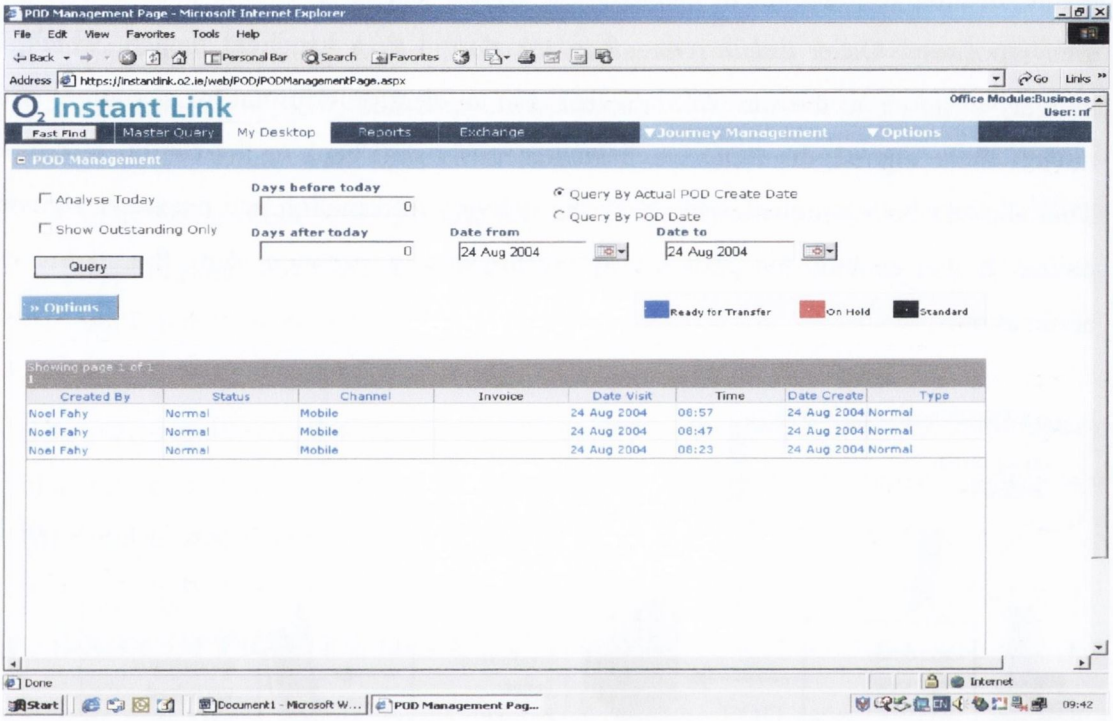


Figure 7.5. Web page of online query of ePODs

7.9 TECHNOLOGY USED

The technology selected for the pilot project was a web-based solution. The technology involved linking the ICT systems of the contractor and the supplier to the O_2 Instant Web Server, which was, in turn, networked to a field handheld PDA device. This ICT infrastructure allowed for the recovering an image of the POD on the screen of a PDA handheld device. The ICT adopted did not in any way require the contractor or the supplier to re-configure their back-end ICT systems, which was an important factor for the two parties. The technology simply allowed for the PO information to be uploaded onto a handheld device, via the O_2 Instant Web Server, which in turn allowed for the

electronic signature of the delivery information to be recovered by way of a wireless connection to the O_2 Instant Web Server.

7.10 PILOT PROJECT CASE STUDY

It was decided at a very early stage to choose a supplier of bulk material, such as a ready-mixed concrete supplier, as a case study for the initial phase of the pilot project. The reason for this decision was to simplify the process so that the project team could concentrate on a proof of concept that the technology would operate efficiently in a construction site environment. For pragmatic purposes, it was also decided to allow the site administrator to retain possession of the handheld device in lieu of the driver or haulier of the material. There were a very large number of drivers who operated as sub-contractors to the concrete supplier, which would have proved difficult to manage and finance should they all possess individual handheld units. This did not affect, however, the principle being tested.

The pilot project was also designed to minimise the impact on the resources of the contractor and the supplier. Therefore, the following measures ensured the least disruption to their business processes :

- the ePOD operated alongside traditional paper-based process.
- a specific project was selected.
- deliveries were only from a specific location or depot.
- only nominated and trained staff used the system.

The case study site was the Ascon Eden Quay project in Dublin City Centre. The supplier, Kilsaran Concrete, dispatched deliveries from its Hanover Quay depot. Only one person in the contractor and the supplier companies were trained to use the system for the purposes of the pilot project. The pilot project was carried out over 6 weeks during July and August 2004. During this time, 38 batches of ready-mixed concrete were delivered to site. Specific details of the delivery schedule are included in Appendix E.1. The pilot project team reported a 100% success rate in the receipt of the ePODs.

7.11 PILOT PROJECT FEEDBACK

Feedback had been seen as a critical part of the pilot project, as it not only provided "lessons learnt" but also substantiated the credibility of the technology deployed in the pilot project. There were teething problems in using the technology. For example, the information initially displayed on the PDA screen did not provide the necessary degree of information regarding the materials delivered. Also, the persons signing the PDA were initially unclear as to what to write on the screen. This varied from unauthorised signatures, authorised signatures, unclear signatures, insertion of dates and insertion of quantities received. However, these problems bated as familiarity emerged during the pilot study. Both the contractor and the supplier felt that there needed to be more time spent in training personnel to use the technology. They also felt that the website was not user-friendly and did not produce suitable reports for their records.

It can be readily seen from the schedule of deliveries documented in Appendix E.1 that there was a great deal of variability in the type and nature of the signatures received on the PDA. This informality and inconsistency, albeit not unusual in the existing paper-dependent system, will be specifically addressed in the 2005 pilot project detailed in Chapter 8. All pilot project team participants were asked to complete a feedback and evaluation questionnaire. Copies of these complete forms are included in Appendix E.2. The following is a summary of the feedback received from the pilot project team.

7.11.1 Contractor Feedback

The contractor representatives surveyed included the financial controller and the site administration co-ordinator. Both individuals were satisfied that the pilot project objectives were realised. They were in agreement to progress to the fully integrated pilot project; however, they were not convinced at the time that electronic invoices would form part of the final solution, as their priorities lay in the matching of electronic orders and delivery notes. Both individuals ranked the reduction of paperwork, avoidance of re-keying of information, elimination of errors and savings in manpower, as the main drivers for their company in partaking in the 2005 pilot project detailed in Chapter 8.

A more comprehensive interview was carried out with the site administrator on the Eden Quay project. The site administrator was responsible for creating GRNs for all material deliveries. He was concerned that the PDA hardware used in the pilot project would simply add an additional layer of responsibility to his task of recording material deliveries and that the task of re-keying all the deliveries on the COINS ERP system remained. The author explained to the administrator that once there was confidence in the technology, there would be no requirement to re-key delivery information into the ERP system, as this would be carried out automatically. The administrator felt very strongly that provision should be made in the re-designed process to allow for the administrator to verify the ePOD on the ERP system.

7.11.2 Supplier Feedback

The supplier representatives surveyed included the financial controller and the operations manager. Both individuals were satisfied that the pilot project objectives were realised. They were in agreement to progress to a re-engineering pilot project and seek to achieve an electronic match of the PO, delivery docket and the supplier invoice. Both individuals also ranked the reduction of paperwork, avoidance of re-keying of information, elimination of errors and savings in manpower as the main drivers for their company partaking in the next pilot project.

The author also carried out a more comprehensive interview with the shipping clerk on the Hanover Quay depot site. The site administrator did not find the technology user friendly, finding it very time consuming to check PODs online. He acknowledged, however, that his job involved too much paper and agreed that the technology would vastly improve his productivity, particularly if he was not required to create multiple copy delivery notes for his drivers and accounts personnel.

Table 7.2 summarises the key feedback obtained by the author from the contractor and the supplier representatives on the 2004 pilot project.

Issues requiring Feedback	Contractor Feedback	Supplier Feedback
Were objectives of the pilot project clear?	Yes	Yes
Do you agree to move to a more integrated pilot project?	Yes	Yes
Indicate where ICT should be applied in the trading process.	Ordering Receiving	Confirmation of order Delivery Invoicing
Top 3 factors attracting your organisation to apply ICT in a more integrated pilot project.	Savings in manpower Reducing paperwork Avoiding re-keying of information.	Savings in manpower Reducing paperwork Avoiding re-keying of information.
Reason for partaking in pilot project.	To see if the technology could help reduce the time spent in locating missing documents and reduce the cost of administrating the purchasing process.	To participate in the introduction of this technology into the industry, which will move our organisation to a more efficient method of docket and system management.

Table 7.2. Key feedback obtained from the contractor and the supplier from 2004 pilot project

It can be seen from Table 7.2, that the feedback was both positive and constructive. Both trading partners agreed to move to the next phase pilot project detailed in Chapter 8, and were satisfied that the original objectives were clearly communicated by the author. The contractor, at the time, was not concerned about the inclusion of electronic invoicing in the next phase pilot project, whilst the supplier was in agreement to include invoicing.

Both parties were in agreement as to the top three drivers, which encouraged them to move to the next phase. Savings in manpower, avoidance of re-keying of information and reducing paperwork volumes were seen as the most important factors to be addressed in the next phase.

7.12 TEAM BDS FINDINGS

Team BDS were specifically required to report on the business benefits that would accrue if the ICT infrastructure devised by the author was fully deployed in the ordering, receiving and invoicing processes within the respective contractor and supplier organisations. Team BDS identified a large number of constraints remaining in both the

contractor and supplier purchasing processes, notwithstanding the introduction of the ePOD technology.

Tables 7.3 and 7.4 summarise the processes and current constraints evident in both the contractor's and supplier's trading arrangements, as identified by Team BDS.

Contractor – Processes and Current Constraints			
Process	**Current**	**Constraint**	**Objectives yet to be achieved**
Ordering	Contractor provides order information.	No constraints evident.	Auto order adjustments based on delivery.
Delivery	Hard copy delivery dockets and ePODs in parallel.	Manual creation of GRN in ERP system. Checking online image of ePOD.	Auto generation of GRN into ERP system. Integration of ePOD into COINS HUB and route into ICT system.
Invoicing	Cross-referencing invoice with COINS GRN records.	Scanning documentation. Missing GRN/scanning documents.	Three-way electronic match of PO, delivery note and supplier invoice.

Table 7.3. Contractor's constraints remaining in the 2004 pilot project (Team BDS, 2004)

Supplier – Processes and Current Constraints			
Process	**Current**	**Constraint**	**Objectives yet to be achieved** **Level of Achievement**
Ordering	Phone and facsimile.	Need to put manually into system.	Auto ordering into system from customer.
Delivery	Hard copy Delivery Dockets.	Missing documents. Packaging of delivery dockets from site. Scanning of delivery dockets in accounts.	Eliminate scanning.
Invoicing	Invoice issued once delivery initiated.	Checking online image of ePOD. Missing documentation.	Auto generation eInvoice into COINS HUB.

Table 7.4. Supplier's constraints remaining in the 2004 pilot project (Team BDS, 2004)

7.12.1 Team BDS Observations on Contractor's Processes and Current Constraints

Team BDS recommended that the contractor should retain the creation of the PO and that the next phase pilot project should attempt to allow for auto order adjustments, based on actual delivery information. They acknowledged that in the case of a supplier of a wider product mix, the probability of a discrepancy occurring between the contractor's order and the supplier's delivery information would be much higher, and thus the ICT solution should cater for this. They noted that there were no constraints in the ordering procedure for the contractor, as the process mainly involved requisitioning materials by telephone.

The consultant was critical of the necessity of the contractor to GRN all the delivery information into the COINS system. They also noted the dissatisfaction of the site staff in checking the online image of the POD, which was independent of the COINS system. They noted the success of the ePOD functionality in the pilot project and recommended that the next phase pilot project would include the creation of eGRNs, which would eliminate the need for the site administrator to re-key the GRN into the COINS system.

The consultant acknowledged that whilst electronic invoicing was not within the scope of the 2004 pilot project, there remained considerable inefficiencies with respect to how the contractor managed the supplier invoice information. They contended that the scanning of invoices should be eliminated and agreed with the author's suggestion that a three-way electronic match of the PO, delivery note and supplier invoice should be included in the scope of the 2005 pilot project detailed in Chapter 8.

7.12.2 Team BDS Observations on Supplier's Processes and Current Constraints

Team BDS noted that one of the key constraints that remained in the supplier process was the need to re-key the PO information into their own ICT system. They recommended that this re-keying be eliminated in the next phase pilot project. The consultant also recommended that the scanning of all delivery dockets by the supplier should be eliminated in any future pilot project. They acknowledged the success of the ePOD technology in the 2004 pilot project; however they also noted the dissatisfaction with the time taken by the supplier accounts personnel in checking the ePOD image online.

7.12.3 Author's commentary on Team BDS Observations

Whilst the author agrees with many of the remaining constraints and objectives identified by the consultant, there are a number of recommendations made by the consultant that were impractical. Table 7.5 summarises these observations.

	Sub-Process	Constraints identified by Team BDS	Objectives yet to be achieved	Observations
Contractor	Ordering	No constraints evident.	Automatic order adjustments based on delivery.	Supplier will create the PO information. Automatic order adjustments are not a practical suggestion.
	Receiving/ GRNs	Manual creation of GRN in ERP system. Checking online image of ePOD.	Automatic generation of GRN into ERP system. Integration of ePOD into COINS HUB and route into ICT system.	ePOD will be routed to the contractor's ICT back-end ICT system (via the COINS HUB). The re-engineered solution will necessitate a degree of intervention/verification by the site administrator before the GRN process is completed.
	Invoicing	Scanning documentation. Missing GRN/scanning documents.	Three-way electronic match of PO, delivery note and supplier invoice.	Scanning of invoices will be eliminated in any further pilot project. Three-way electronic match lies at the core of the next phase pilot project detailed in Chapter 8.
Supplier	Ordering	Need to put manually into system.	Auto ordering into system from customer.	Supplier will create the PO information in the next phase. Automatic ordering impractical.
	Receiving/ GRNs	Missing documents. Scanning of delivery dockets in accounts.	Eliminate scanning.	Scanning of delivery dockets will be eliminated in the next phase 2. ePODs will be routed to back-end ICT system, thus creating delivery confirmation.
	Invoicing	Checking online image of ePOD. Missing documentation.	Automatic generation eInvoice into COINS HUB.	Automatic invoicing impractical; invoice will be created from the ePOD information and routed via COINS HUB.

Table 7.5. Author's observation on Team BDS findings

It can be seen from Table 7.5, that many of the recommendations made by the consultant were impractical. The notion of automatic orders, GRNs and invoices is not viable, as at every stage during the purchasing process, there was a need for human intervention. For example, the process must be initiated by the creation of the PO information. In the case of the re-engineering pilot project, this will be prepared by the supplier, not the contractor, thus ensuring that the delivery information will match the PO information. The ePOD message will be routed into both the contractor's and supplier's back-end ICT systems. However, there will need to be some element of re-keying by personnel at either end to verify the ePOD receipt and to complete the GRN process. It is important to note here, however, that the extent of re-keying, in particular by the contractor, is dramatically reduced in the next phase. Once again, automatic invoicing is not possible, as the supplier's accounts personnel will need to create the invoice from the ePOD confirmation, but once more the extent of re-keying of information will be significantly reduced. This invoice in turn will be routed to the contractor's invoice workbench, thus allowing for the three-way electronic match of the PO, delivery note and supplier invoice.

Team BDS also reported on annual potential savings accruing to both the contractor and the supplier on the assumption that they progress to more fully integrated pilot project and the solution was implemented organisation wide. Table 7.6 summarises the financial savings reported by Team BDS.

Contractor's Projected Annual Savings in fully integrated Pilot Project in €			**Supplier's Projected Annual Savings in fully integrated Pilot Project in €**		
60,000 Invoices per annum 390,000 GRNs per annum			60,000 Invoices per annum 2,400 queries per annum		
Projected savings on business processes	Ordering	20,000	Projected savings on business processes	Demand from customer	20,000
	Receiving/GRNs	15,000		Delivery	100,000
	Invoicing	67,000		Invoicing	24,000
Total Savings Projected		102,000	Total Savings Projected		144,000
Add Work Study Factor +30%		31,000	Add Work Study Factor +30%		43,000
Other savings		5,000	Other savings		5,000
Total Savings Projected		138,000	Total Savings Projected		192,000
Less predicted technology costs		38,000	Less predicted technology costs		108,000
Nett Saving predicted for fully integrated pilot project		100,000	Net Saving predicted for fully integrated pilot project		84,000

Table 7.6 Potential savings for fully integrated pilot project (Team BDS, 2004)

The figures presented by the consultant are conservative, as additional indirect savings in regard to office expenses such as use of paper, printing and copier consumables are not included. Both financial controllers agreed that the savings could be far greater than that shown in Table 7.6.

The independent consultant Team BDS reviewed and verified these figures and recommended that a further 30% work study factor be added to the figures. Both financial controllers agreed to this addition. From a pilot project perspective, the supplier gained the more immediate and tangible benefits from the first phase of the pilot project. Should the POD technology be implemented, the larger investment in hardware and software would have to be made by the supplier not the contractor.

It is important to point out that the predicted technology cost for the supplier is significantly higher in comparison to the contractor's cost. The reasoning for this is that the supplier is the party who has to invest in the handheld technology solution and implement this organisation-wide. The contractor's ICT cost mostly involves investing in additional ERP functionality, as they already have invested in the ERP technology, prior to the pilot project and have ongoing annual costs associated with the ERP license agreement.

The figures presented in Table 7.6, were determined by the consultant, in consultation with the respective financial controllers of both the contractor and the supplier. It is interesting to note that the major cost differences between the supplier and the contractor lie in the cost of the ICT for the delivery mode of the purchasing process for the supplier. It is important, however, to appreciate that this additional cost to the supplier can be spread across a number of their buyer contracts. There is also a greater cost to the contractor than the supplier in processing the invoices as they have the task of verifying the 3-way electronic match and processing the payment of invoices to the supplier.

7.13 ACHIEVEMENT OF PILOT PROJECT OBJECTIVES

The vast majority of the original objectives, as identified earlier, were successfully achieved, however there were lessons learned that would be specifically addressed in the re-engineered solution detailed in Chapter 8.

The problems experienced by both trading partners in this pilot project support the results derived from the surveys and observation studies reported in earlier Chapters. Both parties confirmed that there was a large volume of paper in their current B2B purchasing processes. They both experienced significant delays in the processes due to mislaid documentation and the need to manually match POs, delivery notes and supplier invoices. The supplier's main concern lay in the mislaid delivery dockets. Table 7.7 summarises the achievements of the 2004 pilot project objectives.

Pilot Project Objectives		**Level of Achievement**	**Observations**
1.	Delivery information is made available on handheld	Successfully achieved.	Ensure only requisite information is displayed on screen of PDA.
2.	Record electronic signature	Successfully achieved.	Ensure only authorised signature and accompany with security pin number.
3.	POD with signature is available for queries online.	Successfully achieved.	ePOD will be viewable via the COINS HUB in 2005 pilot project detailed in Chapter 8.
4.	Drivers satisfied with the functionality of the technology.	Not achieved. PDA retained by the contractor not supplier.	For practical reasons the PDA will be retained by the contractor in 2005 pilot project detailed in Chapter 8.
5.	Confirm productivity improvements and potential savings for both the contractor and supplier.	Remaining constraints and potential savings presented by Team BDS. Productivity improvements not measured.	Author to report on potential savings and productivity improvements in 2005 pilot project detailed in Chapter 8.

Table 7.7. Achievement of 2004 pilot project objectives

Both the contractor and the supplier were in agreement with the author that the three-way electronic match of the PO, delivery note and supplier invoice was their ultimate aim. However, the team decided that it was best to approach this re-engineered solution on a phased basis.

7.14 CONCLUSION

The 2004 pilot project sought to record the delivery information electronically and to provide the team with the confidence that the technological functionality was appropriate for construction. This 2004 pilot project provided this technological confidence. Many lessons however, have been learned from this pilot project, which the author will bring forward to the re-engineered solution detailed in Chapter 8. It is important that the correct level of information is made available on the screen of the handheld device. The signatory should be aware of the product description and the quantity. In order to develop additional confidence in the technology, the contractor has asked that a security pin number be used prior to the signature on the screen. This added layer of security will be introduced in the next pilot project in Chapter 8.

During the 2004 pilot project, all ePOD information was routed back to the O_2 Instant website. In order to view this ePOD, both the contractor and the supplier had to exit their respective ICT systems and log onto this website to view this information. This matter will be addressed in the next pilot project, as the ePOD information will be routed back to the contractor's and the supplier's back-end ICT systems directly, thus creating an eGRN.

It was not a practical suggestion to provide the supplier drivers with handheld devices in the 2004 pilot project. All of the ready-mixed concrete lorry drivers were subcontractors to the supplier and the supplier was unable to allocate drivers to particular sites. In order to reduce the costs of the pilot, it was decided that only one handheld would be used.

The potential savings reported by Team BDS were presented in consultation with the financial controllers of both the contractor and the supplier. Whilst the savings reported appear to be very encouraging, these figures will need to be verified by the author in the next pilot project.

The 2004 pilot project is only part of the overall solution. The ePOD technology is a necessary ingredient of the fully integrated re-engineered solution devised by the author. The success of the 2004 pilot project is in providing a platform for the trading partners from which to move forward to the fully re-engineered process.

CHAPTER 8

2005 PILOT PROJECT: RE-ENGINEERING THE PROCESS OF PURCHASING MATERIALS IN THE IRISH CONSTRUCTION INDUSTRY

8.1 INTRODUCTION

The challenge outlined in Chapter 2 was how to apply the proven technique of BPR in a fragmented and project-based construction industry. Modern managerial thinking has no particular allegiance to the Hammer and Champy (1993) principle of re-designing and re-organising the managerial or operational processes, in order to obtain a significant improvement in the performance and competitiveness of an organisation.

The author will seek to demonstrate that this level of improvement will exist as a direct result of the re-engineered solution presented in this Chapter. However, the re-engineered process presented will not be a "slash and burn" approach as advocated by Buchanan (2000). Instead, the solution is more compatible with more modern managerial ideas, such as lean construction (Egan, 1998), supply chain management and partnering (Green et al, 2004). The solution will, in essence, maintain the core stages of ordering, delivery and payment of material, whilst demonstrating how an appropriate ICT infrastructure can achieve significant productivity improvements by enabling an electronic match of the core purchasing documentation.

While the UK Latham (1994) and Egan (1998) reports called for dramatic productivity improvements in the sector, there remains a lack of defined or clear objectives within the industry with respect to the adoption of EC (Ruikar et al., 2001). Whilst the comprehensive research reports of O'Leary (2000) and Ruikar et al. (2003) are meritorious and important, these reports did not seek to provide a singular ICT solution which would achieve re-engineering of the purchasing process in construction.

The 2004 pilot project discussed in Chapter 7 demonstrated that "Proof of Delivery" technology was reliable and an essential ingredient in the re-engineering of the purchasing process in construction. This Chapter will focus on a 2005 pilot project which will seek to achieve a fully integrated re-engineered purchasing process.

8.2 ESTABLISHING THE CASE FOR A RE-ENGINEERED SOLUTION

The case has been established for the re-engineered material purchasing solution through the results of the observation studies and surveys reported in earlier Chapters. It is recognised that the current administration system for materials purchasing consisted of a

large number of processes that were not cost efficient. The processes generated an enormous amount of paperwork and involved a significant number of staff carrying out repetitive and boring tasks, as clearly demonstrated in Chapters 3 and 5.

A summary of the weaknesses found in the 2002 and 2004 observation studies is summarised in Table 8.1.

Area of Weakness	**2002 Observation Study**	**2004 Observation Study**
Paper dependent	The process was almost wholly dependent on paper.	Process remained paper-dependent.
Integration of departments	The Binary ICT system deployed only provided a limited degree of integration of departments.	The ERP system provided a more sophisticated level of integration between departments.
ICT system deployed	Binary ICT system was a DOS based system introduced in 2002.	COINS ERP system was a stand-alone integrated software solution introduced in 2003
Mislaid documentation	Extensive volume of documents mislaid, mostly delivery dockets.	Significantly less documentation mislaid overall.
Management of process	Decentralised management.	Centralised management.
Manual dependency	Manual creation of purchase requisition and GRNs.	Manual creation of purchase requisition retained.
Re-keying of information	Extensive re-keying of information at all stages.	Extensive re-keying of information remained in process.
Deficient supplier information	Use of physical catalogues and outdated supplier price lists.	Use of physical catalogues and outdated supplier price evident.
Matching efficiency	Manual matching of PO, delivery docket and invoice to authorise payment.	Manual matching of supplier invoice to GRN on COINS to authorise payment.

Table 8.1. Summary of findings from 2002 and 2004 observation studies

8.3 INITIAL SOLUTION

The solution proposed here is anticipated to be practical, user-friendly and should only involve a small number of processes. The objective was to have the re-engineered process piloted in a manner that would allow it to be tested while being used alongside the current system.

Having established the weaknesses of the current process, and the successful use of ePODs in the 2004 pilot project, it was decided to progress to the 2005 pilot project through which the new system could be implemented and monitored. The author

examined a number of instances from other industries where paper-based purchasing systems were replaced with electronic based systems. O_2, the mobile phone company and the technology partner in the group, gave an account of the changes that had been effected in the retail sector with the introduction of electronic purchasing systems. A scoping document was prepared that outlined the available options.

A variety of existing technologies were investigated, including bar-coding, text messaging, combined use of mobile phones and a PDA. Figure 8.1 illustrates the original preferred solution devised by the author.

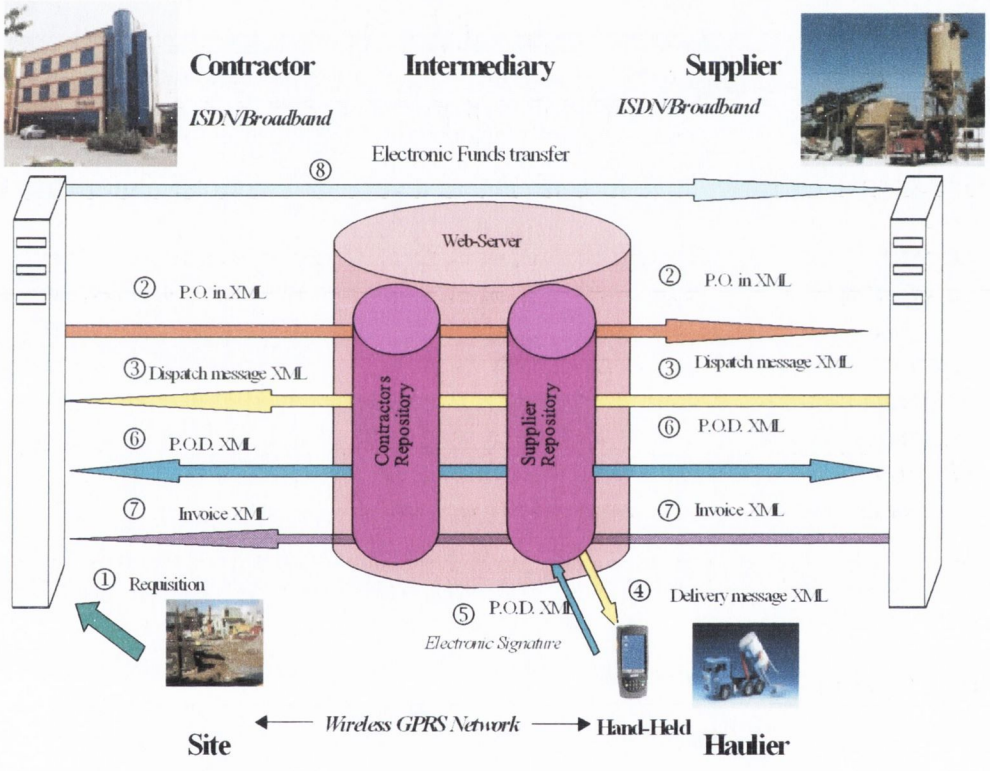


Figure 8.1. Illustration of the original proposal of integrated ICT purchasing solution

The original solution devised by the author stipulated that all purchasing documentation, such as purchase requisitions, POs, delivery dockets and invoices, could be passed electronically through a central web repository, which in turn could be electronically posted into both the contractor's and supplier's back-end ICT systems. The

intended web repository to be utilised was the COINS ETC (Electronic Trading Community) HUB. The architecture of the devised platform enabled a handheld application, with an electronic signature recording capability, to transmit wirelessly a POD from the PDA to both the supplier's and contractor's ICT systems, via an independent central web-based server. The web-based solution would provide on-line access to an image of the signed POD, which would allow for a matching of the order, the delivery record and the supplier invoice.

The operation of the solution involved the following sequential tasks, as shown in Figure 8.1.

1) Site requisitions goods are ordered by site personnel by telephone and/or fax to head office.
2) The contractor's ICT system passes a PO to the independent web-server, which ensures that the purchase format is correct and passes it to the supplier's ICT system.
3) The supplier's ICT system creates a dispatch notice and informs the contractor system if there is any variation between the order and dispatch notice.
4) The delivery details are sent to a delivery driver's hand-held device in XML format via a GPRS network. This message is triggered from the independent web-server based on the supplier dispatch message.
5) Once the delivery is complete, the driver records a signature on site that is transmitted back to the independent web server.
6) The POD is then sent from the independent web-server to both the supplier's and contractor's ICT systems.
7) The supplier sends an electronic invoice to the contractor via the independent web-server, using XML messaging technology.
8) On invoice approval, the contractor authorises electronic funds transfer directly to the supplier.

It was decided, following the successful completion of the 2004 pilot project reported in Chapter 7, to progress to a fully integrated ICT re-engineered solution, using the COINS ETC HUB, which, it was anticipated, would achieve an electronic match of the PO, delivery note and invoice.

8.4 REMAINING LIMITATIONS FOLLOWING 2004 PILOT PROJECT

The following remaining limitations were evident in the process following the completion of the 2004 pilot project discussed in Chapter 7.

1. Over-dependency on the creation of paper documents in the matching process.
2. Poor level of integration between site and head office procedures. Site personnel worked outside the ERP software functionality and created hard copy material requisitions.
3. ICT tools deployed by the contractor and the supplier are not fully interoperable. The ePOD will need to be routed to both the contractor's and the supplier's back-end ICT system via the trading HUB. The online image of the ePOD could only be accessed via the O_2 Instant website which added an additional activity to the GRN process.
4. Large numbers of documents were mislaid which delayed the overall matching process.
5. Extensive re-keying of information remained in the GRN and invoice approval stages. If the delivery information did not match the original PO, the purchasing department needed to create a new line item on the PO before the GRN process was complete.
6. Use of physical catalogues and outdated supplier prices was evident.
7. Correct information was not displayed on the PDA screen and additional security measures were needed on signing of PDA.
8. Scanning of all invoices by the contractor and all delivery notes by the supplier remained in the process.

8.5 2005 ELECTRONIC PURCHASING PILOT PROJECT

8.5.1 Aim and Objectives of Pilot Project

The overall aim of the 2005 pilot project was to re-engineer the purchasing process within a contractor's organisation, by enabling an electronic three-way match of the PO,

delivery docket and invoice data, thus enabling a significant improvement in both productivity and overall administration costs per transaction.

In order to achieve this aim, the following objectives were set:

- To document the current trading procedures utilised within the contractor's organisation.
- To identify the inefficiencies that currently exist within the contracting organisation.
- To re-design the purchasing process with a view to addressing the inefficiencies that currently exist.
- To document the proposed trading processes and the ICT support infrastructure to be utilised between the contractor and the supplier on the intended pilot project.
- To execute the proposed re-engineering process on a live project.
- To measure and report upon the productivity improvements and potential savings accruing to the contractor as a direct result of the re-engineered process.

8.5.2 Pilot Project Team

The author sought to secure the continued participation of the 2004 pilot project team in the second pilot project and to bring in an ERP software provider to enable an end-to-end integration of the purchasing data. Kilsaran Concrete Limited, however, were not available to work on the pilot project due to other commercial pressures on the organisation. An alternative supplier, WT Burdens, who are a large volume supplier of multiple civil engineering products, was secured. The ERP software provider COINS was also secured to partake in the pilot project. The contractors network provider and the handheld technology provider were also retained for the 2005 pilot project.

Figure 8.2 illustrates the relationships between the participants on the pilot project. No independent consultants were utilised to verify the business benefits accruing from the performance of the pilot project, as it was agreed that the author would carry out this task.

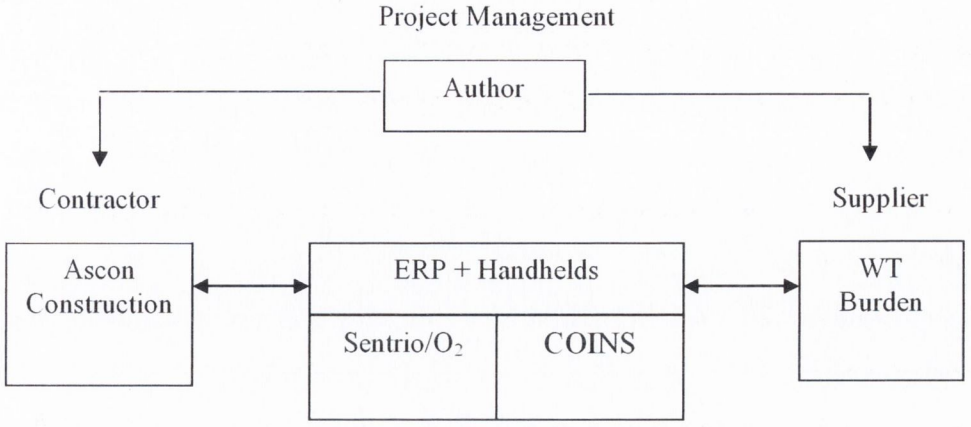


Figure 8.2. CITA 2005 pilot project team

8.5.3 Methodology

The methodology involved using the re-engineering methodology designed by Li (1996). Li suggested that at all stages in the re-engineering process it was important to introduce an experimental loop, in order to ensure the progression of problem solving during the re-design of the business processes. This methodology is illustrated in Figure 8.3.

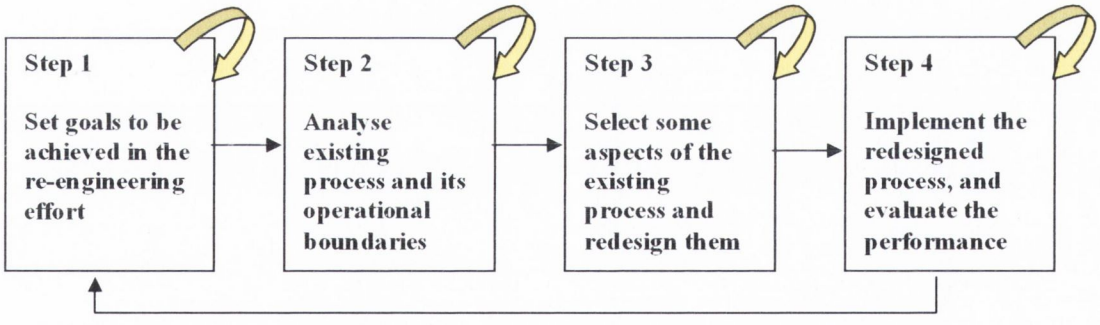


Figure 8.3. Re-engineering methodology adopted in 2005 pilot project (Li, 1996)

The process designed by Li (1996) involved four core stages, namely:

Stage 1 - Set goals for re-engineering - This stage involved the setting of clear and measurable objectives at the outset of the re-engineering process, as identified in 8.5.1 above.

Stage 2 – Analyse existing processes and its operational boundaries - In analysing the existing process, focus was directed to understanding the problems and inefficiencies that existed within the contractor's business process. The problems and efficiencies present in the current purchasing process have been documented previously in the observation studies in Chapters 3 and 5 and the survey findings documented in Chapters 4 and 6.

Stage 3 – Select aspects of the existing process to redesign - Fundamentally, the re-engineered solution devised by the author involves a fully electronic, three-way electronic match of the PO, delivery docket and supplier invoice, minimising as many of the existing identified inefficiencies as possible, while solving any new problems that may arise. In this, no particular inefficiency was singled out in re-designing the process, but those tasks and activities that did not add value to the business process and were costly to administrate were simply removed.

Stage 4 – Implement and evaluate the new process - It was important that the new process was tested for a reasonable period of time. Results from the new process were collected and the evaluation of the results indicated that the re-engineering goals were achieved, as shall be shown.

8.5.4 Goals to be achieved in the Re-Engineering Process

It is important that any re-engineered solution addresses explicitly the problems identified in earlier Chapters and addresses the important lessons from the 2004 pilot project. The pilot project sought to identify goals, in order that a technological solution to the problems would effectively re-design and re-organise the purchasing process, which would lead to a worthwhile and tangible improvement in the performance and competitiveness of both trading partners.

In order to identify these goals, it was first necessary to reconcile the weaknesses identified in the observation studies carried out in 2002 and 2004 with the remaining weaknesses evident in the process following the 2004 pilot pilot. Table 8.2 summarises how the 2005 pilot project will specifically address the weaknesses found in the earlier observation studies and the limitations remaining in the process following the 2004 pilot project.

Areas of weakness in 2002 and 2004 Observation studies	**Weaknesses remaining in process following 2004 Pilot Project**	**2005 Pilot Project**
Over dependency on paper documents	Over dependency on the creation of paper documents. Scanning of invoice by the contractor and delivery notes by the supplier remain in the process.	The 2005 pilot project will involve a paperless process in the creation of the PO, delivery note and the supplier invoice.
Poor level of integration between company departments	Poor level of integration between site and head office procedures. Site personnel did not utilise ERP functionality and created hard copy material requisitions.	The 2005 pilot project will involve site staff requisitioning materials There will be no necessity to complete company material requisition forms.
Poor level of integration between ICT tools deployed	ICT tools deployed by the contractor and the supplier are not fully interoperable. Access image of ePOD on O_2 website.	The ePOD will be routed to both the contractor's and the supplier's ICT system via the COINS ETC HUB.
Mislaid documentation	Large numbers of documents are mislaid which delayed the overall matching process.	Documentation will be captured electronically Should be no mislaid documents.
Re-keying of information	Extensive re-keying of information remains in the GRN and invoice approval stages. If delivery information did not match original PO, purchasing created a new line item on the PO before GRN process complete.	The supplier will create the PO. Verification stages will be introduced into contractor's GRN process. The supplier will route eInvoice to contractor. The re-keying will involve the contractor keying-in "Y" to accept the eGRN.
Deficient supplier information	Use of physical catalogues and outdated supplier prices evident.	PO created by supplier and verified by the contractor.
Matching POs, delivery notes and supplier invoices	Correct information not displayed on PDA screen and additional security measures needed on signing of PDA.	Three-way electronic match of PO, delivery note and supplier information will be realised.

Table 8.2. Extent to which the 2005 pilot project will address observation study weaknesses and limitations following the 2004 pilot project

It can be seen from Table 8.2 that the problems identified in the observation studies (see Table 8.1) and the remaining limitations (see Table 8.2) evident following the 2004 pilot project will be specifically addressed in the 2005 pilot project.

It is not proposed that particular ICT tools should solve individual, unilateral problems but that the re-engineered solution should largely address all the above

remaining limitations in the 2004 pilot project and the problems encountered in the 2002 and 2004 observation studies. Li (1996) suggested that this stage of the re-engineering process should involve an experimental loop to review the re-engineered process on an on-going basis. The pilot project team regularly reviewed the process at progress meetings.

The specific goals to be achieved by the 2005 pilot project include:

1. Create a paperless purchasing process from beginning to end.
2. Maintain a sophisticated level of integration between the ICT tools deployed.
3. Ensure there is no mislaid documentation.
4. Introduce only a limited degree of re-keying of information by the contractor's staff during the matching process, in order to verify receipt of the electronic information.
5. Achieve a three-way electronic match of the PO, delivery docket and the supplier invoice.
6. Ensure a high level of satisfaction with the ICT deployed by the trading parties.
7. Confirm productivity improvements and potential savings for the contractor as a direct result of the 2005 pilot project.

8.5.5 Analysis of Existing Processes and Operational Boundaries

Analysis of Existing Business Processes

The author carried out a detailed examination of the contractor's existing purchasing process, similar to that prepared in Chapter 3 and 5. This involved mapping the process flow charts for the material ordering, material receiving and invoice processing. The results of this exercise are presented in Appendix F.1. Following the completion of this exercise it was evident that many inefficiencies existed in the current process adopted by the contractor. Table 8.3 summaries the overall number of non valued-added tasks associated with the processing of a single transaction from the receipt of the ePOs to the

final payment of the supplier's invoice. The figures are extracted from Tables F.1.1, F.1.2 and F.1.3 in Appendix F.1.

Tasks	Manual/ Handwriting	Photocopy/ Printing	Manual keying of Info.
Material Requisitioning & Order Processing	5	2	6
Receiving and storing materials	4	0	1
Managing payables	4	4	2
Total	13	6	9

Table 8.3. Extent of non-value tasks within a typical purchasing transaction present in contractor's purchasing process

The exercise of examining the existing purchasing process within the contractor's organisation was a necessary step in completing in the overall re-engineering process. The re-engineered solution will collectively address the majority of the problems identified in the observation studies and the deficiencies identified in the contractor's purchasing process during the 2004 pilot project by re-designing the process.

Operational Boundaries

The key focus was to ensure that the contractor on the 2005 pilot project would agree to re-engineer the current purchasing process in order to realise a three-way electronic match, thus addressing the majority of problems referred to in the last section and hence bring about significant productivity improvements and cost savings overall. In order to achieve this overall aim, it was necessary to agree the operational boundaries of the 2005 pilot project.

At a very early stage, the contractor insisted that site personnel would retain their role in requisitioning materials in a variety of ways. In the case of a bulk order, site personnel could requisition materials by using a combination of telephone calls and fax confirmations direct to the supplier. In the case of centrally purchased materials, it was important to the contractor that site retained the task of completing the paper requisitions.

Although there was a concern that the contractor did not intend to utilise fully the site requisitioning functions in their ERP system and that paper dependent processes were to be retained at this initial stage of the order process, this instance would not affect the three-way electronic matching process. As the process was conducted "live", it was important for security of data, to facilitate this parallel system. At the other end of the purchasing spectrum, it was agreed by all parties to the project that electronic payment would not form part of the pilot project scope. This latter conclusion was immaterial to the principal core objectives and could be easily implemented at a later stage were the 2005 pilot project to prove successful.

Figure 8.4 illustrates diagrammatically the operational boundaries or ERP functionality boundaries of the re-engineered pilot process. As stated earlier in this Chapter, the supplier requisitioning functionality of the ERP software did not form part of the re-engineered solution.

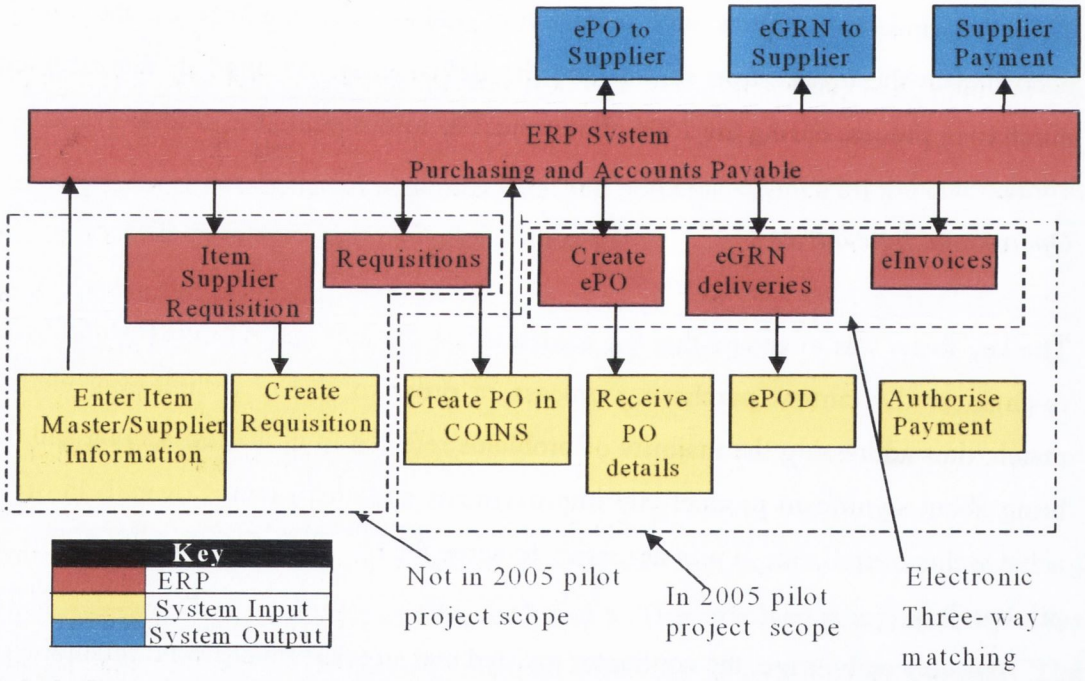


Figure 8.4. Operational boundaries of 2005 pilot project

It is important to appreciate that, in many instances, particular modules of functionality are not utilised by users of modern business software solutions. Notwithstanding this exclusion, this does not in any way compromise the overall aim and objectives of the Phase 2 pilot identified in 8.5.1 earlier. Figure 8.4 also highlights the parameters of the 2005 pilot project, by showing a paperless, fully electronic matching of the POs, delivery notes and the supplier invoices.

8.5.6 Re-Design of Existing Process

In re-designing the contractor's purchasing process, it is necessary to look in detail at the remaining weaknesses in the process and identify the electronic opportunities to remove these weaknesses as a whole. The key to the solution was to allow the supplier to create the PO data, as opposed to the traditional role of the contractor creating the PO. By allowing the supplier to create the PO, delivery note and the invoice information, the problem of the three-way electronic match was much more likely to be solved. However, it is important to stress that the contractor's purchasing personnel have a role to play in checking and approving the PO prior to dispatching of the material.

It is important to stress at this point that the creation of the PO by the supplier is very unlikely to cause any disputes or delays in querying prices. The POs will be created mainly from the master Open Order agreement between the contractor and the supplier. Should the site require materials that are not on the Open Order, the contractor will still have the opportunity to comment or query the PO created by the supplier. The critical point here is that the PO, delivery note and supplier invoice information should match exactly, as they are created from a single source.

The re-designed solution is hinged on the use of a central web-based repository or HUB, which acts as an electronic post office where ePOs, delivery dockets and invoices can be transmitted to and from both the contractor's and supplier's ICT systems. Both the contractor and the supplier will be users of the COINS ETC HUB. The HUB can cater for any file format sent to it electronically via the web. By use of B2B Translator software, all ePOs, ePODs and eInvoices are converted into a Business Application Software Developers Association (BASDA) XML style sheet, which, in turn, can be seamlessly

integrated into the back-end ICT system of the contractor and the supplier. This central COINS ETC HUB allows for the respective electronic file formats to be converted into an XML style sheet, which in turn is sent to the contractor and supplier back-end ICT systems and automatically populates line items on their purchase or sales ledger as appropriate.

Each order involves the contractor's personnel contacting the supplier sales workbench, which in turn, creates a PO confirmation, which is forwarded to the contractor electronically via the COINS ETC HUB. This PO Confirmation is checked by site personnel and approved and uploaded onto the contractor's PO workbench. On the delivery of materials to site, an approved person electronically signs the PDA, which should display the PO information. Following the inspection of the materials, the ePOD is forwarded to both the contractor's and supplier's back-end workbench, via the O_2 Instant and COINS ETC HUB. The contractor's site administrator will need to register a GRN for the material formally in their COINS ERP system, however, the level of re-keying simply involves an acknowledgement input of "Y" (as in Yes) into the system. Upon receipt by the supplier of the ePOD, the supplier's accounts department prepares an electronic invoice, which is routed to the contractor's invoice workbench in COINS, via the COINS ETC HUB. Figure 8.5 illustrates the flow of the XML data between the contractor and supplier ICT systems. This figure is consistent with the flow of electronic data shown earlier in Figure 8.1.

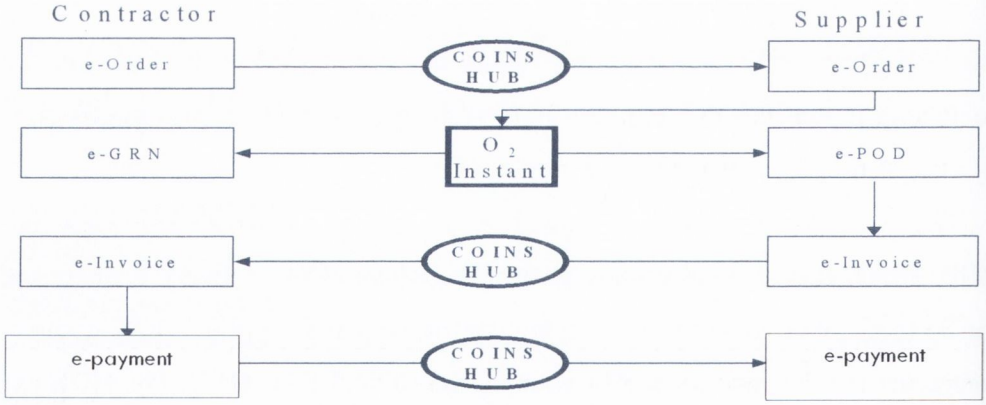


Figure 8.5. Seamless integration of purchasing data

The contractor's accounts department should now be in a position to electronically match the PO confirmation, the eGRN and the eInvoice, thus bringing about a significant improvement in overall productivity levels. An illustration of the re-engineered process map is shown in Figure 8.6.

Table 8.4 summaries the dramatic improvements made in the re-designed purchase process.

Tasks	Manual/ Handwriting		Photocopy/ Printing		Manual keying of Info.	
	Pre BPR	Post BPR	Pre BPR	Post BPR	Pre BPR	Post BPR
Material Requisitioning & Order Processing	5	2	2	1	6	1
Receiving and storing materials	4	1	0	0	1	1
Managing payables	4	0	4	0	2	1
Total	13	3	6	1	9	3

Table 8.4. Evidence of anticipated improvement in level of inefficiency in purchasing process

It can be seen that, in this re-engineered process, there is a minimal amount of manual work to be carried out. This is limited to the creation of the Open Order in COINS, the necessity to approve the PO Confirmation and the electronic signature of the handheld device. There will be no necessity to photocopy or print documentation other than to receive the Open Order details initially. There will be a requirement to allow interrogation of the COINS system with limited re-keying of information with respect to PO, delivery note and invoice confirmations.

The purpose of the re-keying involves the contractor's personnel acknowledging receipt of the various electronic transactions. The re-keying will only involve contracting personnel confirming that they have checked that the ePO, eGRN and eInvoice details are correct and match successfully. The matching process is electronic and will no longer necessitate the need to retrieve large volumes of paper and match manually the PO, delivery note and the supplier invoice. Nor, indeed will it be necessary to seek resolution of the many thousands of mis-matched POs, GRNs and invoices, as identified in Table 8.3.

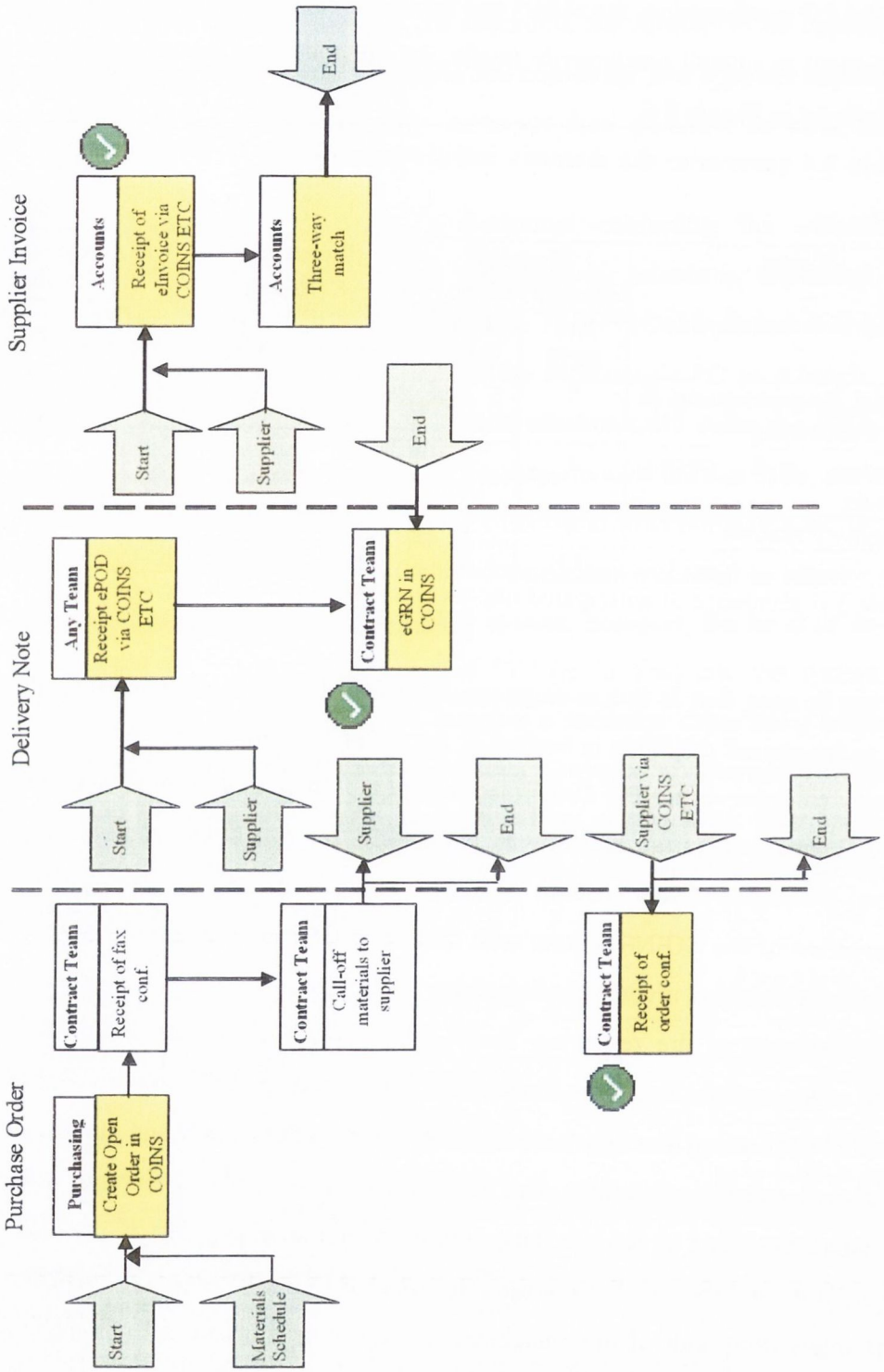


Figure 8.6. Re-engineered purchasing process

8.5.7 Implementing the Re-Designed Process

While it is clear that the re-designed process has potential to reduce the problems highlighted earlier, it was, nevertheless essential to test the process in a live site environment. The process of implementation involved the following sequential steps, namely :

Step 1 - Agree on the ICT providers for Phase 2

Step 2 – Design an ICT infrastructure for the pilot project

Step 3 - Select suitable handheld technology hardware and agree use strategy

Step 4 - Address the problems identified in the contractor's purchasing process

Step 5 – Select a pilot case study

Step 6 - Place an Open Order in COINS for supply of material

Step 7 – Implement the pilot project and monitor progress

Step 1 – Agree on ICT Providers for 2005 Pilot Project

To facilitate this three-way matching, it was necessary for the trading partners to agree on the technology providers to provide the ICT infrastructure for the project. Nowithstanding the supporting role that telephones, fax machines, fax/modems cards, e-mail and applications software will continue to have in the process, a number of technology providers were approached to achieve the re-engineered solution. Table 8.5 identifies the technologies, the ICT provider and a summary of the role of these technologies.

Technology	**ICT Provider**	**Role of Technology**
Electronic Market	COINS ETC HUB	For POs, delivery notes and invoices to be routed to ETC users.
Data Translation Software	First B2B	To ensure that data is converted into a standard XML format for end-to-end integration into respective trading partners back-end ICT systems.
ERP Software	COINS – Contractor provider Unison – Supplier provider	To ensure the integration of inter-organisational departments.
O2 Instant	O_2	To cater for electronic "Proof of Delivery" information.
Handheld	Sentrio Technologies	ePODs to be captured electronically.

Table 8.5. Role of technologies utilised in the 2005 pilot project

Step 2 – Design ICT Infrastructure for Pilot Project

The proposed ICT infrastructure to be adopted in Phase 2 will involve the electronic transfer of PO, delivery notes and invoices via a central web-based repository as mentioned previously, the COINS ETC HUB. The HUB is able to convert any incoming EDI, XML or spreadsheet documents from either the contractor's COINS ERP system or the supplier Unison ERP system into a format suitable to the particular receiving ICT system. The HUB is also capable of sending outbound messages in these formats for basic information purposes or integration into other customer's ERP systems.

Figure 8.7 illustrates the ICT infrastructure.

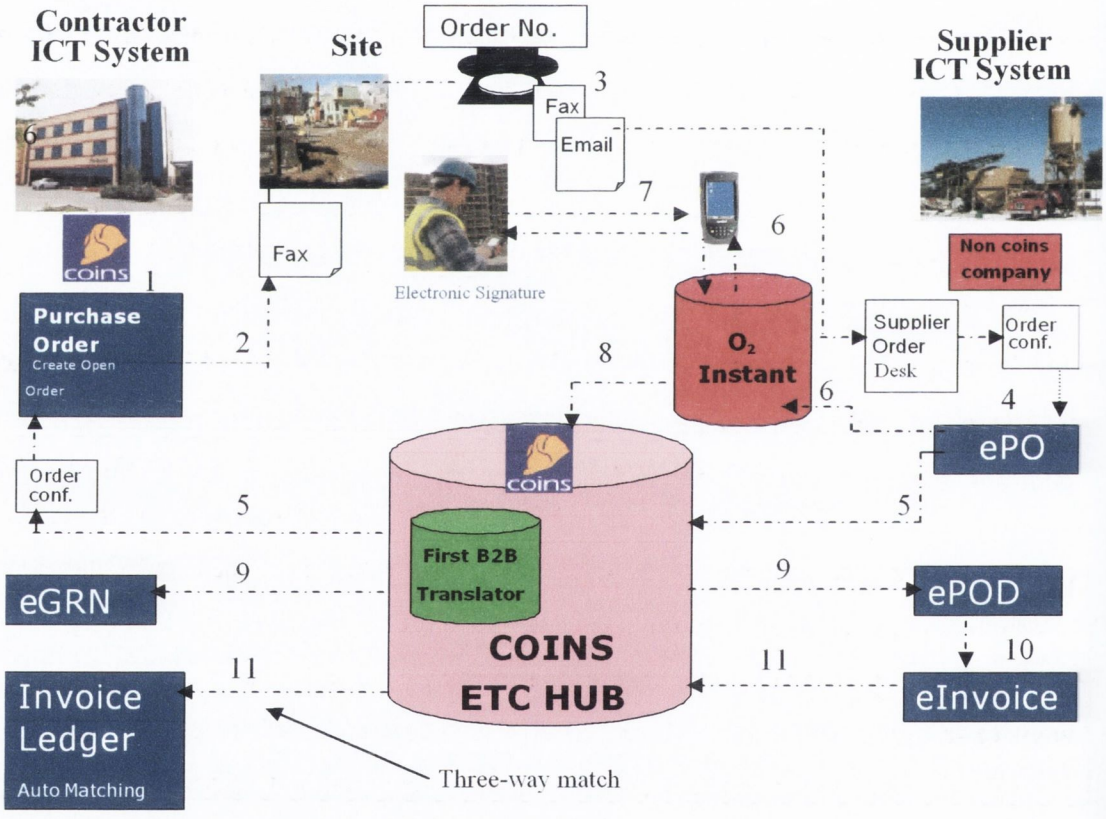


Figure 8.7. Proposed trading process and ICT infrastructure

The proposed solution shown in Figure 8.7 is an improvement on the initial solution shown in Figure 8.1 earlier.

In the original proposal the PO process was initiated by the contractor creating a PO requisition on site, followed by the creation and transfer of an ePO by head office to the supplier's ICT system, via the COINS ETC HUB. The proposal adopted involved the trading parties creating an agreed Open Order in COINS (Step 1). In advance of this communication, the contractor would have negotiated a schedule of prices for particular products from the supplier. The proposed process created an automatic fax to site detailing a unique PO number (Step 2). The open order in COINS authorised site personnel to order materials by telephone, fax or email to the supplier (Step 3). The key difference between the initial proposal and the proposed solution was the fact that the supplier created the ePO information, not the contractor, as in the initial proposal (Step 4). The ePO was electronically sent to the COINS ETC HUB. The ETC Hub converted the data into a BASDA XML message, which, in turn, is forwarded to the contractor's back-end database and populates a line item on the contractor's purchasing workbench (Step 5).

The remaining proof of delivery and invoice processes proposed in the re-engineered solution are identical to the original proposal shown in Figure 8.1 earlier. The ePO created by the supplier is dispatched to the O_2 Instant repository, which, in turn, routes the message to a handheld computer (Step 6). The supplier delivers the material to site and the contractor electronically signs the PDA. The ePO is routed back to the O_2 Instant repository (Step 7) and onto the COINS ETC HUB to verify proof of delivery (Step 8). The ePOD is routed to both the contractor's and the supplier's back end database and populates line items in their respective ICT systems, thus creating a eGRN (Step 9). The receipt of the ePOD in the supplier's back-end system, will allow the supplier to create an eInvoice from the ePOD and ePO data (step 10). The supplier eInvoice is routed via the COINS ETC HUB to the contractor's invoice workbench on the COINS ERP software.

The initial solution included provision for the EFT which was not included in the scope of the re-engineered solution. The creation of the electronic PO, proof of delivery and invoice by the supplier, with minimum paper and re-keying, will ensure that there will be a much greater likelihood of a successful three-way match. Steps 2 and 3 of the

process were introduced following a request by the contractor. These are optional parallel paper-processes that could easily be removed from the process in the future.

Step 3 - Selection of Handheld Technology Hardware and Use Strategy

The O_2 Instant software was proven to work successfully in Phase 1 pilot study. There was, however, some criticism with respect to the type of handheld device chosen and the data that was displayed on the PDA screen. This concern was specifically dealt with by the pilot project team in the 2005 pilot project. A Panasonic CF-P1 device was selected, in lieu of the Symbol device selected in the 2004 pilot project. An image of the new PDA display screen used in the 2005 pilot project is shown in Figure 8.8.

The new PDA device had a large screen area and had additional functionality, in comparison to the Symbol device used in the 2004 pilot project. There was also concern expressed in the 2004 pilot project about the informality surrounding the electronic signature. It was agreed that only authorised signatures would be accepted. An additional measure of requiring the inputting of a pin number was also a mandatory requirement.

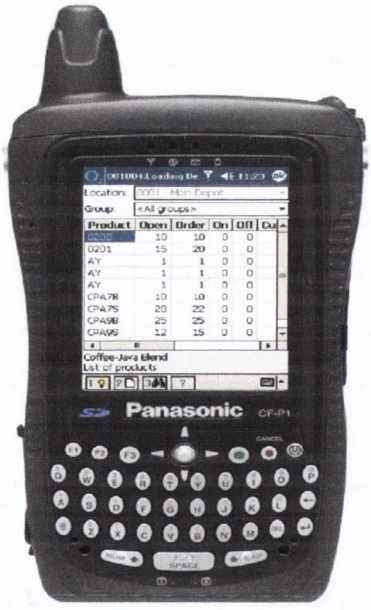


Figure 8.8. Image of PDA device used on 2005 pilot project

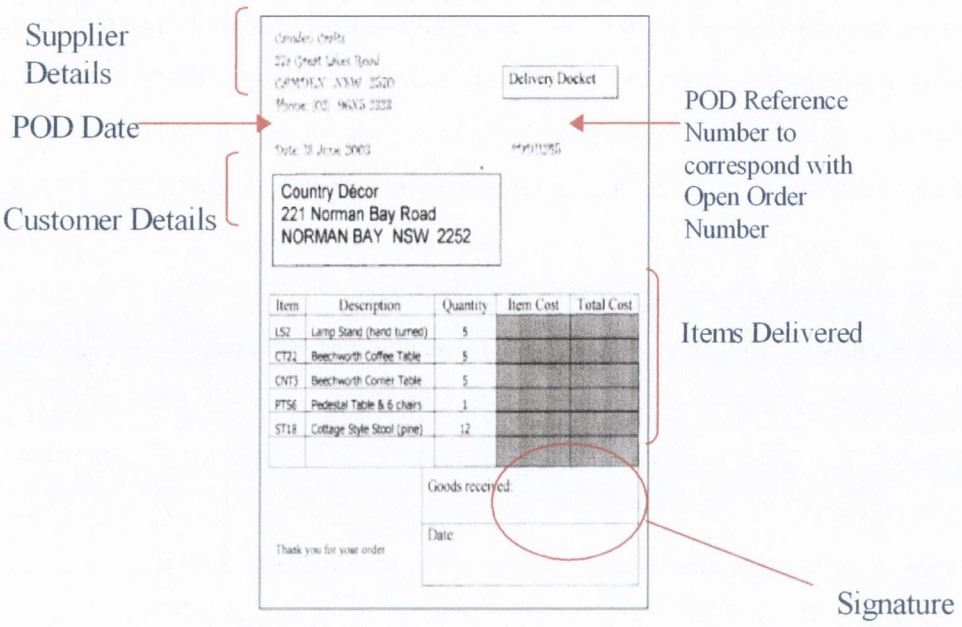


Figure 8.9. Image of PDA screen

Figure 8.9 provides an image of the actual screen display encountered by contracting personnel. The entry of the pin number simply involved keying in a unique ID number to activate the PDA.

For practical reasons, it was only possible to utilise a single handheld device on the pilot project, which was retained by an individual within the contractor's organisation. It will be seen from the feedback provided by the pilot project team that the information displayed on the screen was much clearer and overall the PDA was easier to use. Due to the fact that the haulage of the materials was mainly outsourced by WT Burden to different haulage contractors, the logistics of providing a large group of drivers with handhelds was impractical. It is important, however, to restate that, as in the 2004 pilot project, this decision did not affect the principle of the technology being tested.

Step 4 - Addressing the Problems Identified in the Contractor's Purchasing Process

It is important that any re-engineered solution addresses explicitly the inefficiencies identified earlier in this thesis. The author analysed in detail the inefficiencies present in the pilot project contractor's purchasing process in Appendix F.1 Table 8.6 summarises

how these inefficiencies within each sub-process in the re-designed purchasing process will be significantly improved. Whilst the responsibility of creating the PO in the 2005 pilot project was that of the supplier, it will be seen later in the review and evaluation of the 2005 pilot project, that the supplier was willing to take on the responsibility, as it meant that the three-way electronic matching would ensure a significant reduction on queries of prices and mislaid signed delivery notes.

Inefficiencies	**PO**	**Receiving Materials**	**Managing Payables**
Manual reliance	The manual process of creating the purchase requisition was retained. This did not affect the principle and can be eliminated when the contractor's confidence has been secured. The purchasing department will negotiate prices list with the supplier and create an Open Order on COINS.	The manual process of signing for the deliveries will not change, however instead of signing a paper delivery note, site will sign the PDA screen and record the Proof Delivery electronically. This is the critical part of the process, as the electronic signature will create an ePOD, which is one of the ingredients of the matching process.	There will be no necessity for accounts to manually match the documents for the POs, delivery notes and the supplier invoices. The receipt of the eInvoice into the back-end of the contractors ICT system will enable the 3-way matching process in COINS.
Photocopying/ Printing	The printing and photocopying of POs will no longer be necessary as the information will be readily available on the COINS system.	Very large savings in photocopying and printing costs should be made here, as this process is paperless. The supplier's process of scanning all delivery notes will be eliminated.	There will be no necessity for the extent of printing and photocopying. The contractor's scanning costs of invoices will be eliminated.
Re-keying of information	Purchasing will no longer key in all the data in COINS to create the PO, as this will be created by the supplier on their ICT system.	Site GRN the material, however, the inputting of data is minimal in comparison to the traditional process, as only limited re-keying is necessary to acknowledge the eGRN.	The process will require some re-keying of information in the approval of payment but not to the same extent.

Table 8.6. Addressing the problems

Step 5 - Selection of Pilot Case Study

The selection of a live project for the 2005 pilot project was dependent on the contractor and the supplier reaching a commercial agreement with respect to a material supply order and on the timing of the material deliveries and how this fitted into the overall contract programme for a live project. At the time of carrying out the pilot project it was not possible to secure a particular project that had a large number of deliveries.

The pilot project team were, however, keen to progress to the 2005 pilot project and to select a multiple product type supplier, in order to challenge the capability of the ICT infrastructure and to more closely reflect the vast majority of supplier types in which contractors traded. WT Burden Limited, suppliers of civil engineering products, based in the UK and in Ireland, agreed to partake in the pilot with Ascon Limited.

As in the 2004 pilot project, the 2005 pilot project was designed to minimise the impact on the resources of the contractor and the supplier. Therefore, the following measures ensured the least disruption to their business processes :

- Ensure that the electronic three-way matching of POs, delivery notes and supplier invoices operated alongside the traditional paper-based process.
- Ensure deliveries from a specific location or depot.
- Only one nominated staff was trained to use the ICT system within the contractor and supplier organisations. This would ensure that constructive feedback could be given by both nominated persons on the completion of the pilot phase.
- Electronic transactions would only occur on the test systems for both the contractor and the supplier, in order that a Proof of Concept would be completed and that a level of confidence was achieved by both parties that the technologies worked successfully.

The initial series of live data was obtained from the Kilbeggan By-pass project. The project consisted of the construction of a 24 km motorway by-pass of the town of Kilbeggan with five motorway intersections. The data was obtained from all the deliveries made by PVF Limited over a two week period during the last week of October and the first week of November 2005. This ensured that all data collect was "live" data.

Step 6 – Place Open Order in COINS for Supply of Material

It was necessary to ensure that Open Orders were agreed by the contractor and the supplier, as only Open Orders would realise the electronic three-way match on the 2005 pilot project. A copy of the Open Order schedule agreed for the Kilbeggan By-pass is included in Appendix F.2. The prices quoted by the supplier were their standard commercial rates, however, particular items were further discounted for the contractor, as can be seen on the schedule. An Open Order reference number M5046/0114 was allocated by the contractor to this Open Order. Alternative Open Order numbers were agreed for other projects which were utilised in the 2005 pilot project.

Step 7 – Implementing the Pilot and Monitoring Progress

The implementation phase commenced with the contractor communicating the Open Order number by email to the supplier and requesting that this number be used in the creation of all ePOs, ePODs and eInvoices during the pilot phase. Table 8.7 provides a sample listing of the first three transactions.

Description of Material		**Quantity**
Transaction 1	Polypipe RD450mmx6m	10 nr
	Polypipe SRD450mm sealing	20 nr
	Polypipe CRD450mm	10 nr
Transaction 2	HEP30 150mmx6m	100 nr
	200mm gate valve acc (RNBS)	4 nr
	Nuts and bolts M16x65mm	1500 nr
Transaction 3	Flange adaptor 108mm-130mm	10 nr
	150mm gate valve cc (NBS)	6 nr
	100mm B/C	25 nr
	EPDM rubber gasket 6/150mm	50 nr

Table 8.7. Sample orders of material by contractor during the 2005 pilot project

In order to demonstrate the successful implementation of the technology the three-way matching process in operation will be described. The complete listing of data captured during the 2005 pilot project is included in Appendix F.3 and F.4.

Receipt by Contractor Electronic PO

The first stage of the electronic process involves the contractor creating the Open Order in COINS, as illustrated in Figure 8.10. The eOpen Order number M5046/0114 was communicated to the supplier. It is important to appreciate that the eOpen Order at this stage is blank.

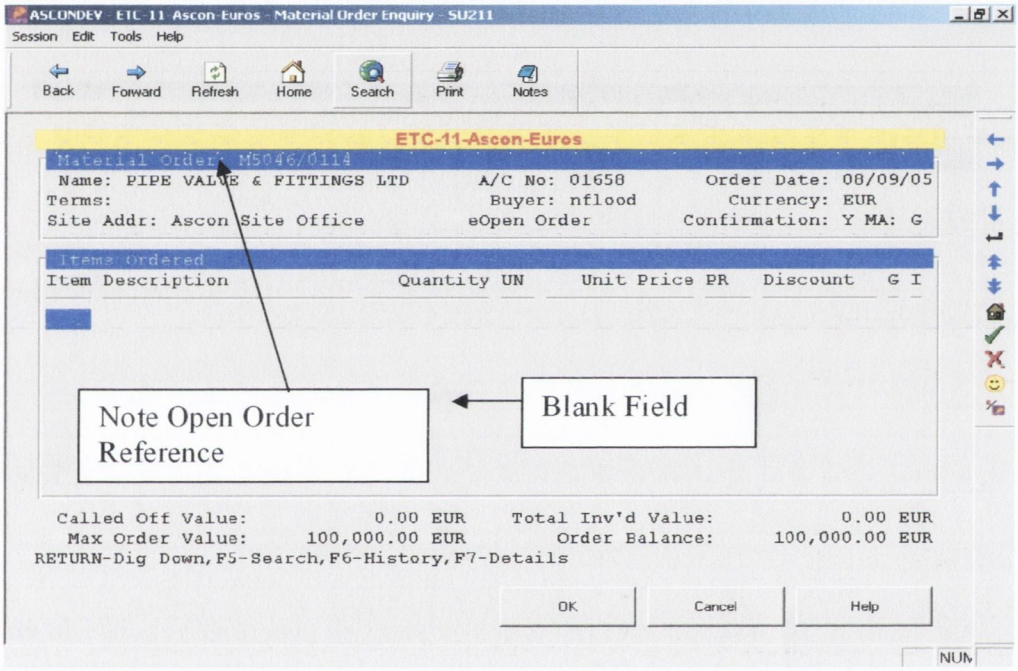


Figure 8.10. Image of eOpen Order workbench in COINS software

The next stage involves site personnel requisitioning material by telephone direct to the supplier. The supplier takes note of the site requirements and creates the ePO on their system internally and attributes a unique XML tag of "Ascon1" to the communication. The supplier personnel should take care to consult the Open Order description and prices agreed with the contractor when preparing the ePO. The COINS ETC HUB has a live link to both the supplier's and contractor's ERP systems. The technology automatically scans all ETC clients ICT systems every 15 minutes (during normal working hours) for

any electronic transaction data and routes the data to the appropriate COINS ETC client system automatically, in this case the appropriate account is "Ascon1". This data is in turn then populated automatically into the Ascon1 COINS ERP ePO workbench, as shown in Figure 8.11. The data refers to Transaction 1, 2 and 3 as in Table 8.7 presented earlier.

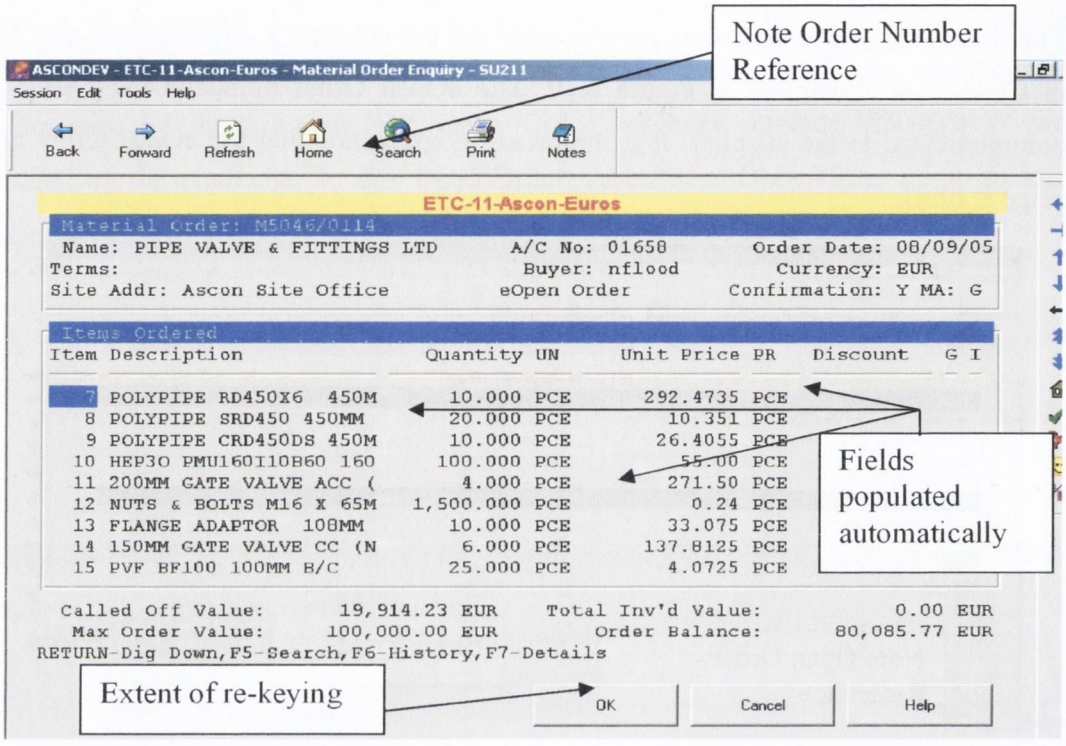


Figure 8.11. Image of eOpen Order automatically populated in COINS

Note: Items listed in the ePO workbench are scrolling items and as such will not all be visible on the screen at once. It is also possible for the contractor's personnel to view the full description of the product ordered. It is not possible to see this in this field image.

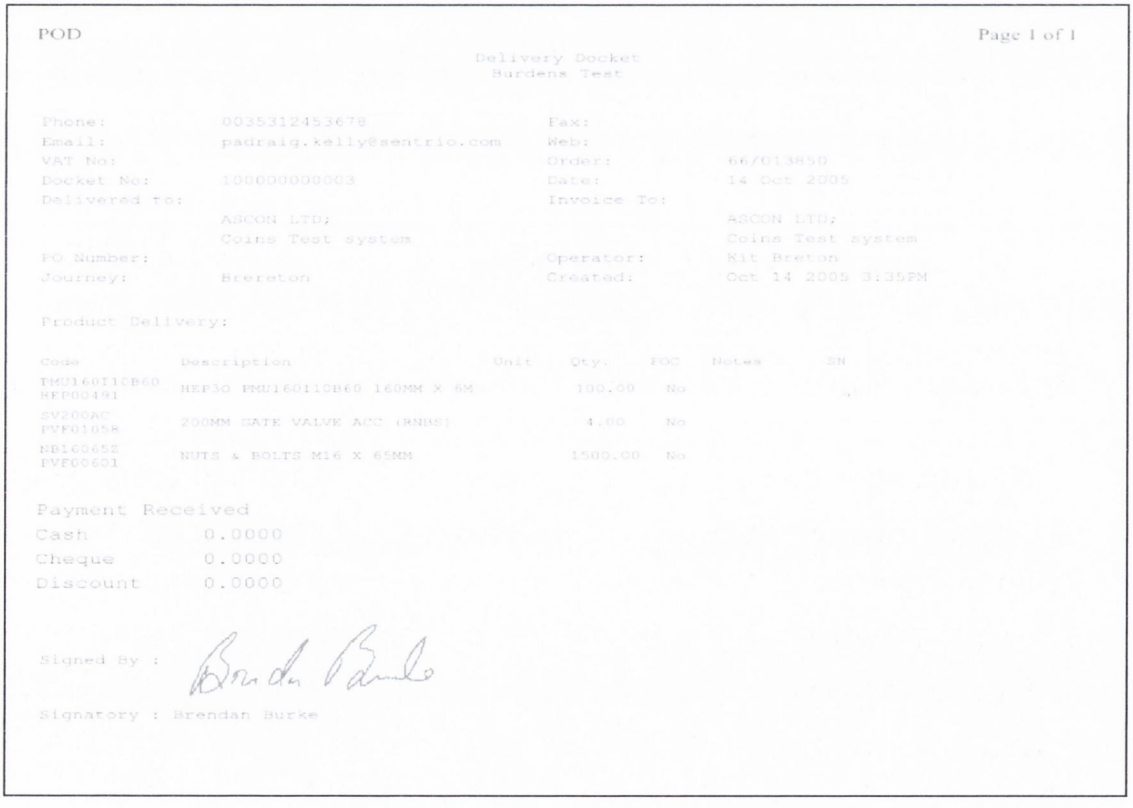
If the contractor's personnel are in agreement with the ePO content and it corresponds to the Open Order agreement, then all the contractor has to do is click the OK button, as shown in Figure 8.11. This is the full extent of re-keying needed to be done by the contractor's personnel and represents a significant improvement on existing practice.

Figure 8.11 shows the population of the contractor's ERP system PO workbench following the receipt of the ePOs from the supplier for the materials referred to in Table 8.7 earlier. The first stage of the three-way matching process is now complete.

Receipt by Contractor and Supplier of ePOD

The second stage of the process involves the PO information being routed to the handheld device in readiness for the signing of the PDA screen. As stated earlier, the PDA would, in practice, be retained by the supplier and be made available to all their drivers. In the case of the pilot, however, it was a particular individual within the contractor's organisation that was given the responsibility to retain the PDA, to sign the screen and to enter a unique pin number, following confirmation that the correct Open Order number was contained in the data on the ePOD screen, together with the correct product descriptions.

Following the signing and entering of the pin number, the information is routed via the COINS ETC HUB back to both the contractor's and supplier's ICT systems, thus providing both parties with an eGRN. The ePOD can be viewed online via the COINS ETC HUB at anytime by both parties. Figure 8.12 provided an image of the first ePOD signed by the contractor's pilot contact. The ePOD refers to transaction 2 given earlier in Table 8.7.


POD

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Delivery Docket
Burdens Test

Phone: 0035312453678
Email: padraig.kelly@sentrio.com
VAT No:
Docket No: 100000000003
Delivered to:
ASCON LTD;
Coins Test system
PO Number:
Journey: Brereton

Fax:
Web:
Order: 66/013850
Date: 14 Oct 2005
Invoice To:
ASCON LTD;
Coins Test system
Operator: Kit Breton
Created: Oct 14 2005 3:35PM

Product Delivery:

Code	Description	Unit	Qty.	FOC	Notes	SN
PMU160110B60 REF00491	REF3O PMU160110B60 160MM X 6M		100.00	No		
SV200AC PVF01058	200MM GATE VALVE ACC (BNBS)		4.00	No		
NB160652 PVF00601	NUTS & BOLTS M16 X 65MM		1500.00	No		

Payment Received
Cash 0.0000
Cheque 0.0000
Discount 0.0000

Signed By :

Signatory : Brendan Burke

Figure 8.12. Electronic proof of delivery for transaction 2

The ePOD will be routed to the contractor's ICT system via the COINS ETC HUB onto a GRN workbench in COINS, as shown in Figure 8.13. The GRN workbench will need to be set up by the contractor in advance of receiving the ePODs for a particular project. This workbench is thus in a position of readiness to receive the ePODs. Figure 8.13 shows the population of the contractor's GRN workbench following the receipt of the ePODs from the handheld device for transactions 1, 2 and 3 referred to in Table 8.7 earlier.

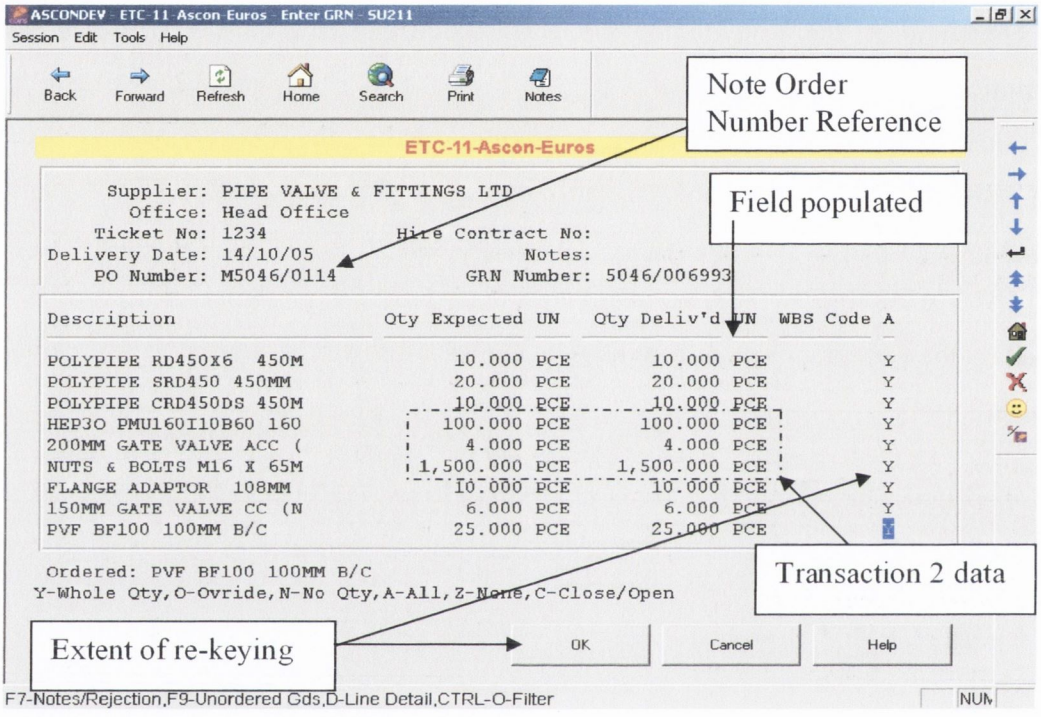

Figure 8.13. Image of eGRNs automatically populated in COINS

The second stage of the three-way matching process is now complete. It can be seen in Figure 8.13 that the extent of re-keying only involves the contractor keying in "Y" following the viewing of the image of the ePOD illustrated in Figure 8.12.

Receipt by Contractor of eInvoice

The third stage of the process involves the supplier creating an eInvoice on their ICT system following receipt of the ePOD. This information is retrieved by the COINS ETC HUB, similarly to the ePO at the first stage. This information is routed through the

COINS ETC HUB to the contractor. Once again the supplier uses a unique client XML tag account code "Ascon 1", to ensure that it is routed to the correct HUB user.

This information will, in turn, be populated onto the COINS invoice workbench, in a similar fashion to the PO and GRN workbenches. The eInvoice workbench shown in Figure 8.14 will need to be set up by the contractor in advance of receiving the eInvoices for a particular project. This workbench is thus in a position of readiness to receive the eInvoices.

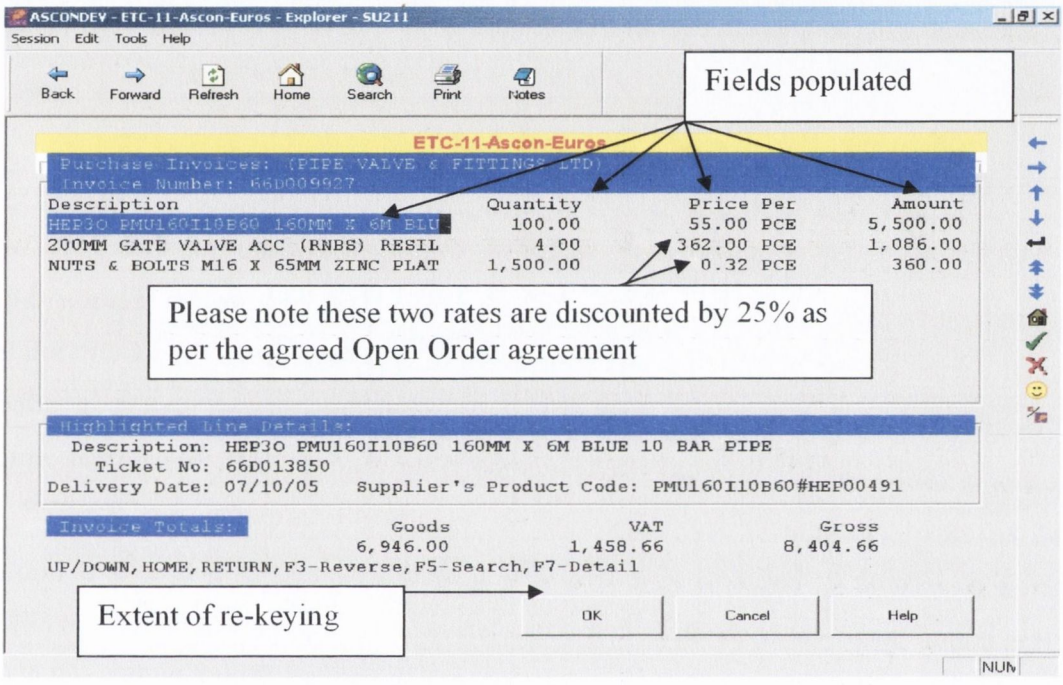

Figure 8.14. Image of eInvoice for transaction 1 automatically populated in COINS

Figure 8.14 shows the population of the contractor's ERP system Invoice workbench following receipt of the eInvoice for transaction 2 referred to in Table 8.7 earlier. The third and final stage of the three-way matching process is now completed. It is possible at this stage to view the eInvoice on the COINS CIM (COINS Image System) system. Following the successful electronic matching of the PO, delivery note and the invoice, the payment process can now proceed.

Further samples of the three-way electronic match are shown in Appendix F.4.

Monitoring Progress

In total, there were 37 electronic transactions carried out in October and December 2005 between the contractor and the supplier, with a 100% success rating on the matching of the PO, delivery note and the invoice. The principal reason for this level of success is that the information was created from the one source, that is, the supplier. A full listing of the electronic transactions carried out during the pilot phase is included in Appendix F.3 and F.4. The process dealt efficiently with any amendments from the original Open Order, as the contractor had the opportunity to approve or reject any PO confirmations from the suppliers.

Use of XML in Pilot Project

It has been mentioned at length in this thesis, the importance of the role that XML will play in the re-engineered solution. All the data transferred between the contractor and the supplier via the COINS ETC HUB was transmitted in an XML format. The COINS ETC HUB provided a service which included a data conversion service which, in effect, accepted a variety of file formats and converted them into an XML file format which could be routed through the HUB. This work was specifically carried out by First B2B, as referred to in Table 8.5 earlier.

It is important however, to stress that if two businesses want to trade in this way, there is no necessity to use such a middleware data conversion service. If both parties can agree on an XML format between them, this purchasing data can be seamlessly integrated into their respective back-end ICT systems.

The sole purpose of the First B2B software was to ensure that a many-to-many trading relationship can be developed by using a particular XML standard. Part of the marketing of the HUB solution would include encouraging users to adopt a particular XML standard, thus reducing the workload of First B2B reconfiguring data from alternate HUB clients. The particular XML standard promoted by COINS was the Business Application Software Developers Association (BASDA) standard.

8.5.8 Evaluate the Performance of the Pilot

The 2004 pilot project identified a number of problems with the functionality and presentation of the data on the PDA device. This was greatly improved in the 2005 pilot project with the introduction of a security pin number and the restriction to a single authorised signature only. In practice, it would be necessary to make a defined number of site personnel aware of the security pin number. Three core participants in the 2005 pilot project were asked to complete a pilot feedback and evaluation questionnaire. Copies of these completed forms are included in Appendix F.5. The following is a summary of the feedback received from the pilot project team.

Contractor Feedback

The contractor representatives surveyed included the financial controller and the site administrator co-ordinator as in Phase 1. Both of the contractor's representatives were satisfied with the outcome of Phase 2. When questioned about the achievements of the pilot goals, both agreed that a number of the goals were not fully realised. There was an acknowledgement that the re-engineered process did not create a paperless purchasing process and that interoperability issues still remained between the head office and site. It was agreed by both parties that the following pilot goals were fully realised :

- A sophisticated level of integration between the ICT tools deployed was maintained.
- There was no mislaid documentation;
- Only a limited degree of re-keying of information was required by the contractor's staff during the matching process, in order to verify receipt of the electronic information;
- A three-way electronic match of the PO, delivery docket and the supplier invoice was achieved.
- Productivity improvements and potential savings for the contractor as a direct result of the 2005 pilot project were confirmed.

No particular lessons were identified by the contractor's parties, other than the fact that the pilot project results proved that the re-engineering concept and the technology worked. They are currently considering investing in the technology as they felt it was a commercially viable investment. The decision to invest however will depend on a sufficient number of their suppliers investing in the use of this technology also.

Supplier Feedback

The supplier representative surveyed was the manager of the business. This person was intimately involved in the 2005 pilot project from the beginning and was fully briefed by the other supplier personnel involved in the pilot project. The supplier was satisfied with the outcome of the pilot project, stating that there was considerable time saved in re-keying information and an overall reduction in potential errors. There was, however, an acknowledgement that there would be no advantage gained in re-keying information, as the supplier will need to create the ePO, ePOD and eInvoice data. However, the supplier representative reported real savings in the reduction of errors, and the matching of PO to the delivery note and the invoice.

The supplier's representative also agreed that the goal of creating a paperless process was not fully achieved. The supplier was also not fully satisfied with the level of ICT deployed. When further investigated by the author, the following limitations remaining in the process were identified by the supplier:

1. The ePOD was only accessible outside their ICT system by logging onto the O_2 Instant website facility. This was not ideal as it meant exiting their own ICT system and then logging to an alternative resource. The supplier felt that the ePOD should be available to view on the central COINS ETC HUB.
2. eInvoice XML data should include a facility to show the supplier's discount.
3. The supplier's firewall had to be disabled in order to allow the data to enter and exit their ICT system.
4. Open Order numbers should be clearly visible on all electronically matching documents.

The supplier's representative was considering investing in the technology, however, similar to the contractor's representatives, they would like to see more of their supply chain adopting this technology in order to defray the set up and annual maintenance costs. The supplier's representative was convinced that the contractor's re-keying would be significantly reduced with a minimal possibility of errors between PO, delivery notes and supplier invoices. From the supplier's perspective, this will lead to significantly less queries and faster payment. The solution provided the supplier with the confidence that the 30 days credit target could easily be achieved, however, there maybe some reluctance in the marketplace, in particular from contractors to becoming more efficient in their payment cycles.

Productivity and Potential Savings Reported by Contractor

The productivity and potential savings for the contractor is presented in Appendix F.6. It was shown that approximately 45 minutes could be saved per transaction by adopting the re-engineered solution with a supplier such as PVF Limited (See Table 8.8 below).

Process	**Time for Current Process (mins)**	**Time for Re-designed Process (mins)**	**Savings in Time (mins)**
Ordering	20	4	16
Receiving/GRN	35	16	19
Invoicing	21	10	11
Total in minutes per transaction	76	30	46

Table 8.8. Overall time improvements as direct result of the re-designing B2B purchasing process between the pilot contractor and the supplier

It is explained in Appendix F.6 that this time saving could conservatively lead to a potential saving of €10,000 per annum for the contractor. It is important to appreciate that PVF Limited are a relative small volume supplier to Ascon Limted, in comparison to others. It has been reported here that there were 596 POs between the two companies in 2004. The more suppliers that invest in the technology and that trade with the contractor, the greater the potential savings for the contractor.

Achievement of Pilot Objectives

The vast majority of original objectives, identified earlier, were fully achieved. However, there were lessons learned that could be looked at in future research work. Table 8.9 summarises the achievements of the pilot project objectives.

2005 Pilot Project Objectives	**Observations**
To document the current trading procedures utilised within the contractor's organisation.	This is fully documented in Appendix F.1.
To identify the inefficiencies that currently exist within the contracting organisation.	This is fully documented in Appendix F.1.
To re-design the purchasing process with a view to addressing the inefficiencies that currently exist.	This is fully documented in Appendix F.1.
To document the proposed trading processes and the ICT support infrastructure to be utilised between the contractor and the supplier on the intended pilot project.	This is fully explained in 8.5.7 of this Chapter.
To execute the proposed re-engineering process on a live project.	Successfully carried out on Kilbeggan by-pass project.
To measure and report upon the productivity improvements and potential savings accruing to the contractor as a direct result of the re-engineered process.	This is fully documented in Appendix F.6.

Table 8.9. Achievement of the 2005 pilot project objectives

It can be seen in Table 8.9 that all the 2005 pilot project objectives were successfully achieved. The problems addressed by this pilot project overcame the inefficiencies identified from the surveys and observation studies reported in earlier Chapters. Both parties confirmed that a very large volume of paperwork could potentially be removed from the purchasing process, a significant amount of re-keying can be eliminated from the contractor's process and significant savings could accrue to trading parties if the re-engineered solution was deployed.

8.6 CONCLUSION

The 2005 pilot project sought to build on the successes of the 2004 pilot project and provided additional confidence that the technology was wholly appropriate to support construction purchasing processes.

It was important that only appropriate information was presented on the PDA screen prior to signature. A security pin number was used prior to signature in Phase 2. It was hoped that the eGRN could be viewed within the COINS ETC HUB. Whilst this is technically possible, it was not possible to include this work in the scope of Phase 2. As a direct result, all eGRNs had to be views on the O_2 Instant website. Prior to describing the implementation of the three-way electronic matching process, it is important that both the contractor and the supplier are subscribing clients of the COINS ETC HUB.

As in the 2004 pilot project, it was not possible to provide all the supplier's drivers with PDAs. In order to minimise the cost and cause as little disruption as possible to the business operations of the trading partners, it was agreed to deploy only one PDA device that was retained by the contractor on the pilot site.

The overall aim of the 2005 pilot project was to re-engineer the purchasing process within a contractor's organisation, by enabling an electronic three-way match of the PO, delivery docket and invoice data, thus enabling a significant improvement in both productivity and overall administration costs per transaction. In order to verify that the process has been successfully re-engineered, Li (1996) suggested that an evaluation of the results must indicate that the re-engineering goals were achieved.

The goal of achieving a paperless process was largely achieved with an acknowledgement that some paper is a necessary ingredient of any business process. A sophisticated level of integration was achieved between the ICT tools deployed in the pilot project, with an end-to-end seamless population of data between both trading partner's ICT systems. There was no incidence of mislaid documentation being reported throughout the pilot project period. There was only a limited degree of re-keying of information by the contractor's staff during the matching process, namely, in order to verify receipt of the electronic information. The ultimate goal of achieving a three-way electronic match of the PO, delivery docket and the supplier invoice was fully realised. These results show clearly that significant productivity improvements and potential savings are achievable for the wider construction industry should this re-engineered solution be deployed.

CHAPTER 9

SUMMARY AND FURTHER STUDY

9.1 SUMMARY

This thesis has demonstrated that ICTs are currently in place to process purchasing transactions more easily and at less cost than one can process paper transactions (Hore and West, 2005c). ICT is changing almost all functional aspects of a modern business, particularly in industries such as financial services, travel, airline and retailing. With the continued expansion of the Internet, EC provides unparalleled opportunities for more traditional paper-based industries, such as the construction industry, to being greater efficiencies in transaction based commercial activities (Hore and West, 2005b).

Specific EC deployment is having a varying impact on different business sectors. The main players within each sector will need to take a lead in adopting a new technological strategy in order to affect change. ICT standards are the driver that will force companies to embrace EC in B2B purchasing transactions. The technology behind EC is not the problem. The problem is getting the buy-in from all parties concerned. The biggest savings from eBusiness can be achieved from exchanging orders, delivery notes and invoices electronically. Savings in B2B transactions can be realised through the elimination of duplicate data entry principally by achieving a three-way match of the purchase order, delivery note and the invoice. Increased awareness of the benefits within the Irish construction industry is likely to be the key factor in encouraging wider uptake of EC technologies. An industry-wide education initiative, which combines the results of the pilot programmes outlined in Chapter 7 and Chapter 8 with dissemination of information within the technical press, could, in part achieve this goal. Particular efforts should be made to increase awareness of EC technologies among contractors and suppliers with lower levels of ICT utilisation (Hore and West, 2004; Hore et al., 2004; Hore and West, 2005d).

The main findings of this research will now be reviewed.

9.1.1 Review of Main Findings

Chapter 2 - Literature Review

Much inefficiency exists in the mainly paper-based purchasing process deployed predominantly in the construction industry. Currently, at each stage of the procurement process there are discrete activities to be carried out that typically involving the creation of various paper documents, faxing, photocopying, scanning,

posting and re-keying of information into computer databases, by both contractors and suppliers. The main causes of this inefficiency include a fragmented industry, the temporary nature of construction, the uniqueness of construction and a dependence on a single-project model. This has led to poor communication and inefficient information practices that have contributed to the emergence of dysfunctional supply chains.

Improved productivity levels and greater efficiency are possible by the use of an integrated ICT EC solution. The author outlined an array of appropriate technologies, data exchange standards and alternative EC models currently available to support the sourcing, ordering, receiving and payment of materials in the construction industry. The author provided examples of EC models currently being adopted in construction industries throughout the world. The CII 2002 study revealed that EC was much more a people and culture issue and not so much of an ICT or process issue. They further concluded that private owners were leading the implementation of eProcurement models, with the greater successes with MRO or commodity type products.

More recent research suggests that the focus is on incremental improvement rather than re-engineering. The author stressed the importance of SCM. Supply chain processes and relationships are increasingly being designed to exploit changes in technology. Changing supply chain processes have evolved from classic paper-based systems and documents, towards re-engineered processes that involve electronic recording and transmission of less document information.

Chapter 3 - 2002 Observation Study

The 2002 observation study confirmed that many large construction companies, such as the one observed, are wholly inefficient in the way that they utilise ICT. The ICT infrastructure observed consisted of a number of discrete software packages that were not integrated.

The results of the direct observations by the author were illustrated by use of business process maps. Individual process maps for purchase ordering, delivery of materials and invoice payment, showed significant inefficiencies, such as manual work, extensive photocopying and printing and re-keying of information, were present throughout the purchase cycle.

The author chose to focus on the purchasing transactions of three core suppliers over a defined period, from initial requisition of materials by site personnel to final payment. The results showed that the payment periods for some suppliers could be extended far beyond the credit periods agreed due to the incidence of mislaid delivery dockets and mismatching of purchasing documentation generally. The discrepancies observed between purchase requisitions and purchase orders were found to be extensive. The most concerning aspect of the observation study results was the extent of documents that could not be located by the author during the observation period. The key observation by the author was the extent of the discrepancies between purchase orders, delivery notes and supplier invoices. The author failed in many instances to manually match these paper documents during the observation period.

The results of the observation study underpin the contention that the current traditional paper-based approach to material procurement does not work efficiently. A great deal of time and money is spent in duplicating the purchasing process. There are too many pieces of paper, there are too many people involved in the process and there is not sufficient ICT investment to automate much of the paper-based audit trail.

Chapter 4 - 2004 Survey 1

The author presented the findings of a 2004 questionnaire survey of the top 100 construction companies in the Republic of Ireland. The objective of the survey was to examine the extent to which the top Irish construction building suppliers and contractors were currently exploiting electronic purchasing, the drivers and barriers to electronic purchasing and the likely future direction of EC in the Irish construction industry.

The results show that there is a relatively low up-take of ICT to support B2B purchasing transactions by Irish construction companies. Results showed limited EC activity within the Irish construction industry, mainly due to a low level of awareness of the benefits of EC. There was considerable concern within the sample with regard to the adoption of a web-based strategy in construction purchasing, due to the perceived lack of security of transaction data and lack of broadband facilities across the country. Reduced paper volumes, error reduction and manpower savings were ranked as the most important driving forces for applying ICT in construction purchasing. The lack of clarity as to the potential benefits of electronic purchasing and the prohibitive costs associated with implementation of such technology were

considered to be the major barriers within organisations to the greater deployment of electronic purchasing. Increased awareness and the introduction of industry standards were seen as the most important future directions, which would encourage the greater use of electronic purchasing.

Despite the estimated increase in EC activity in the near future, the majority of respondents did not have an EC strategy and were unlikely to develop and use such a strategy in the near future. This apparent general lack of strategic thinking in relation to EC is both surprising and a major concern for the future investment and use of ICT by these firms and the construction sector in general. On a positive note, there is evidence that the leading firms are prepared to change the way their existing purchasing activities are carried out and take more advantage of ICT.

Chapter 5 - 2004 Observation study

This observation study demonstrated that the introduction of the ERP system into a contractor's organisation improved the material purchasing process. Whilst improvement had been made, many of the traditional inefficiencies remained in the system, such as dependency on manual processes including form filling by hand, photocopying and re-keying of information. The prolonged payment periods reported in the first observation study, did not materialise in this study, as the information was readily available in the ERP software. The matching of purchase orders, delivery notes and invoices, albeit on a largely manual basis, had improved in comparison to the 2002 observation study results.

This observation study confirmed that the introduction of the ERP system alone does not remove many of the inefficiencies in the traditional paper-based system. The author suggested what is required is the adoption of an ICT infrastructure, which includes an ERP capability, that will eliminate the need for manual inputting, printing, re-keying of information and lead to the successful re-engineering of the material purchasing process in the Irish construction industry.

Chapter 6 - 2004 Survey 2

The author presented the findings of a 2004 questionnaire survey of the top companies in the Republic of Ireland. The objective of the survey was to examine the extent to which the top Irish businesses are currently exploiting electronic purchasing, the

drivers and barriers to electronic purchasing and the likely future direction of EC in the Irish business sectors.

The results show that there is a healthy up-take of ICT to support B2B purchasing transactions in Irish business. There was, however, limited evidence of EC activity within the Irish construction industry, mainly due to a low level of awareness of the benefits of EC. There was considerable concern within the construction and manufacturing sectors with respect to the adoption of a web-based strategy in purchasing, in particular, they were concerned about the sensitivity of publishing price data on the web. Almost all sectors agreed that savings in manpower, reduced paperwork, avoid re-keying and fewer errors were the main driving forces to the use of ICT in business purchasing. The prohibitive development costs in deploying ICT, the justification of investment and uncertainty about how to measure cost and benefits of ICT investment were considered to be the major barriers within the research sample.

Eurostat figures confirm that EC activity in Ireland overall is far above the EU average, however only 10% of Internet sales were domestic. This is the lowest reported among the other EU member states. The most recent European e-Business report stated that respondents were not enthusiastic about EC and were quite downbeat about the role of e-Business in the future.

Chapter 7 - 2004 Pilot Project – Electronic Proof of Delivery

The findings of the 2004 pilot projects showed clearly that the POD technology is readily available and is an essential ingredient of the re-engineered purchase process. A number of constraints were identified as remaining in this pilot project, which were explicitly dealt with in the 2005 pilot project.

This pilot project provided the platform for the pilot team to move to a second phase, in order to achieve a three-way electronic match of the purchase order, delivery note and the supplier invoice. The 2004 pilot project showed that, by integrating handheld wireless technology and a web-based repository, electronic proof of delivery is achievable in the construction industry.

Chapter 8 – 2005 Pilot Project – Re-engineered Purchasing Process

The 2005 pilot project demonstrated that trading partners could achieve significant productivity improvements and cost savings by the use of a compatible ICT

infrastructure, which allows for an end-to-end integrated ICT solution. It is worthwhile restating the principles of the re-engineered solution.

9.2 THE RE-ENGINEERED SOLUTION

The author adopted a methodology designed by Li (1996). This involved initially setting goals to be achieved in the re-engineered solution, analysing the existing processes and its operational boundaries, selecting aspects of the process to be re-designed and implementing the re-designed process and finally evaluating the performance of the solution.

Chapter 2 outlined that ICT is a tool that can improve efficiency and effectiveness when applied appropriately to a process. The author carefully assessed the purchasing process to determine when and where the application of ICT is most appropriate and what technology should be selected. In realising the re-engineering objectives, the current processes, problems and opportunities for re-engineering were fully understood. The author did not seek a "slash and burn" attitude to the exiting process and, thus, the solution was not founded on a complete reappraisal and re-design of the entire purchasing process from sourcing to final payment of suppliers.

The key to unlocking the re-engineered solution was to ensure that the core documents matched electronically. The 2002 and 2004 observation studies showed that there was a very high incidence of discrepancies between the purchase order information and the supplier documentation. The main reason for this was because what the contractor required did not match what the supplier could deliver. This part of the process needed to be re-designed, following the Li (1996) principle. By allowing the supplier to create all three core documents, the problem was solved and the three-way electronic match was achieved.

9.3 ACHIEVEMENT OF THESIS OBJECTIVES

It is worthwhile restating that the overall aim of this research was to re-engineer the purchasing process by enabling an electronic match of the purchase order, delivery note and supplier invoice, thus enabling a significant improvement in both productivity and overall purchasing administration costs. Table 9.1 summarises the achievements of the thesis objectives.

Thesis Objectives	Author's Findings
Identify the inefficiencies that currently exist within the material purchasing process in construction.	Manual creation of paper documents, re-keying of information, faxing, scanning and photocopying.
Review the appropriateness of currently available ICT tools to support electronic purchasing in the construction industry.	Web-based solution with ERP software and handheld technology found to be the most appropriate ICT solution.
Examine the application of BPR and the enabling role of ICT, in seeking to achieve dramatic productivity and administrative cost savings in the purchasing of materials in construction.	The interpretation of BPR by Li (1996) was found to be the most appropriate methodology to achieve re-engineering by the author.
Observe the inefficiencies present in a traditional paper-based administration and management systems for ordering, receipt and payment of building materials in a large contracting organisation.	2002 observation study of a large contracting organisation confirmed that significant inefficiencies existed in its purchasing operations.
Examine the extent to which the top 100 Irish construction building contractors and building suppliers are currently exploiting electronic purchasing, the drivers and barriers to electronic purchasing and the likely future direction of EC in the Irish construction industry.	ICT use very low with only limited evidence of EC activity. Reduced paper volumes, error reduction and manpower savings were seen as main drivers and return on ICT investment was seen as main barrier.
Observe the inefficiencies remaining in the administration and management systems for ordering, receipt and payment of building materials, following the implementation of a standalone ERP software solution in a large contracting organisation.	2004 observation study confirmed that significant inefficiencies remained in their purchasing operations, notwithstanding a significant investment in ERP software.
Examine the extent to which the top 75 Irish companies are currently exploiting electronic purchasing, the drivers and barriers to electronic purchasing and the lessons that can be learned from other business sectors by the Irish construction industry.	Healthy up-take of ICT in B2B transactions in Irish business. Savings in manpower, reduced paperwork and fewer errors were seen as main drivers and return on investment seen as the main barrier.
Demonstrate by use of a pilot project, that delivery data can be successfully captured electronically and be acceptable as a "Proof of Delivery" for the construction industry.	Electronic proof of delivery was successfully achieved in the 2004 pilot project with an acknowledgement that lessons would be taken into account in the 2005 pilot project.
Re-engineer the purchasing process within a contractor's organisation, by enabling an electronic three-way match of the purchase order, delivery docket and supplier invoice, thus enabling an improvement in both productivity and overall administration costs per purchasing transaction.	Electronic three-way match of purchase order, delivery note and supplier invoice achieved on live pilot projects. Significant improvement in productivity and administration cost reductions were achieved.

Table 9.1. Achievement of thesis objectives

9.4 FURTHER STUDY

There is a general awareness in the construction industry of the benefit of deploying readily, available ICTs in improving purchasing process in construction. The reality however, is that in order to achieve these business benefits, the larger construction companies need to invest in ICT. The re-engineered solution presented in Chapter 8, is a singular solution for the trading partners involved in the pilot project. Future research will need to show how the Irish construction supply chain can benefit overall from an industry wide solution. In order to achieve this, closer collaboration is needed between the major players in the industry and longer term relationships are needed between supply chain organisations

There is broad agreement within the Irish construction industry of the need to agree standards for data exchange, such as XML. The re-engineered solution presented here included a B2B data conversion technology, which would not be required if both trading partners agreed on an XML data exchange standard. This is a very important area that warrants research, as other industries have successfully achieved data exchange standards.

Almost all the business sectors in Ireland agree that the top three driving forces to the adoption of ICT in supporting purchasing were savings in manpower, reduced costs and fewer errors. Construction companies in Ireland must target these driving forces when conducting future B2B purchasing transactions. There was broad agreement that the top three organisational barriers included prohibitive development costs in deploying ICT, the justification of investment and uncertainty about how to measure cost and benefits of ICT investment. The key to unlocking the greater potential of ICT in construction purchasing is to demonstrate that significant business benefits can accrue to the wider industry by investing in appropriate technologies. While this thesis goes some way to producing evidence to demonstrate the cost benefit from utilising ICT in an integrated way, a larger scale implementation of the principles which have been formulated and tested here should be undertaken.

The technologies deployed in the pilot projects presented by the author are mature and appropriate ingredients in re-engineering the purchase process in construction. However, there needs to be a level of maturity among the larger contractors and suppliers in the Irish construction industry that traditional paper-based processes should not be maintained in any re-engineered business process.

The manufacturing and construction sectors, in particular, are concerned about the adoption of a web-based strategy for B2B purchasing transactions. Price sensitivity is a significant factor of concern, as is the need for a larger critical mass before buying into web-based trading. It is important to appreciate that it is unlikely that large contracting organisations will invest in the re-engineered solution unless a wider supply chain also adopts the solution. The larger construction companies appear at present to be giving nothing more than lip service, with respect to a willingness to adopt greater use of ICT in B2B purchasing transactions. There is little evidence of this happening on the ground at the present moment.

In the author's opinion the main causes of the inefficiencies present in the purchasing procedures used in the Irish construction industry are mainly due to a dysfunctional supply chain. Further research must include encouraging the larger construction companies to lead the way in showing the wider industry how ICT can be deployed successfully in driving out unnecessary processing costs.

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APPENDIX A

OBSERVATION STUDY 1

Appendix A.1 – Payment Periods

Appendix A.2 – Matching of Prices

Appendix A.3 – Sample Transactions – Supplier C

APPENDIX A.1

PAYMENT PERIODS

Supplier A – Credit Period 60 Days						
Transaction No.	Invoice Number	Invoice Date	Date registration on AS400 system	Internal registration number	Date Paid	Period of Payment Approx.
1	285132	29.11.01	21.12.01	282047	01.02.02	63
2	287116	19.12.01	19.01.02	287116	01.03.02	69
3	287613	07.01.02	22.01.02	282567	04.04.02	86
4	294470	20.03.02	12.04.02	285557	31.05.02	72
5	295359	28.03.02	19.04.02	286203	31.05.02	64
6	295009	26.03.02	19.04.02	285768	31.05.02	66
7	296299	15.04.02	02.05.02	286543	31.05.02	46
8	297332	24.04.02	02.05.02	286545	31.05.02	37
9	298693	09.05.02	20.05.02	287462	01.08.02	83
10	301328	21.05.02	15.07.02	288807	HELD	Disputed
11	299792	21.05.02	06.05.02	287911	01.08.02	71
12	302023	14.06.02	05.07.02	288829	29.08.02	75
13	303850	03.07.02	18.07.02	289379	26.09.02	92
14	304195	08.07.02	18.07.02	289398	26.09.02	52
15	304597	11.07.02	18.07.02	289411	11.10.02	77
16	306718	09.08.02	21.08.02	290245	29.10.02	48
17	307577	20.08.02	21.08.02	290823	29.10.02	52
18	307642	21.08.02	21.08.02	291027	29.10.02	69
					Average	62.3

Table A.1.1. Supplier A - Payment periods achieved for period 29/11/01 to 21/08/02

Supplier B – Credit Period 60 Days						
Transaction No.	Invoice Number	Invoice Date	Date registration on AS400 system	Internal registration number	Date Paid	Period of Payment Approx.
1	211193770	30.11.01	21.12.01	148308	01.02.02	62
2	211298495	31.12.01	15.01.02	148591	01.03.02	59
3	211298496	31.12.01	15.01.02	148590	01.03.02	59
4	211296466	16.12.01	15.01.02	148849	01.03.02	74
5	211193771	30.11.01	21.12.01	148309	01.02.01	62
6	220110945	31.01.02	18.02.02	148549	04.04.02	62
7	220110946	31.01.02	18.02.02	148548	04.04.02	62
8	220110947	31.01.02	18.02.02	148547	04.04.02	62
9	220110948	31.01.02	18.02.02	148546	04.04.02	62
10	220110949	31.01.02	18.02.02	148545	04.04.02	62
11	220110950	31.01.02	18.02.02	148544	04.04.02	62
12	220110945	31.01.02	18.02.02	148549	04.04.02	62
13	220110946	31.01.02	18.02.02	148548	04.04.02	62
14	220110068	14.02.02	07.03.02	149061	01.05.02	75
15	220110948	31.01.02	18.02.02	148546	04.04.02	62
16	220110949	31.01.02	18.02.02	148545	04.04.02	62
17	220214067	14.02.02	07.03.02	149062	10.05.02	81
18	220216327	28.02.02	29.03.02	149941	01.05.02	62
19	220216328	28.02.02	19.03.02	149940	01.05.02	62
20	220319004	14.03.02	19.04.02	150399	31.05.02	78
21	220319005	14.03.02	18.04.02	150398	31.05.02	78
22	220319003	14.03.02	19.04.02	150400	31.05.02	78
23	220319006	14.03.02	18.04.02	150397	31.05.02	78
24	220316331	28.02.02	19.03.02	149936	01.05.02	62
25	220316330	28.02.02	19.03.02	149938	01.05.02	62
26	220316329	28.02.02	19.03.02	149939	01.05.02	62
27	220316327	28.02.02	19.03.02	149941	01.05.02	62
28	220319002	14.03.02	14.04.02	150401	31.05.02	78
29	220319001	14.03.02	14.04.02	150402	31.05.02	78
30	220321358	31.03.02	19.04.02	150675	31.05.02	61
31	220321359	31.03.02	19.04.02	150674	31.05.02	61
32	220321360	31.03.02	19.04.02	150673	31.05.02	61
33	220321362	31.03.02	19.04.02	150671	31.05.02	61
34	220321361	31.03.02	19.04.02	150672	31.05.02	61
					Average	65.8

Table A.1.2. Supplier B - Payment periods achieved for period 30/11/01 to 31/03/02

Supplier C – Credit Period 60 Days						
Transaction No.	Invoice Number	Invoice Date	Date registration on AS400 system	Internal registration number	Date Paid	Period of Payment Approx.
1	NR589047	13.11.01	11.12.01	281332	01.03.02	107
2	NR589581	16.11.01	11.12.01	281373	01.03.02	104
3	NR590709	26.11.01	06.12.01	281750	01.03.02	94
4	NR592354	07.12.01	06.12.01	282504	04.04.02	118
5	NW276370	16.11.01	11.12.01	281371	01.03.02	106
6	NR590165	12.11.01	11.12.01	281423	01.03.02	108
7	NR591237	29.11.01	02.01.02	282014	01.03.02	90
8	NW277986	04.12.01	17.12.01	281891	04.04.02	131
9	NW277858	03.12.01	17.12.01	281922	04.04.02	122
10	NR591627	03.12.01	17.12.01	281843	04.04.02	122
11	NW277313	27.11.01	06.12.01	281590	01.05.02	154
12	NR589781	19.11.01	11.12.01	281386	01.03.02	102
13	NR589782	19.11.01	11.12.01	281387	01.03.02	102
14	SA192362	21.11.01	11.12.01	281413	01.03.02	100
15	SA193339	29.11.01	12.12.01	281885	01.03.02	92
16	SA193179	28.11.01	17.12.01	281907	01.03.02	93
17	SA193838	04.12.01	17.12.01	281875	01.05.02	147
18	NR591628	03.12.01	17.12.01	281844	04.04.02	122
19	NR592203	06.12.01	17.12.01	281854	04.04.02	119
20	NR592854	07.12.01	08.01.02	282478	04.04.02	118
21	NR593404	17.12.01	07.01.02	282519	04.04.02	108
22	NR592858	12.12.01	08.01.02	282482	01.05.02	139
23	NR592857	12.12.01	07.01.02	282481	01.05.02	139
24	NR592405	17.12.01	07.01.02	282520	04.04.02	108
25	NR594153	03.01.02	04.02.02	283438	01.05.02	117
26	NR594911	10.01.02	04.02.02	283379	01.05.02	110
27	NW281049	18.01.02	24.02.02	283488	01.05.02	102
28	NR596499	23.01.02	04.02.02	283457	01.05.02	97
29	NR596498	23.01.02	04.02.02	283458	01.05.02	97
30	NW281778	28.01.02	18.02.02	283725	01.05.02	92
31	NR597369	30.01.02	21.02.02	284264	01.08.02	182
32	NR597523	31.01.02	21.02.02	284246	01.05.02	89
33	NR598114	06.02.02	08.03.02	284437	31.05.02	114
34	NR598289	07.02.02	08.03.02	284425	31.05.02	113
35	NR599715	20.02.02	06.03.02	284696	31.05.02	100
36	NR599716	20.02.02	06.03.02	284695	31.05.02	100
37	NR600616	27.02.02	21.03.02	285006	12.06.02	105
38	NR600826	28.02.02	21.03.02	285100	31.05.02	92
39	NR599918	21.02.02	12.05.02	284815	12.06.02	111
40	NW283220	12.02.02	06.03.02	284772	15.07.02	151
41	NW281177	21.01.02	04.02.02	283479	01.05.02	99
					Average	112.6

Table A.1.3. Supplier C - Payment periods achieved for period 13/11/01 – 27/02/02

APPENDIX A.2

MATCHING OF PRICES

Supplier A – Matching of Prices				
Transaction	Purchase Order	Purchase Order Prices excl VAT €	Supplier Invoice	Supply Invoice Prices excl VAT €
1	558451	249.61	285132	126.42
2	558521	Not found	Not found	-
3	558962	Not found	287116	45.99
4	559118	Not found	287613	530.25
5	561067	173.73	294470	149.76
6	561299	12.16	295359	28.92
7	561215	133.31	295009	80.38
8	561223	Not found	Not found	-
9	561516	692.36	296299	692.27
10	561793	465.13	297332	465.14
11	561880	58.08	298693	142.14
12	562126	183.37	298693	142.14
13	562479	532.50	301328 & 299792	1,340.40
14	562478	234.90	Not found	-
15	562888 & 562890	Not found	Not found	-
16	562909	366.36	302023	432.70
17	563418	183.87	303850	183.88
18	563553	43.12	304195	42.26
19	563651	275.40	304597	237.18
20	564153	30.69	306718	51.90
21	564295	281.60	Not found	-
22	564344	Not found	Not found	-
23	564423	Not found	Not found	-

Table A.2.1. Supplier A - Matching of prices

Supplier C – Matching of Prices				
Transaction	Purchase Order	Purchase Order Prices excl VAT €	Supplier Invoice	Supply Invoice Prices excl VAT €
1	558047	5,622.42	11 separate invoices	5,567.23
2	558164	262.60	NR589781 & NR589782	219.92
3	558222	26.88	SA192362	10.37
4	558313	67.92	Not found	-
5	558047 & 558453	230.80	SA193339, SA193179,SA193838	224.99
6	558453	Incl in 5 above		
7	558582,558683, 58682,558719	2,609.63	NR591628,NR592203,NR592854	660.68
8	558719,558941,558796	790.49	NR593404 & NR592858	559.88
9	558837	190.50	NR592857	150.00
10	558933 & 559011	Approx. 3,119,82	Not found	-
11	Void			
12	559075	123.03	NR594153	123.03
13	559253	17.48	NR594911	11.30
14	559455	907.75	Not found	-
15	559545,559598, 5559678	570.26	NR596499,NR596498,NW281778	628.29
16	559745	367.58	NR597369	447.80
17	559802	261.57	NR597523	284.58
18	559924 & 559975	354.70	NR598114 & NR598289	368.82
19	560286 & 560319	380.17	NR599715 & NR599716	363.22
20	560497	76.20	NR600616	42.03
21	560580	28.20	Not found	-
22	560580	18.12	Not found	-

Table A.2.2. Supplier C - Matching of prices

APPENDIX A.3

SAMPLE TRANSACTION DATA
SUPPLIER C – Transaction 1

Site Requisition					
Number	**Quantity**	**Description**	**Date Completed**	**Date Req**	**Office Use**
110001	200	sheets of 18" x 2.4 x 1.2 shuttering grade plywood	13/11/01	13/11/01	558047
	83	6"x3"x3.300 long deal timbers			
	34	100x75x3.300 long deal timbers			
	750	metres of 100x50 deal timbers			
	1	box of 4" Rw/n, 3" Rw/n, 2" Rw/n.			
	1	Length of 4" wavin sewer			
	10	Length of 9" wavin/ducting pipe			

Table A.3.1. Site requisition data

Purchase Order					
Number	**Quantity**	**Description**	**Price per Unit €**	**Total Value of Order €**	**Date of Issue**
558047	200	Sheets plywood grade CDX 18mm x 2.40 x 1.20m	14.98	2,996.00	12/11/01
	273.9	Metres whitedeal rough timber 75 x 150 3.30m	2.57	703.92	
	112.2	Metres whitedeal rough timber 75 x 100 3.30m	1.71	191.86	
	750	White deal rough timber 44 x 100mm	1	750.00	
	1	Box nails round wire 4" 100mm x 4.5mm (25kg) box	13.97	13.97	
	1	Box nails round wire 3" 75mm x 4mm (25kg) box	13.97	13.97	
	1	Box nails round wire 2" 50mm x 3.35mm (25kg) box	13.97	13.97	
	1	Length sewer pipe integral socketed 100mm x 6m	11.05	11.05	
	10	Length sewer pipe integral socketed 225mm x 6m	50.28	502.80	
	20	5 litre tin of white undercoat paint	20.32	406.20	
	2	Roller tray metal 9"	3.81	7.62	

Table A.3.2. Purchase order data

Good Received Note				
Date Completed	**Delivery Docket Number**	**Order Number**	**Quantity Received**	**Description**
13/11/01	NRZ30275	558047	159.9	75 x 150 white deal rough
			202.8	44 x 100 white deal rough
			10	Sheets of ply 2.44 x 1.22 x 18mm
			10	6m PVC sewer pipe
16/11/01	NRZ30746	558047	50	Sheets of ply 2.44 x 1.22 x 18mm
16/11/01	NRZ32022	558047	112.2	75 x 150 white deal rough
			270	44 x 100 white deal rough
			50	Sheets of 18mm plywood
			20	5 litre white undercoat
			1	Paint brush
			2	9" roller set
			1	Basta lock set
19/11/01	NRZ33603	558047	35	Sheets of 18mm plywood
			1	Round wire nails
			4 pair	Hinges scotch 12"
19/11/01	NRZ40223	558047	318.6	44 x 100 white deal rough
21/11/01	NRZ31390	558047	1	Round wire nails 75 x 4
			1	Round wire nails 100 x 4.5
			1	Ringshank nails 65mm
			1	Jack handsaw 22"
29/11/01	NRZ32453	558047	50	18mm sheeting grade ply 2.44 x 1.22
04/12/01	NRZ41765	558047	19.8	75 x 225 white deal rough
			9.6	75 x 225 white deal rough
03/12/01	NRZ41688	558047	108	75 x 150 white deal rough
03/12/01	NRZ32870	558047	50	18mm sheeting grade ply

Table A.3.3. Good received note data

Delivery Note					
Delivery Advice Number	**Order Number**	**Quantity**	**Description**	**Supplier Code**	**Date of Delivery**
NRZ30275	558047	159.9	75 x 150 white deal rough	Sw075150	13/11/01
		202.8	44 x 100 white deal rough	Sw044100	
		10	Sheets of ply 2.44 x 1.22 x 18mm	397001	
		10	6m PVC sewer pipe	325809	
NRZ30746	558047	50	Sheets of ply 2.44 x 1.22 x 18mm	397001	16/11/01
NRZ32022	558047	112.2	75 x 150 white deal rough	Sw075100	16/11/01
		270	44 x 100 white deal rough	Sw044100	
		50	Sheets of 18mm plywood	397001	
		20	5 litre white undercoat	564553	
		1	Paint brush	583330	
		2	9" roller set	583330	
		1	Basta lock set	146773	
NRZ33603	558047	35	Sheets of 18mm plywood	397001	07/12/01
		1	Round wire nails	101189	
		4 pair	Hinges scotch 12"	227755	
NRZ40223	558047	318.6	44 x 100 white deal rough	Sw044100	16/11/01
NRZ31390	558047	1	Round wire nails 75 x 4		21/11/01
		1	Round wire nails 100 x 4.5		
		1	Ringshank nails 65mm		
		1	Jack handsaw 22"		
NRZ32453	558047	50	18mm sheeting grade ply 2.44 x 1.22	397100	29/11/01
NRZ41765	558047	19.8	75 x 225 white deal rough	Sw075225	04/12/01
		9.6	75 x 225 white deal rough	Sw075225	
NRZ41688	558047	108	75 x 150 white deal rough	Sw075150	03/12/01
NRZ32870	558047	50	18mm sheeting grade ply	397100	03/12/01
NRZ41069	558047	201.6	75 x 150 white deal rough		27/11/01

Table A.3.4. Delivery note data

Sales Invoice						
Order No.	**Invoice No.**	**Invoice Date**	**Quantity**	**Description**	**Price per unit €**	**Total Excl VAT €**
558047	NR589047	13/11/01	159.9	75 x 150 white deal rough	202.5/100	323.80
			202.8	44 x 100 white deal rough	79.2/100	160..62
			10	Sheets of ply 2.44 x 1.22 x 18mm	11.50	115.00
			10	6m PVC sewer pipe	39.60	396.00
	NR589581	16/11/01	50	Sheets of ply 2.44 x 1.22 x 18mm	12.5	625.00
	NR590709	26/11/01	112.2	75 x 150 white deal rough	135.00/ 100	151.47
			270	44 x 100 white deal rough	79.2/100	213.84
			50	Sheets of 18mm plywood	11.80	590.00
			20	5 litre white undercoat	16.00	320.00
			1	Paint brush	3.15	3.15
			2	9" roller set	7.51	15.02
			1	Basta lock set	8.00	8.00
	NR592354	7/12/01	35	Sheets of 18mm plywood	11.80	413.00
			1	Round wire nails	11.00	11.00
			4 pair	Hinges scotch 12"	1.96	7.84
	NW276370	16/11/01	318.6	44 x 100 white deal rough	79.2/100	252.33
	NR590165	21/11/01	1	Round wire nails 75 x 4	11.00	11.00
			1	Round wire nails 100 x 4.5	11.00	11.00
			1	Ringshank nails 65mm	29.09	29.09
			1	Jack handsaw 22"	7.70	7.70
	NR591237	29/11/01	50	18mm sheeting grade ply 2.44 x 1.22	11.80	590.00
	NW277986	4/12/01	19.8	75 x 225 white deal rough	334.7/100	66.27
			9.6	75 x 225 white deal rough	303.75/ 100	29.16
	NW277858	3/12/01	108	75 x 150 white deal rough	202.50/ 100	218.70
	NR591627	3/12/01	50	18mm sheeting grade ply	11.80	590.00
	NW277313	27/11/02	201.6	75 x 150 white deal rough	202.50/ 100	408.24

Table A.3.5. Sales invoice data

SAMPLE TRANSACTION DATA
SUPPLIER C – Transaction 7

Site Requisition					
Number	**Quantity**	**Description**	**Date Completed**	**Date Req**	**Office Use**
110016	30	6" x 3" rough deal timber, 17' lengths	30/11/01	03/12/01	558582
	400	Metres of 4" x 2" rough 17' lengths			
	12	CSH bolts 10mm dia x 170mm			
	3	9" x 3" x 6.600 rough timber			
	2	9" x 3" x 4.500 rough timber			558683
	500	Rebar protection caps 5-16mm dia			
	500	Rebar protection caps 16-32mm dia			
	100	600 x 600 x 50mm concrete paving slabs			558682
	1	9" barrell bolt & 3" padlock			558719
	1	15" barrell bolt & 3" padlock			
	6	Boxes of 4" x 60 pozie drive screws			

Table A.3.6. Site requisition data

Purchase Order					
Number	**Quantity**	**Description**	**Price per Unit €**	**Total Value of Order €**	**Date of Issue**
558582	99	30 x 3.30m lengths of whitedeal rough timber 75mm x 150	2.57	254.43	30/11/01
	400	4.80m whitedeal rough timber 44 x 100mm	1.00	1,920.00	
	19.8	whitedeal timber 75mm x 325mm	3.86	76.42	
	9.00	whitedeal timber 65mm x 225mm	3.86	34.74	
558682	100	paving slabs 600x600x50	3.17	317.00	05/12/01
558719	1	pad bolts galvanised 10"	3.01	3.01	06/12/01
	1	pad bolts galvanised 12"	4.03	4.03	

Table A.3.7. Purchase order data

Goods Received Note				
Date Completed	**Delivery Docket Number**	**Order Number**	**Quantity Received**	**Description**
03/12/01	NRZ32871	558582	75	44 x 100 white deal rough
			7	Csh bolts & nuts
06/12/01	NRZ33542	558682	100	Concrete paving 600 x 600 x 50
19/11/01	NRZ33607	558719	1	Pad bolts galvanised 10"
			1	Cross bolt galvanised 18"
			2	Master padlock no 150
			2	Snips steel fixers

Table A.3.8. Good received note data

Delivery Note					
Delivery Advice Number	**Order Number**	**Quantity**	**Description**	**Supplier Code**	**Date of Delivery**
NRZ32871	558582	75	44 x 100 white deal rough		03/12/01
		7	Csh bolts & nuts		
NRZ33542	558682	100	Concrete paving 600 x 600 x 50		06/12/01
NRZ33607	558719	1	Pad bolts galvanised 10"		07/12/01
		1	Cross bolt galvanised 18"		
		2	Master padlock no 150		
		2	Snips steel fixers		

Table A.3.9. Delivery note data

Sales Invoice						
Order No.	**Invoice No.**	**Invoice Date**	**Quantity**	**Description**	**Price per unit €**	**Total Excl VAT €**
558582	NR591628	03/12/01	405	44 x 100 white deal rough	79.20/100	320.76
			7	Csh bolts & nuts	27.52/100	1.93
558682	NRZ33542	06/12/01	100	Concrete paving 600 x 600 x 50	2.50	250.00
558719	NRZ33607	07/12/01	1	Pad bolts galvanised 10"	2.37	2.37
			1	Cross bolt galvanised 18"	22.30	22.30
			2	Master padlock no 150	19.71	39.42
			2	Snips steel fixers	11.95	23.90

Table A.3.10. Sales invoice data

APPENDIX B

QUESTIONNAIRE SURVEY 1

ICT Purchasing Awareness and Take-Up Study 2004
Top 100 companies in Irish Construction Industry

Appendix B.1 – The Online Survey

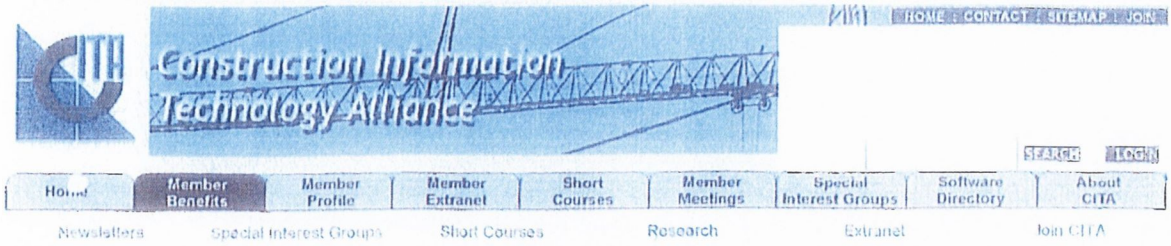
Appendix B.2 - Survey Sample

Appendix B.3 – Analysis and Presentation of Results

Appendix B.4 – Spearman's Rank Correlation Calculations

APPENDIX B.1

THE ONLINE SURVEY



ICT Purchasing Study 2004

Irelands 100 Top Companies Study 2004

ICT Purchasing Awareness and Take-Up Study 2004

* Denotes required field, Please answer questions 1-14 below

Name *	
Position *	
Company *	
Nature of your business *	Architect
Address *	
Phone *	
Fax *	
E-mail address *	

Please indicate company size by turnover *	Small < € 10m	Medium € 10-40m	Large > € 40m

For the purposes of this study ICT denotes any computer hardware or software that collects, processes, stores, analyses and disseminates information for a specific business purpose.

Return to Top

1. **In your opinion how would you rate the current level of ICT usage in the Irish construction industry?**
   - Poor
   - Satisfactory
   - Good
   - Very Good

2. **Please indicate how you would rate the current level of ICT usage in your organisation's business-to-business purchasing transactions.**
   - No Use
   - Little Use
   - Some Use

Moderate Use

Regular or Constant Use

Please give examples, if appropriate

3. **Please indicate your current state of awareness of ICT deployment in construction purchasing.**

   Not Aware

   Somewhat Aware (heard/ read about it)

   Aware (participated in conversations/ tried some of these activities)

   Moderately Aware (occasionally use it as receiver or generator)

   Very Aware (use it as a matter of course frequently)

4. **Please indicate your willingness to consider applying existing technologies in your business-to-business transactions.**

   For the purposes of this question "existing technologies" would include the Internet, Extranets, Electronic Catalogs, Bar Coding, Smart Cards, Radio Frequency ID, Enterprise Resource Planning Systems, Hand Held Computers, Electronic Data Interchange, Extensible Mark-Up Language and Electronic Funds Transfer.

   Unwilling to consider at present moment

   Willing to consider applying existing technologies

   Currently applying existing technologies in purchasing processes

   Please provide commentary to justify your selection

5. **Would you agree that e-commerce has significantly affected the strategies of construction businesses in this country?**

   Yes

   No

Please provide commentary to justify your selection

6. **Do you expect an increasing significance of e-commerce over the next 3 years?**

   Yes

   No

7. **To what extent does your company make use of the following technologies in the sales/ purchasing of construction materials?**

	Always	Most times	Sometimes	Very little	Not yet used
Internet					
Extranets					
Electronic Catalogs					

Bar Coding

Smart Cards

Radio Frequency ID

Enterprise Resource Planning Systems (ERP)

Hand Held Computers

Electronic Date Interchange (EDI)

Extensible Mark-Up Language (XML)

Electronic Funds Transfer (EFT)

Other Technologies or experiences with the above (please state below)

8. How is your company's involvement in eBusiness and the use of the Internet expected to change within the next 3 years?

   For the purposes of this question eBusiness denotes a broad definition of electronic commerce that refers not just to buying and selling, but also to servicing customers, collaborating with business partners, and conducting electronic transactions within an organisation.

   Great increase expected

   Little increase expected

   No increase expected

9. Does your company have concerns over adopting a web-based strategy for future business-to-business purchasing transactions?

   Yes

   No

10. If Yes, to question 9, what are / have been your company's concerns with regard to adopting a web-based strategy for business-to-business purchasing transactions?

	Most concerned	Moderately concerned	Not concerned
Lack of awareness or knowledge of Internet capabilities			
Customer / supplier may not possess adequate eBusiness capabilities			
Lack of available funding			
Total costs			
Security of sensitive data			
Interoperability between transaction parties			
Legal implications			
Training and inability to use technology			
Need for critical mass buy-in			

Other concerns (please state below)

11. Please rank in order (1-10) the following factors, which attract or are likely to attract your organisation to apply existing technologies in construction purchasing.

Reducing paperwork (orders, invoices and delivery dockets)	1
Avoidance of re-keying information into computer systems	1
Saving manpower in processing invoices and other information	1
Fewer errors in recording and handling information	1
Reduced cost of capturing data	1
Improved accessibility to time and cost data: providing real time information	1
Ability to contribute to data interchange in a national standard format	1
Service differentiation from competitors	1
Clients who may encourage or stipulate the use of ICT in purchasing	1
Competitor organisations who may have applied ICT in purchasing processes	1

Other factors (please state and rank 1-10)

12. Please rank in order (1-6) the barriers which undermine the use of ICT in construction purchasing within your organisation.

A lack of awareness of ICT deployment in purchasing	1
Development costs are prohibitive (hardware, software and training)	1
Technology is not yet reliable enough for use in construction environment	1
Potential benefits of electronic purchasing are not likely to be sufficient to justify investments	1
Uncertainty about how to measure the costs and benefits of such investments	1
Employees are likely to resist the introduction of new technologies	1

Other factors (please state and rank 1-6)

13. Please rank in order (1-6) the barriers which undermine the use of ICT in construction purchasing in the Irish construction industry.

There is a general lack of awareness of ICT capabilities in construction purchasing and its potential benefits to the Irish construction supply chain	1
There is a high incidence of technologically conservative organisations in the Irish construction industry	1
The temporary nature of relationships between organisations results in an unwillingness to invest in ICT which may only be short lived	1
There is no motivation for organisations to apply ICT in construction	

purchasing when other parties will benefit	1
There are too many construction products and components to make the adoption of ICTs in construction purchasing widespread	1
There is a general lack of leadership from the government to actively promote the use of ICT in construction procurement	1

Other factors (please state and rank 1-6)

14. Please indicate your position on the following statements.

	Strongly Agree	Agree	No opinion	Disagree	Strongly Disagree
There is a general awareness of the benefits of deploying existing technologies in construction purchasing processes					
A construction industry standard should be introduced for electronic data interchange in business-to-business transactions					
There is an increase in IT literacy and familiarity of electronic purchasing					
Longer term relationships between supply chain organisations, allow development costs and on-going advantages to be shared					
Closer collaboration is required between contractors and suppliers					
Main contractors should stipulate the use of electronic purchasing in future business-to-business transactions with suppliers					
Time consuming and inappropriate search methods for the mass of information available on the Internet, discourage one from making full of the technology					
Involvement in e-business is of vital importance for improving efficiency and effectiveness along the supply chain					
Customers/Manufacturers/Suppliers are very keen on doing business with our company electronically via the Internet					
Extensible Mark-Up Language (XML)					
Electronic Funds Transfer (EFT)					

Other Technologies or experiences with the above (please state below)

Click here to submit the survey

APPENDIX B.2

2004 ICT Construction Purchasing and Awareness and Take-Up Study

Top 100 Contractors and Suppliers in the Irish Construction Industry

Source: irishconstruction.com

Company	Address	Contact	Role	Responded
Architectural Aluminium Ltd	Oak Road, Western Business Park, Dublin 12	Brian Kennedy	IT Manager	Yes
Armitage Shanks	M50 Business Park, Ballmount, Dublin 12	Shelia Kilbride	MD	
Ascon Ltd	Kill, Co. Kildare	Tom Bambrick	IT Manager	Yes
Associated Hardware Ltd	Magna Drive, Magna Business Park, City West Road, Dublin 22	Ciaran Kendellan	IT Manager	Yes
Basta Parsons Ltd	Tubbercurry, Co. Sligo	Patrica Cassidy	IT Manager	
Brian McCarthy Building and Civil	Unit 6, Quin Road Business Park, Ennis, Co. Clare	Edel Mee	IT Manager	Yes
Brookes Thomas	Bluebell, Naas Road, Dublin 12	Suzanne Walshe	IT Manager	Yes
Capco Holdings Ltd	Mount Tallant Avenue, Terenure, Dublin 6W	Francis Coogan	IT Manager	Yes
Carey Glass Ltd	Limerick Road, Co. Tipperary	Tony Moran	IT Manager	
Carroll Joinery	P.O. Box 831, Bluebell, Dublin 12	Michael Delaney	IT Manager	
Castlemore Group	Crookstown, Co. Cork	Jackie O'Sullivan	IT Manager	Yes
Cedar Building Co.	Abbeylands, Arklow, Co. Wicklow	Eddie Holly	MD	
Century Homes Ltd	Clones Road, Monaghan	Sean McElvaney	IT Manager	
Christopher Bennett Construction Ltd	Milltownpass, Co. Westmeath	Rita Cuffe	IT Manager	Yes
Chubb Ireland Plc	Stillorgan Industrial Estate, Blackrock, Co. Dublin	Michael Devitt	IT Manager	Yes
Cleary and Doyle Ltd	Larkins Cross, Wexford	Neil Connelly	IT Manager	
Coffey Construction Ltd	Athenry, Co. Galway	Padraic Leader	IT Manager	Yes
Concast Precast Group	Hazelhatch, Newcastle, Co. Dublin	Caroline Quinn	IT Manager	Yes
Cosgrave Developments	13 Wentworth, Eblana Villas, Dublin 2	Conor Molloy	IT Manager	Yes
CRH plc	Belgard Castle, Clondalkin, Dublin 22	Matt O'Brien	IT Manager	Yes
David Flynn Ltd	Paragon House, Waterford Business Park, Cork Road, Waterford.	Thomas Holden	IT Manager	Yes
Davies of Fairview	Richmond Avenue, Fairview, Dublin 3	Ken Kealy	IT Manager	
DPL Group Ltd	Old Kilmainham, Dublin 8	John Peare	IT Manager	
Duggan Brothers Ltd	Richmond, Templemore, Co. Tipperary	Edward Cleary	IT Manager	
FKM Group	14 Riverwalk, Citywest Business Campus, Dublin 24	Tadhg Sullivan	IT Manager	Yes
FP McCann Ltd	Knockloughrim Quarry, 3 Drumard Road, Magheraflelt, Co. Derry	Brian Law	IT Manager	Yes
G&T Crampton Plc	Sandymount Buildings, Simmonscourt Road, Ballsbridge, Dublin 4	Clive Chapple	IT Manager	
Glennan Brothers Timber	Sawmills, Dublin Road, Longford	Donal Hogan	IT Manager	Yes
Grafton Group plc	Heron House, Corrig Road, Sandyford Industrial Estate, Dublin 18	Michael Fox	IT Manager	
Graham	Lagan Mills, Dromore, Co. Down, BT25 1AS	Andrew Howes	IT Manager	
Grainger Saw Mills	Main Street, Enniskeane, Co. Cork	Gordon Straub	IT Manager	Yes
Gypsum Industries	Unit 14, Park West Industrial Park, Dublin 12	Tom Farrell	IT Manager	Yes
Heiton Holdings plc	Ashfield, Naas Road, Clondalkin, Dublin 22	Paul Sherwood	IT Manager	Yes
Hevac Ltd	Muirfield Drive, Naas Road, Dublin 12	Chris Harden	IT Manager	
Ibstock Building Products Ltd	54 Dartmouth Square, Dublin 6	Niall MacCarvile	Director	Yes
IJM Timber Engineering Ltd	Latiurgan, Monaghan	Chris Fogharty	IT Manager	Yes
Irish Cement Ltd	Stillorgan, Co. Dublin	Dara Phillips/Pat Fu	IT Manager	Yes
Irish Enco Construction	Hartwell Upper, Kill, Co. Kildare	Shay White	IT Manager	Yes
James McMahon Ltd	Corcanree, Dock Road, Limerick	Ger Murphy	IT Manager	
Jer Ryan Electrical Contractors Ltd	Cooleen House, Western Road, Clonmel, Co. Tipperary	Bobby Bourke	IT Manager	Yes
JJ Rhatigan & Co. Ltd	Heritage Hall, Kirwan's Lane, Galway	AnneMarie Keogh	IT Manager	
John Fleming Construction Ltd	New Cork Road, Bandon, Co. Cork	Martin Hennigan	IT Manager	Yes
John Paul Construction Ltd	Dundrum Business Park, Dundrum Road, Dublin 14	Jimmy Mitchell	IT Manager	Yes
John Sisk & Son Ltd	Wilton Works, Naas Road, Clondalkin, Dublin 22	Joe Gaffney	IT Manager	Yes
Jones Engineering Ltd	Waterways House, Grand Canal Quay, Dublin 2	John Maurice	IT Manager	Yes
Karl Holdings Ltd	92 Old Ballyrobin Road, Muckamore, Co. Antrim	Aran Blackbourne	MD	
Kelly Builders (Rosemount) Ltd	Unit 7E, Lough Sheever Corporate Park, Robinstown, Mullingar, Co. Westmeath	Not Confirmed	IT Manager	
Kentech	Hexagon House, Little Island, Cork	Not Confirmed	IT Manager	
Kilcawley Building & Civil Engineering Ltd	Strandhill Road, Sligo	Not Confirmed	IT Manager	
Killeshal Precast Concrete Ltd	Daingean, Co. Offaly	William Farrell	Sales	Yes
Kingscourt Bricks Ltd	Drumgill Kingscourt, Co. Cavan	Kevin McCoy	IT Manager	Yes
Kingscroft Developments	1 Setanta Place, Dublin 2	Heidi Baxter	IT Manager	
Kingspan Group plc	Dublin Road, Kingscourt, Co. Cavan	Sean Hickey	IT Manager	Yes
Loftus Civil Engineering Ltd	Kilbarry House, Dublin Hill, Cork	Marcus	QS	Yes
M Kelligher	Ballymullen, Tralee, Co. Kerry	Denis Kelleher	IT Manager	Yes
Masonry Fixings Ltd	Unit 83, Cherry Orchard Industrial Estate, Dublin 10	Gerard O'Carroll	Director	Yes
McGratten & Kenny Ltd	Unit 65, Riverview Business Park, New Nangor Road, Dublin 12	John Doherty	Director	
McInerney Holdings plc	29 Kenilworth Square, Rathgar, Dublin 6	Terry Anderson	IT Manager	Yes
Mecury Holdings	Mercury House, Sandyford Industrial Estate, Foxrock, Dublin 18	Derek Mizak	IT Manager	
Michael Fitzgerald & Sons Ltd	Raheen, Gort, Co. Galway	Not Confirmed	IT Manager	
Michael Lynch Ltd	Clare Road, Ennis, Co. Clare	John Browne	IT Manager	Yes
Michael McNamara & Co.	Grattan Bridge House, 3 Upper Ormand Quay, Dublin 7	Seoirse Macgabhar	IT Manager	Yes
Munster Joinery Ltd	Ballydesmond, Mallow, Co. Cork	Gerry Coffey	IT Manager	
Murnane & O'Shea Ltd	Lanadane, Bantry. Co. Cork	Not Confirmed	IT Manager	
Murray Timber Products Ltd	Ballygar, Co. Galway	Brendan Penny	MD	
O'Hare & McGovern Ltd	Carnbane House, Shephards Way, Newry, Co. Down	Not Confirmed	IT Manager	Yes
O'Reilly Bros. Kingscourt Ltd	Larchfield, Kingscourt, Co. Cavan	Barry Smyth	Director	
Paddy Burke (Builders) Ltd	Atlantic Road, Lisdoonvarna, Co. Clare	Dara Lynch	IT Manager	Yes
P. Elliott & Co. Ltd	Century Business Park, Dublin Road, Cavan	Eamonn Duffy	Director	
Pierse Contracting	Birmayne House, Mulhuddart, Dublin 15	Tim Brady	IT Manager	Yes
PJ Hegarty & Sons Ltd	Davitt Road, Inchicore, Dublin 12	Kieran Molloy	IT Manager	Yes
PJ Walls Ltd	City Junction Business Park, Northern Cross, Malahide Road, Dublin 17	Peter Kingston	IT Manager	Yes
Priority Construction Ltd	162 Clontarf Road, Dublin 3	Christina Griffin	IT Manager	
Qualceram Shires plc	South Quay, Arklow, Co. Wicklow	Trevor Broughal	IT Manager	Yes
Quinn Group	Gortmullen, Derrylin, Co. Fermanagh BT92 9AU	Siobhan McManus	IT Manager	
Rational Vinduer	P.O. Box 831, Bluebell, Dublin 12	Declan Loy	IT Manager	
Readymix plc	5-23 East Wall Road, Dublin 3	Mark McNally	IT Manager	
Rennick Manufacturing	Kilbride, Mulhuddard, Dublin 15	Katherine Synnott	IT Manager	
Ring Gard Group	Ring Gard House, Dublin 13	Tadhg Twomey	MD	Yes
Roadbridge Ltd	Ballyclough House, Ballsheedy, Co. Limerick	Rory Moore	IT Manager	Yes
Senator Windows Ltd	Seaview Industrial Estate, Wexford	Dairmuid Dunbar	IT Manager	Yes
Siac Construction Ltd	Monastery Road, Clondalkin, Dublin 22	Barbara White	IT Manager	Yes
Siemens	8 Raglan Road, Dublin 4	John O'Sullivan	IT Manager	
SMC Group	Coes Road, Dundalk, Co. Louth	Michael Kearney	IT Manager	
Sorensen Holdings Ltd	Forge Hill Cross, Kinsale Road, Cork	Not Confirmed	IT Manager	
Steel Company of Ireland (Chorus)	Ballymount Road, Clondalkin, Dublin 22	John Sheehan	IT Manager	
Suir Engineering	32 Upper Pembroke Street, Dublin 2	Michael Melay	IT Manager	
T.H. Contractors Ltd	Castlebar, Co. Mayo	John Henry	IT Manager	
Tegral Building Products	6 South Leinster Street, Dublin 2	John Page	IT Manager	Yes
Tom Hayes Ltd	Killaloe, Co. Clare	Tom Burke	Director	Yes
Townlink Construction Ltd	10 Greenhills Business Park, Dublin 24	Not Confirmed	IT Manager	Yes
Uniform Construction Ltd	The Grange, Newcastle, Lucan, Co. Dublin	Gerry Preston	IT Manager	Yes
Wavin Ireland Ltd	Balbriggan, Co. Dublin	Paul Norton	IT Manager	Yes
Williaam Cox Ireland Ltd	Robinhood Industrial Estate, Dublin 22	Paddy Doyle	IT Manager	Yes
Wright Window Systems	Milltownpass, Co. Westmeath	Not Confirmed	IT Manager	

APPENDIX B.3
ICT PURCHASING AWARENESS AND TAKE-UP STUDY 2004
TOP 100 COMPANIES IN IRISH CONSTRUCTION INDUSTRY
ANALYSIS AND PRESENTATION OF RESULTS

	In your opinion how would you rate the current level of ICT usage in Irish construction industry?			
		Contractor	**Supplier**	
Q1	Poor	56%	52%	54%
	Satisfactory	35%	41%	39%
	Good	9%	7%	7%
	Very Good	0	0	0
		100%	100%	100%

Table B.3.1. Current level of ICT usage in the Irish Construction Industry

	Please indicate how you would rate the current level of ICT usage in your organisations business-to-business purchasing transactions.			
		Contractor	**Supplier**	**Overall**
Q2	No Use	24%	3%	13%
	Little Use	28%	38%	33%
	Some Use	8%	38%	24%
	Moderate Use	16%	7%	11%
	Regular or Constant Use	24%	14%	19%
		100%	100%	100%

Table B.3.2. Current level of ICT usage in B2B purchasing transactions

	Please indicate your current state of awareness of ICT deployment in construction purchasing.			
		Contractor	**Supplier**	**Overall**
Q3	Not Aware	8%	3%	5%
	Somewhat Aware (heard/read about it)	36%	41%	39%
	Aware (participated in conversations/tried some of these activities)	24%	24%	24%
	Moderately Aware (occasionally use it as receiver or generator)	16%	24%	20%
	Very Aware (use it as a matter of course frequently)	16%	8%	12%
		100%	100%	100%

Table B.3.3. Current state of awareness of ICT deployment in construction purchasing

	Please indicate your willingness to consider applying existing technologies in your business-to-business transactions.			
		Contractor	**Supplier**	**Overall**
Q4	Unwilling to consider at present moment	4%	4%	4%
	Willing to consider applying existing technologies	52%	62%	57%
	Currently applying existing technologies in purchasing processes	44%	34%	39%
		100%	100%	100%

Table B.3.4. Willingness to consider applying existing technologies

Cross Tabulation of Question 2 and Question 4

		Q2					
		No use	**Little**	**Some**	**Moderate**	**Regular**	**Total**
Q4	Unwilling	**1**	**1**	**0**	**0**	**0**	**2**
	Vertical %	14.29	5.56	0.00	0.00	0.00	3.70
	Horizontal %	50.00	50.00	0.00	0.00	0.00	100
	Willing	**6**	**12**	**8**	**2**	**3**	**31**
	Vertical %	85.71	66.67	61.54	33.33	30.00	57.41
	Horizontal %	19.35	38.71	25.81	6.45	9.68	100
	Applying	**0**	**5**	**5**	**4**	**7**	**21**
	Vertical %	0.00	27.78	38.46	66.67	70.00	38.89
	Horizontal %	0.00	23.81	23.81	19.05	33.33	100
	Total	**7**	**18**	**13**	**6**	**10**	**54**
	Vertical %	100.00	100.00	100.00	100.00	100.00	100.00
	Horizontal %	12.96	33.33	24.07	11.11	18.52	100

Table B.3.5. Cross tabulation of Questions 2 and 4

Q5		Would you agree that e-commerce has significantly affected the strategies of construction businesses in this country?					
			Contractor	Supplier	Total		
		Yes	28%	28%	28%		
		No	72%	72%	72%		

Table B.3.6. Impact of e-commerce on construction business strategies

Q6		Do you expect an increasing significance of e-commerce over the next 3 years?			
			Contractor	Supplier	Total
		Yes	76%	76%	76%
		No	24%	24%	24%

Table B.3.7. Increasing significance of e-commerce over next 3 years

	To what extent does you company make use of the following technologies in the sales/purchasing of construction materials?						
	Existing Technology	**Always**	**Most Times**	**Sometimes**	**Very Little**	**Not yet used**	**Total**
Q7	Enterprise Resource Planning Systems (ERP)	30%	6%	0%	9%	55%	100%
	Internet	13%	19%	35%	19%	14%	100%
	Bar coding	11%	7%	6%	17%	59%	100%
	Electronic Funds Transfer (EFT)	9%	13%	43%	13%	22%	100%
	Electronic Catalogues	4%	6%	41%	22%	27%	100%
	Radio Frequency ID	4%	4%	2%	11%	79%	100%
	Extranets	2%	5%	17%	20%	56%	100%
	Electronic Date Interchange (EDI)	2%	5%	17%	13%	63%	100%
	Hand Held Computers	2%	4%	19%	20%	55%	100%
	Smart Cards	0%	0%	9%	13%	78%	100%
	Extensible Mark-Up Language (XML)	0%	0%	9%	13%	78%	100%

Table B.3.8. Overall use of technologies in sales/purchasing of construction materials

	Suppliers	To what extent does you company make use of the following technologies in the sales/purchasing of construction materials?					
	Existing Technology	**Always**	**Most Times**	**Sometimes**	**Very Little**	**Not yet used**	**Total**
Q7	Enterprise Resource Planning Systems (ERP)	20%	10%	6%	3%	61%	100%
	Bar coding	14%	7%	14%	7%	58%	100%
	Hand Held Computers	14%	7%	10%	14%	55%	100%
	Electronic Funds Transfer (EFT)	10%	10%	37%	7%	36%	100%
	Radio Frequency ID	10%	0%	0%	20%	70%	100%
	Internet	7%	14%	48%	24%	7%	100%
	Smart Cards	3%	3%	6%	17%	71%	100%
	Extranets	0%	7%	10%	27%	56%	100%
	Electronic Catalogues	0%	7%	10%	27%	56%	100%
	Electronic Date Interchange (EDI)	0%	3%	24%	3%	70%	100%
	Extensible Mark-Up Language (XML)	0%	0%	10%	17%	73%	100%

Table B.3.9. Suppliers use of technologies in sales of construction materials

	Contractors	To what extent does you company make use of the following technologies in the sales/purchasing of construction materials?					
	Existing Technology	**Always**	**Most Times**	**Sometimes**	**Very Little**	**Not yet used**	**Total**
Q7	Internet	16%	28%	24%	13%	19%	100%
	Enterprise Resource Planning Systems (ERP)	12%	0%	0%	8%	80%	100%
	Electronic Funds Transfer (EFT)	8%	12%	38%	25%	17%	100%
	Electronic Catalogues	8%	4%	44%	20%	24%	100%
	Bar coding	4%	4%	0%	16%	76%	100%
	Hand Held Computers	4%	0%	12%	25%	59%	100%
	Smart Cards	0%	4%	4%	8%	84%	100%
	Smart Cards	0%	4%	4%	8%	84%	100%
	Radio Frequency ID	0%	4%	0%	8%	88%	100%
	Electronic Date Interchange (EDI)	0%	0%	12%	8%	80%	100%
	Extensible Mark-Up Language	0%	0%	8%	8%	84%	100%

Table B.3.10. Contractors use of technologies in purchasing of construction materials

	How is your company's involvement in eBusiness and the use of the Internet expected to change within the next 3 yrs?			
		Contractor	**Supplier**	**Overall**
Q8	Great increase expected	64%	54%	59%
	Little increase expected	36%	38%	37%
	No increase expected	0%	8%	4%
		100%	100%	100%

Table B.3.11. Expectant change in the use of Internet and eBusiness over the next 3 years

Cross Tabulation of Question 4 and Question 8

		Q8			
		Great Increase	**Little Increase**	**No Increase**	**Total**
Q4	Unwilling	**0**	**2**	**0**	**2**
	Vertical %	0.00	10.00	0.00	3.70
	Horizontal %	0.00	100.00	0.00	100
	Willing	**13**	**17**	**1**	**31**
	Vertical %	40.63	85.00	50.00	57.41
	Horizontal %	41.94	54.84	3.23	100
	Applying	**19**	**1**	**1**	**21**
	Vertical %	59.38	5.00	50.00	38.89
	Horizontal %	90.48	4.76	4.76	100
	Total	**32**	**20**	**2**	**54**
	Vertical %	100.00	100.00	100.00	100.00
	Horizontal %	59.26	37.04	3.70	100

Table B.3.12. Cross tabulation of Questions 4 and 8

		Does your company have concerns over adopting a web-based strategy for future business-to-business purchasing transactions?		
		Contractor	**Supplier**	**Overall**
Q9	Yes	52%	55%	54%
	No	48%	45%	46%
		100%	100%	100%

Table B.3.13. Concern over a web-based B2B strategy

	If Yes, to question 9, what are / have been your company's concerns with regard to adopting a web-based strategy for business-to-business purchasing transactions?			
		Overall %		
		Most concerned	**Moderately concerned**	**Not concerned**
Q10	Security of sensitive data	72%	14%	14%
	Inadequate eBusiness capabilities	59%	33%	8%
	Interoperability between transaction parties	57%	39%	4%
	Legal implications	48%	34%	18%
	Need for critical mass buy-in	36%	50%	14%
	Total costs	30%	48%	22%
	Training and inability to use technology	11%	71%	18%
	Lack of awareness	4%	59%	37%
	Lack of available funding	0%	64%	36%

Table B.3.14. Concerns over a web-based strategy

Rank Correlation - Driving Forces to Adoption

		Please rank in order (1-10) the following factors, which attract or are likely to attract your organisations to apply existing technologies in construction purchasing.																									
			1		2		3		4		5		6		7		8		9		10		Total			Ranking		
			Suppliers	Contractors	Suppliers	Contractors	Suppliers	Contractors	Suppliers	Contractors	Suppliers	Contractors	Suppliers	Contractors	Suppliers	Contractors	Suppliers	Contractors	Suppliers	Contractors	Suppliers	Contractors	Overall	Suppliers	Contractors	Overall
Q11	a	Reducing paperwork (orders, invoices and delivery dockets)	1	8	2	8	12	3	28	0	35	0	30	12	28	21	0	8	9	18	20	0	243	5	1	2
	b	Avoidance of re-keying information into computer systems	1	2	4	6	9	3	36	16	40	20	12	12	0	7	16	24	0	9	50	0	168	6	5	6
	c	Saving manpower in processing invoices and other information	7	2	12	10	12	6	0	8	20	20	24	0	7	7	16	16	9	9	30	20	235	1	4	1
	d	Fewer errors in recording and handling information	2	1	10	6	9	18	12	16	10	10	24	0	35	7	16	24	27	0	18	10	255	4	2	4
	e	Reduced cost of capturing data	4	1	8	2	9	12	8	8	20	10	12	36	49	7	24	24	9	0	10	10	263	2	6	5
	f	Improved accessibility to time and cost data: providing real time information	6	1	4	0	9	6	20	16	10	15	30	24	14	0	16	24	27	0	18	10	250	3	3	3
	g	Ability to contribute to data interchange in a national standard format	0	1	0	0	6	3	4	8	5	15	18	0	42	35	32	16	36	27	110	40	398	10	9	10
	h	Service differentiation from competitors	4	0	4	2	0	3	4	4	15	0	24	6	35	14	48	88	27	18	30	20	346	7	10	7
	I	Clients who may encourage or stipulate the use of ICT in purchasing	1	2	4	2	6	3	8	4	25	0	18	18	0	7	56	32	63	72	30	0	351	8	8	8
	j	Competitor organisations who may have applied ICT in purchasing processes	1	1	4	2	3	0	12	4	15	5	0	6	7	28	56	8	72	0	60	80	364	9	7	9

Table B.3.15. Rank Correlation - Driving Forces for Adoption

Rank Correlation - Inter-organisational Barriers to Adoption

		Please rank in order (1-6) the barriers which undermine the use of ICT in construction purchasing within your organisation																									
			1		2		3		4		5		6										Total			Ranking		
			Suppliers	Contractors	Suppliers	Contractors	Suppliers	Contractors	Suppliers	Contractors	Suppliers	Contractors	Suppliers	Contractors									Suppliers	Contractors	Total	Suppliers	Contractors	Total
Q12	a	A lack of awareness of ICT deployment in purchasing	6	5	8	4	12	18	12	8	25	10	42	12									105	57	162	4	1	3
	b	Development costs are prohibitive (hardware, software and training)	5	3	12	14	12	3	36	24	20	15	6	6									91	65	156	2	3	2
	c	Technology is not yet reliable enough for use in construction environment	3	3	10	8	18	9	8	12	50	25	18	12									107	69	176	5	4	4
	d	Potential benefits of electronic purchasing are not likely to be sufficient to justify investments	7	5	8	8	12	9	32	20	25	5	6	12									90	59	149	1	2	1
	e	Uncertainty about how to measure the costs and benefits of such investments	5	1	8	4	21	9	24	12	15	40	24	18									97	84	181	3	6	5
	f	Employees are likely to resist the introduction of new technologies	2	2	10	4	12	12	8	8	15	15	72	42									119	83	202	6	5	6

Table B.3.16. Rank Correlation - Inter Organisational Barriers to Adoption

Rank Correlation - External industry Barriers to Adoption

		Please rank in order (1-6) the barriers which undermine the use of ICT in construction purchasing in the Irish construction industry																							
			1		2		3		4		5		6								Total			Ranking		
			Suppliers	Contractors	Suppliers	Contractors	Suppliers	Contractors	Suppliers	Contractors	Suppliers	Contractors	Suppliers	Contractors							Suppliers	Contractors	Total	Suppliers	Contractors	Total
Q13	a	There is a general lack of awareness of ICT capabilities in construction purchasing and its potential benefits to the Irish construction supply chain	8	6	14	6	12	6	20	12	20	15	18	6							92	51	143	2	1	1
	b	There is a high incidence of technologically conservative organisations in the Irish construction industry	6	5	6	2	24	12	20	16	30	10	12	18							98	63	161	3	3	2
	c	The temporary nature of relationships between organisations results in an unwillingness to invest in ICT which may only be short lived	2	1	14	10	15	15	20	8	40	25	12	6							103	65	168	4	4	4
	d	The is no motivation for organisations to apply ICT in construction purchasing when other parties will benefit	4	1	10	6	27	12	20	20	20	20	6	18							87	77	164	1	6	3
	e	There are too many construction products and components to make the adoption of ICTs in construction purchasing widespread	4	3	10	6	12	15	16	4	20	15	48	18							110	61	171	5	2	5
	f	There is a general lack of leadership from the government to actively promote the use of ICT in construction procurement	2	2	12	4	15	15	20	4	10	15	54	30							113	70	183	6	5	6

Table B.3.17. Rank Correlation - External Organisational Barriers to Adoption

Future Directions

		Please indicate your position on the following statements	Strongly Agree	Agree	No Opinion	Disagree	Strongly Disagree	Total
Q14	e	Introduction of data exchange standards	26%	48%	10%	10%	6%	100%
	g	Closer collaboration between contrcators and suppliers	19%	67%	7%	4%	3%	100%
	h	Need for longer term relationships	15%	61%	13%	11%	0%	100%
	a	Improving efficiency and effectiveness	11%	56%	20%	13%	0%	100%
	c	Internet discourages use of ICT	7%	44%	20%	22%	7%	100%
	f	Main contractors to stipulate use of ICT	4%	46%	22%	20%	8%	100%
	d	Increase in IT literacy and familarity	2%	74%	11%	13%	0%	100%
	b	Awareness of benefits	2%	33%	13%	43%	9%	100%
	I	Supply chain keen to do business	2%	30%	22%	39%	7%	100%

Table B.3.18. Future Directions

APPENDIX B.4

SPEARMAN'S RANK CORRELATION CALCULATIONS

This appendix presents mathematical rank correlation calculations associated with Question 11, 12 and 13 of the author's 2004 questionnaire detailed in Chapter 4. These questions sought to identify how the respondents would rank particular drivers and barriers to EC. The closeness of the relationship between the two groups (in this case contractors and suppliers), determines the validity of the collective conclusion drawn. Rank correlation allows for a numerical measure of the degree of similarity between the ranking of factors presented by the author in the questionnaire.

There are different statistical measures to determine the degree of this closeness. The one most generally used for ranking of characteristics is *Spearman's Coefficient of Rank Correlation*. The formula is shown in Equation B.4.1.

$$\text{Spearmans's coefficient of rank correlation, } r = 1 - \frac{6\sum d^2}{n(n^2 - 1)}$$

Equation B.4.1. Spearmans' Coefficient of Rank Correlation (Harper, 1991)

where d is the *difference* between the rankings of the same item in each series (since these differences are squared in the formula, there is no need to be concerned about whether they are positive or negative and n = number of choices in the question.

Sample Example

Contractors Rank	*Suppliers Rank*	*d*	d^2
3	1	2	4
2	4	2	4
1	2	1	1
4	3	1	1
6	5	1	1
5	7	2	4
7	6	1	1
			16

Table B.4.1. Sample example for rank correlation calculation

Applying equation B.4.1:

$$r = 1 - \frac{6\sum d^2}{n(n^2 - 1)} = 1 - \frac{6 \times 16}{7(7^2 - 1)} = 0.714$$

The result of 0.714 suggested a fairly strong correlation, bearing in mind that a value of 1.00 is a perfect correlation between the two groups. Since the result is generated from a sample of two distinct groups (contractors and suppliers), it is necessary to determine whether the result is a reliable measure of the correlation between the two populations from which the samples are drawn. This is examined through a significance test of the sample result.

Using the result of Spearman's calculation, it is now possible to test the sample result for reliability as a measure of the population correlation. To do this a statistical method of Hypothesis Testing is used. Setting up and testing hypotheses is an essential part of statistical inference.

- H0: there is no correlation in ranking between the contractors and suppliers. This is normally referred to as the Null Hypothesis i.e. $r = 0$.
- H1: there is a correlation in ranking between the contractors and supplier. This is normally referred to as the Alternative Hypothesis i.e. .$r \neq 0$.

The equation adopted to test the significance of the result is shown Equation B.4.2.

$$Z = \frac{r}{\frac{1}{\sqrt{n - 1}}} = r\sqrt{n - 1}$$

Equation B.4.2. Hypothesis Test Formula (Harper, 1991)

where in this instance r = sample Spearman's rank correlation and n = number of ranking factors.

In a normal distribution, 95% of the distribution falls within a range of +/- 1.96 standard deviation, and 98% of the distribution falls within a range of +/-2.58 standard deviation.

Where the result of the significance test, z, is in excess of the 95% level of 1.96 but below the 98% level of 2.58, the result is significant and therefore reliable.

Each of the ranking questions are now tested for statistical significance.

Question 11 : *Please rank in order (1-10) the following factors, which attract or are likely to attract your organisations to apply existing technologies in construction purchasing.*

The computation of Spearman's coefficient of rank correlation in respect to Question 11, is given in Table B.4.2.

Drivers	Contractors Rank	Suppliers Rank	d	d^2
Saving manpower in processing invoices and other information; fewer errors in recording and handling information	4	1	3	9
Reducing paperwork (orders, invoices and delivery dockets)	1	5	4	16
Improved accessibility to time and cost data: providing real time information; ability to contribute to data interchange in a national standard forma	3	3	0	0
Fewer errors in recording and handling information	2	4	2	4
Reduced cost of capturing data	6	2	4	16
Avoidance of re-keying information into computer systems	5	6	1	1
Service differentiation from competitors	10	7	3	9
Clients who may encourage or stipulate the use of ICT in purchasing	8	8	0	0
Competitor organisations who may have applied ICT in purchasing processes	7	9	2	4
Ability to contribute to data interchange in a national standard format	9	10	1	1
				60

Table B.4.2. Rank correlation calculation for question 11.

Applying equation B.4.1 to the values in Table B.4.2 gives r at 0.64. This figure represents a sample estimate of the degree of rank correlation between the two groups in relation to the driving forces. To test its statistical robustness, a hypotheses test is carried out for Question 11, where using equation B.4.2, the test significance Z is 1.94. This value is sufficiently close to the value of 1.96 to conclude a 95% distribution level can be assumed for the responses to this question. The result allows the author to conclude that the relative importance of the factors which attract companies to apply existing technologies is similar across both groups of contractor and suppliers.

Question 12 : Please rank in order (1-6) the barriers which undermine the use of ICT in construction purchasing within your organization.

The computation of Spearman's coefficient of rank correlation in respect to Question 11, is given in Table B.4.3.

Internal Barriers	**Contractors Rank**	**Suppliers Rank**	**d**	**d^2**
Potential benefits of electronic purchasing are not likely to be sufficient to justify investments	2	1	1	1
Development costs are prohibitive (hardware, software and training)	3	2	1	1
A lack of awareness of ICT deployment in purchasing	1	4	3	9
Technology is not yet reliable enough for use in construction environment	4	5	1	1
Uncertainty about how to measure the costs and benefits of such investments	6	3	3	9
Employees are likely to resist the introduction of new technologies	5	6	1	1
				22

Table B.4.3. Rank correlation calculation for question 12.

Applying equation B.4.1 to the values in Table B.4.3 gives r at 0.37. This figure represents a sample estimate of the degree of rank correlation between the two groups

in relation to the internal barriers to EC. To test its statistical robustness, a hypotheses test is carried out for Question 12, where using equation B.4.2, the test significance Z is 0.83.

The value of 0.83 is not close to the 95% distribution value of 1.96. There is a relatively small number of factors or choices to be ranked in comparison to question 11 (10 down to 6). As a direct result of this reduction, it is more difficult to statistically indicate the existence of a correlation of this response within the population. This does not also disprove the existence of a correlation mathematically. However, when one examines the results in Table B.4.3, it is would appear that there is a reasonable degree of similarity between the two groups in respect to the ranking of barriers in this question to draw conclusions.

Question 13 : Please rank in order (1-6) the barriers which undermine the use of ICT in construction purchasing in the Irish construction industry.

External Barriers	Contractors Rank	Suppliers Rank	d	d^2
There is a general lack of awareness of ICT capabilities in construction purchasing and its potential benefits to the Irish construction supply chain	1	2	1	1
There is a high incidence of technologically conservative organisations in the Irish construction industry	3	3	0	0
There is no motivation for organisations to apply ICT in construction purchasing when other parties will benefit	6	1	5	25
The temporary nature of relationships between organisations results in an unwillingness to invest in ICT which may only be short lived	4	4	0	0
There are too many construction products and components to make the adoption of ICTs in construction purchasing widespread	2	5	3	9
There is a general lack of leadership from the government to actively promote the use of ICT in construction procurement	5	6	1	1
				36

Table B.4.4. Rank correlation calculation for question 13.

Applying equation B.4.1 to the values in Table B.4.4 gives r at 0.03. This figure represents a sample estimate of the degree of rank correlation between the two groups in relation to the external barriers to EC. To test its statistical robustness, a hypotheses test is carried out for Question 13, where using equation B.4.2, the test significance Z is 0.067.

The value of 0.067 is not close to the 95% distribution value of 1.96. As in question 12, there is a relatively small number of factors or choices to be ranked in comparison to question 11 (10 down to 6). As a direct result of this reduction, it is again more difficult to statistically indicate the existence of a correlation of this response within the population. This does not also disprove the existence of a correlation mathematically. However, when one examines the results in Table B.4.4, it is would appear that there is a reasonable degree of similarity between the two groups in respect to the ranking of barriers in this question to draw conclusions.

The reason for the relatively low values obtained for Z and r obtained for Questions 12 and 13 is mainly due to the small number of ranking options given to the respondents (10 down to 6). This factor affected the sensitivity of the results obtained and highlights one of the main weaknesses of the Spearmans' coefficient of rank correlation formula.

APPENDIX C

OBSERVATION STUDY 2

Appendix C.1 – Payment Periods

Appendix C.2 – Matching of Prices

Appendix C.3 – Extent of 100% Matching of Purchase Orders, Delivery Dockets and Supplier Invoices

APPENDIX C.1

PAYMENT PERIODS

Supplier A – Credit Period 60						
Transaction No.	Invoice Number	Invoice Date	Date registration on COINS system	Internal registration number	Date Paid	Period of Payment Approx.
1	361724	03/02/04	16.02.04	04020224	29.04.04	72
2	363966	20/02/04	24.02.04	04021570	29.04.05	64
3	366735	15/03/04	22.03.04	04031721	27.05.04	66
4	365963	09/03/04	24.03.04	04032391	27.05.04	64
5	366117	10/03/04	24.03.04	04032410	27.05.04	64
6	366158	10/03/04	24.03.04	04032412	27.05.04	64
7	366342	11/03/04	24.03.04	04032386	27.05.04	64
8	366497	11/03/04	24.03.04	04032416	27.05.04	64
9	366789	16/03/04	22.03.04	04031745	27.05.04	64
10	368067	29/03/04	23.04.04	04040726	27.05.04	64
11	368238	30/03/04	23.04.04	04040723	27.05.04	64
12	368840	02/04/04	22.04.04	04040370	27.05.04	66
13	369346	07/04/04	27.04.04	04041445	27.05.04	61
14	370240	20/04/04	06.05.04	04044053	27.06.04	67
15	370861	23/04/04	06.05.04	04050057	27.06.04	60
16	371115	28/04/04	11.05.04	04044083	27.06.04	60
17	371087	27/04/04	11.05.04	04050047	27.06.04	61
					Average	64.1

Table C.1.1. Supplier A - Payment periods achieved for period 03/02/04 to 26/04/04

Supplier B – Credit Period 60 Days						
Transaction No.	Invoice Number	Invoice Date	Date registration on COINS system	Internal registration number	Date Paid	Period of Payment Approx.
1	144101	16/02/04	26.02.04	04022425	22.04.05	65
2	144102	16/02/04	26.02.04	04022426	22.04.05	65
3	144103	16/02/04	26.02.04	04022429	22.04.05	65
4	146871	29/02/04	08.03.04	04024478	06.05.04	67
5	146872	29/02/04	08.03.04	04024477	06.05.04	67
6	149690	13/03/04	23.03.04	04032012	06.05.04	82
7	152728	31/03/04	19.04.04	04035898	06.06.04	66
8	152729	31/03/04	19.04.04	04035902	06.06.04	66
9	156175	22/04/04	04.05.04	04043328	26.06.04	64
10	141516	31/01/04	20.02.04	04020703	22.04.04	81
11	159685	30/04/04	10.05.04	04044765	26.06.04	56
					Average	67.6

Table C.1.2. Supplier B - Payment periods achieved for period 16/02/04 to 30/04/04

Supplier C – Credit Period 60 Days						
Transaction No.	Invoice Number	Invoice Date	Date registration on COINS system	Internal registration number	Date Paid	Period of Payment Approx.
1	SA263070	12/02/04	24.02.04	04021653	29.04.04	62
2	SA263071	12/02/04	24.02.04	04021651	29.04.04	62
3	SA262346	04/02/04	21.02.04	04021127	29.04.04	65
4	NR674714	05/02/04	21.02.04	04021144	29.04.04	65
5	SA262446	05/02/04	21.02.04	04021140	29.04.04	65
6	SA262931	10/02/04	24.02.04	04021668	29.04.04	62
7	SA262822	10/02/04	27.02.04	04022844	29.04.04	59
8	SA263183	13/02/04	24.02.04	04021627	29.04.04	62
9	SA264028	24/02/04	05.03.04	04024238	29.04.04	57
10	NR676127	19/02/04	03.03.04	04023809	29.04.04	57
11	NW345322	23/02/04	05.03.04	04024279	29.04.04	57
12	NR677471	03/03/04	19.03.04	04031496	27.05.04	69
13	SA264408	27/02/04	15.03.04	04025840	29.04.04	45
14	NR678289	04/03/04	22.03.04	04031693	27.05.04	66
15	SA264905	04/03/04	15.03.04	04031108	27.05.04	73
16	NR677820	05/03/04	24.03.04	04032310	27.05.04	64
17	NR677822	05/03/04	24.03.04	04032307	27.05.04	64
18	SA265967	16/03/04	02.04.04	04033955	27.05.04	54
19	SA065131	08/03/04	24.03.04	04032353	27.05.04	65
20	NR679298	19/03/04	01.04.04	04033580	27.05.04	56
21	NR678157	09/03/04	24.03.04	04032334	27.05.04	64
22	NR678158	09/03/04	24.03.04	04032347	27.05.04	64
23	NW346744	09/03/04	24.03.04	04032315	27.05.04	64
24	SA266309	27/03/04	01.04.04	04033518	27.05.04	56
25	SA266308	22/03/04	01.04.04	04033519	27.05.04	56
26	SA266835	26/03/04	22.04.04	04040408	27.05.04	34
27	NR680822	30/03/04	23.04.04	04040801	28.06.04	66
28	NR680281	30/03/04	23.04.04	04040606	28.06.04	66
29	SA267082	30/03/04	23.04.05	04040590	27.05.04	34
30	NR680683	02/04/04	27.04.04	04041287	28.06.04	62
31	NW349289	08/04/04	05.05.04	04043545	28.06.04	54
32	SA267544	05/04/04	27.04.04	04041269	28.06.04	62
33	SA267697	06/04/04	27.04.04	04041248	28.06.04	62
34	SA269016	26/04/04	13.05.04	04045428	28.06.04	44
35	NR682291	05/04/04	13.05.04	04045437	28.06.04	44
36	NW349290	08/04/04	05.05.04	04043542	28.06.04	54
37	SA268548	20/04/04	13.05.04	04045444	28.06.04	44
38	SA268545	20/04/04	13.05.04	04045449	28.06.04	44
39	SA269017	26/04/04	13.05.04	04045427	28.06.04	44
40	SA269019	26/04/04	13.05.04	04045420	28.06.04	44
					Average	57.3

Table C.1.3. Supplier C - Payment periods achieved for period 12/02/04 to 26/04/04

APPENDIX C.2

MATCHING OF PRICES

Supplier A – Matching of Prices				
Transaction	Purchase Order	Value excl VAT	Supplier Invoice	Total excl VAT
1	DM0718/0225	340.63	3671724	340.63
2	DM0718/0225	94.85	363966	115.16
3	DM0718/0225	33.80	366735	33.80
4	DM0718/0285	61.27	365963	61.27
5	DM0718/0285	30.68	366117	91.95
6	DM0718/0289	47.42	366117	47.42
7	DM0718/0289	0.03	366117	15.41
8	DM0718/0289	51.04	366117	51.04
9	DM0718/0289	28.74	366117	81.24
10	DM0718/0289	27.96	366117	27.96
11	DM0718/0289	33.00	366117	33.00
12	DM0718/0289	20.28	366117	20.28
13	DM0718/0290	333.63	366158	333.68
14	DM0718/0293	333.63	366342	333.68
15	DM0718/0295	51.04	366497	51.04
16	DM0718/0299	24.15	366789	24.15
17	DM0718/0299	25.29	366789	25.29
18	DM0718/0310	62.30	368067	51.37
19	DM0718/0314	790.00	368238	790.00
20	DM0718/0324	40.56	368840	40.56
21	DM0718/0324	45.60	368840	45.60
22	DM0718/0334	148.99	369346	148.99
23	DM0718/0334	20.31	369346	20.31
24	DM0718/0344	320.95	370789	320.95
25	DM0718/0352	306.60	370789	306.60
26	DM0718/0352	178.68	370789	178.68
27	DM0718/0352	56.93	370789	56.93
28	DM0718/0352	15.78	370789	15.78
39	DM0718/0328	434.69	370861	163.66
30	DM0718/0328	329.73	370861	125.48
31	DM0718/0328	42.25	370861	24.24
32	DM0718/0359	20.05	371087	18.71
33	DM0718/0359	6.61	371087	6.61
34	DM0718/0352	219.00	371155	219.00

Table C.2.1. Supplier A - Matching of Prices

Supplier C – Matching of Prices				
Transaction	Purchase Order	Value excl VAT	Supplier Invoice	Total excl VAT
1	DM0718/0238	48.02	SA263070	48.02
2	DM0718/0244	161.40	SA263071	173.97
3	DM0718/0226	70.00	SA262346	70.00
4	DM0718/0238	53.80	SA262346	53.80
5	DM0718/0231	425.74	NR674714	425.74
6	DM0718/0229	152.04	SA262446	126.71
7	DM0718/0229	114.66	SA262446	63.35
8	DM0718/0229	16.97	SA262446	16.89
9	DM0718/0242	623.22	SA262931	623.94
10	DM0718/0242	446.88	SA262931	446.88
11	DM0718/0240	623.22	SA262822	623.94
12	DM0718/0248	19.05	SA263183	19.05
13	DM0718/0248	13.97	SA263183	13.97
14	DM0718/0248	20.58	SA264028	20.58
15	DM0718/0253	97.44	NR676127	97.44
16	DM0718/0258	218.99	NW345322	253.88
17	DM0718/0257	1,010.88	NR677471	1,006.20
18	DM0718/0262	241.80	SA264408	187.20
19	DM0718/0262	58.00	SA264408	58.00
20	DM0718/0262	91.00	SA264408	88.40
21	DM0718/0262	120.00	SA264408	120.00
22	DM0718/0267	459.95	NR678289	459.95
23	DM0718/0262	156.00	SA264905	124.80
24	DM0718/0262	119.00	SA264905	115.60
25	DM0718/0262	40.00	SA264905	40.00
26	DM0718/0276	27.20	NR677820	27.20
27	DM0718/0276	19.50	NR677820	19.50
28	DM0718/0276	17.85	NR677820	17.85
29	DM0718/0280	320.00	NR677822	320.00
30	DM0718/0280	49.50	NR677822	49.50
31	DM0718/0280	13.68	NR677822	13.68
32	DM0718/0294	18.40	SA265967	18.40
33	DM0718/0294	9.90	SA265967	9.90
34	DM0718/0294	8.20	SA265967	8.20
35	DM0718/0294	6.10	SA265967	6.10
36	DM0718/0294	11.04	SA265967	11.04
37	DM0718/0294	12.70	SA265967	12.70
38	DM0718/0294	11.96	SA265967	11.96
39	DM0718/0294	26.66	SA265967	26.66
40	DM0718/0294	18.40	SA265967	18.40
41	DM0718/0294	15.24	SA265967	15.24
42	DM0718/0294	174.00	SA265967	174.00
43	DM0718/0294	42.84	SA265967	42.84
44	DM0718/0282	81.60	SA065131	81.60
45	DM0718/0267	191.52	NR679298	191.52
46	DM0718/0280	6.24	NR678157	6.24
47	DM0718/0280	6.85	NR678157	6.85
48	DM0718/0280	82.86	NR678157	82.86
49	DM0718/0279	19.16	NR678158	19.16

Table C.2.2. Supplier C – Matching of Prices

Supplier C – Matching of Prices				
50	DM0718/0281	431.26	NW346744	4310.80
51	DM0718/0281	184.82	NW346744	184.63
52	DM0718/0267	478.80	NR679298	478.80
53	DM0718/0267	446.88	NR679298	446.88
54	DM0718/0267	239.40	NR679298	239.50
55	DM0718/0267	35.40	NR679298	35.40
56	DM0718/0304	63.00	SA266309	61.20
57	DM0718/0304	64.00	SA266309	64.00
58	DM0718/0294	21.50	SA266308	21.50
59	DM0718/0294	9.40	SA266308	9.40
60	DM0718/0279	241.80	-	
61	DM0718/0279	459.95	-	
62	DM0718/0304	49.00	SA266835	47.60
63	DM0718/0316	388.80	NR680822	774.00
64	DM0718/0316	156.00	NR680822	156.00
65	DM0718/0279	16.50	-	
66	DM0718/0316	205.80	NR680281	205.80
67	DM0718/0313	30.36	SA267082	30.36
68	DM0718/0313	30.42	SA267082	30.42
69	DM0718/0322	292.50	NR680683	292.50
70	DM0718/0322	107.60	NR680683	107.60
71	DM0718/0325	299.75	NW349289	301.80
72	DM0718/0313	15.18	SA267544	15.18
73	DM0718/0313	3.38	SA267544	3.38
74	DM0718/0329	13.97	SA267697	13.97
75	DM0718/0329	13.97	SA267697	13.97
76	DM0718/0329	14.30	SA267697	14.30
77	DM0718/0329	20.30	SA267697	20.30
78	DM0718/0329	31.75	SA267697	31.75
79	DM0718/0329	37.50	SA267697	37.50
80	DM0718/0357	9.58	SA269016	50.79
81	DM0718/0321	224.40	NR682291	224.40
82	DM0718/0325	86.22	NW349290	86.22
83	DM0718/0325	0.53	NW349290	0.53
84	DM0718/0325	190.26	NW349290	190.26
85	DM0718/0325	221.97	NW349290	221.97
86	DM0718/0325	357.52	NW349290	351.07
87	DM0718/0349	59.25	SA268548	59.25
88	DM0718/0349	280.90	SA268548	280.80
89	DM0718/0342	140.00	SA268545	140.00
90	DM0718/0342	21.60	SA268545	21.60
91	DM0718/0342	20.96	SA268545	20.96
92	DM0718/0357	30.50	SA269016	30.50
93	DM0718/0357	51.41	SA269016	50.68
94	DM0718/0353	47.20	SA269017	47.20
95	DM0718/0357	61.92	SA269019	61.92

Table C.2.3. Supplier C - Matching of Prices

APPENDIX C.3

EXTENT OF 100% MATCHING OF PURCHASE ORDERS, DELIVERY NOTES AND SUPPLIER INVOICES

Company A

CONTRACT: 0718 Stocking Lane

DELIVERY DATES: FROM 31/01/04 TO 01/05/2004

Supplier	Delivery Date	Ticket No	PO Number	Description	Quantity Delivered	Unit	Value	Quantity	Int Ref	Matching Amount	Invoice	100% Match
Supplier A	02/02/2004	298122	DM0718/0225	UPAT ANCHORS EXPRESS ZP 10/15	5	HN	340.63	5	4020224	340.63	1	Yes
	19/02/2004	300499	DM0718/0255	UPAT NAIL PLUGS UN 6/40/70	8	HN	94.85	8	4021570	115.16	2	No
	19/02/2004	300499	DM0718/0255	DRILL BIT SDS 6x160x105mm	10	EA	33.80	10	4021570	33.80		
	08/03/2004	302517	DM0718/0285	UPAT ANCHORS EXPRESS S/S A1 G303	0.14	HN	61.27	0.14	4031721	61.27	3	No
	08/03/2004	302517	DM0718/0285	DRILL BIT SDS 12x260x205mm	4	EA	30.68	4	4031721	91.95		
	09/03/2004	302673	DM0718/0289	UPAT NAIL PLUGS UN 6/40/70	4	HN	47.42	4	4032410	47.42		
	09/03/2004	302673	DM0718/0289	UPAT NAIL PLUG UN 6/12/47	3	HN	0.03	3	4032410	15.41		
	09/03/2004	302673	DM0718/0289	UPAT NAIL PLUGS UN 8/60/100	3	HN	51.04	3	4032410	51.04		
	09/03/2004	302673	DM0718/0289	DRILL BIT SDS 6x210x155mm	6	EA	28.74	6	4032410	81.24	4	No
	09/03/2004	302673	DM0718/0289	DRILL BIT SDS 8x210x155mm	6	EA	27.96	6	4032410	27.96		
	09/03/2004	302673	DM0718/0289	DRILL BIT SDS 10x210x150mm	6	EA	33.00	6	4032410	33.00		
	09/03/2004	302673	DM0718/0289	DRILL BIT SDS 6x160x105mm	6	EA	20.28	6	4032410	20.28		
	09/03/2004	302723	DM0718/0290	Spit Drill 322 SN:S38900010	1	NO	333.63	1	4032412	333.63	5	Yes
	10/03/2004	302915	DM0718/0293	Spit Drill 322 SN:54878	1	NO	333.63	1	4032386	333.63	6	Yes
	11/03/2004	303089	DM0718/0295	UPAT NAIL PLUGS UN 8/60/100	3	HN	51.04	3	4032416	51.04	7	Yes
	15/03/2004	303366	DM0718/0299	SPIT SC9 25mm BUTT HEAD PINS FOR	3	HN	24.15	3	4031745	24.15	8	Yes
	15/03/2004	303366	DM0718/0299	SPIT CARTRIDGES SPIT P200 for C9	3	HN	25.29	3	4031745	25.29		
	26/03/2004	304721	DM0718/0310	FIXINGS HAMMER-IN NU 6x42ZZ	10	HN	62.30	10	4040726	51.37	9	No
	29/03/2004	304898	DM0718/0314	UPAT ANCHORS EXPRESS S/S A1 G303	10	HN	790.00	10	4040723	790.00	10	Yes
	01/04/2004	305525	DM0718/0324	DRILL BIT SDS 6x160x105mm	12	EA	40.56	12	4040370	40.56	11	Yes
	01/04/2004	305525	DM0718/0324	DRILL BIT SDS 8X160X105mm	12	EA	45.60	12	4040370	45.60		
	06/04/2004	306074	DM0718/0334	UPAT ANCHORS EXPRESS S/S A1 12/1	0.5	HN	148.99	0.5	4041445	148.99	12	Yes
	06/04/2004	306074	DM0718/0334	DRILL BIT SDS 12x210x155mm	3	EA	20.31	3	4041445	20.31		
	18/04/2004	306776	DM0718/0345	200X 300 DIAMOND BITS	2	EA	162.67	2	4044052	162.67	13	Yes
	19/04/2004	306974	DM0718/0344	UPAT ANCHORS EXPRESS S/S A4 G316	0.5	HN	320.95	0.5	4044053	320.95	14	Yes
	23/04/2004	307565	DM0718/0352	THREADED ROD STAINLESS STEEL A2	70	M	306.60	70	4044057	306.60		
	23/04/2004	307565	DM0718/0352	UPAT CHEMICAL MORTAR UPM44 345ml	12	EA	178.68	12	4044057	178.68	15	Yes
	23/04/2004	307565	DM0718/0352	UPAT UPM CHEMICAL MORTAR APPLICA	1	EA	56.93	1	4044057	56.93		
	23/04/2004	307565	DM0718/0352	DRILL BIT SDS 14x210x150mm	2	EA	15.78	2	4044057	15.78		
	23/04/2004	307676	DM0718/0328	SHIMS STRUCTURAL 5mm x 70mm x 70	20	HN	434.69	20	4044083	163.66		
	23/04/2004	307676	DM0718/0328	SHIMS STRUCTURAL 9mm x 70mm x 70	10	HN	329.73	10	4044083	125.48	16	No
	23/04/2004	307676	DM0718/0328	SHIMS STRUCTURAL 2mm x 70mm x 70	5	HN	42.25	5	4044083	24.24		
	27/04/2004	307921	DM0718/0359	UPM 44 CHEMICAL MORTAR BLOW-OUT	1	EA	20.05	1	4050047	18.71	17	No
	27/04/2004	307921	DM0718/0359	UPM 44 BRUSH SET 14mm DIA PK 2	1	EA	6.61	1	4050047	6.61		
	27/04/2004	307988	DM0718/0352	THREADED ROD STAINLESS STEEL A2	50	M	219.00	50	4050083	219.00	16	Yes
										Total	17	11

Table C.3.1. Extent of 100% matching of Supplier A account

EXTENT OF 100% MATCHING OF PURCHASE ORDERS, DELIVERY NOTES AND SUPPLIER INVOICES

Company A

CONTRACT: 0718 Stocking Lane

DELIVERY DATES: FROM 31/01/04 TO 01/05/2004

Supplier	Delivery Date	Ticket No	PO Number	Description	Quantity Delivered	Unit	Value	Quantity	Int Ref	Matching Amount	Invoice	100% Match
Supplier B	02/02/2004	210165	DM0718/0028	26 BLOCKS 100mm SOLID CONCRETE 5N/mm2 IS20	0.86	TH	371.52	0.86	4022425	371.52	1	No
	02/02/2004	210165	DM0718/0028	29 BLOCKS 65mm FILLER SOLID CONCRETE 5N/mm2	0.29	TH	83.52	0.29	4022425	169.34		
	03/02/2004	210741	DM0718/0028	31 MORTAR TROWEL READY GREY	1	M3	83.00	1	4022425	83.00		
	04/02/2004	212073	DM0718/0028	23 CONCRETE 40/N/20 PUMPMIX	7.5	M3	498.75	7.5	4022425	498.75		
	04/02/2004	212086	DM0718/0028	23 CONCRETE 40/N/20 PUMPMIX	7.5	M3	498.75	7.5	4022425	498.75		
	04/02/2004	212103	DM0718/0028	23 CONCRETE 40/N/20 PUMPMIX	7.5	M3	498.75	7.5	4022425	498.75		
	04/02/2004	212120	DM0718/0028	23 CONCRETE 40/N/20 PUMPMIX	7.5	M3	498.75	7.5	4022425	498.75		
	04/02/2004	212166	DM0718/0028	23 CONCRETE 40/N/20 PUMPMIX	7.5	M3	498.75	7.5	4022425	498.75		
	04/02/2004	212262	DM0718/0028	23 CONCRETE 40/N/20 PUMPMIX	7.5	M3	498.75	7.5	4022425	498.75		
	04/02/2004	212292	DM0718/0028	23 CONCRETE 40/N/20 PUMPMIX	7.5	M3	498.75	7.5	4022425	498.75		
	04/02/2004	212304	DM0718/0028	23 CONCRETE 40/N/20 PUMPMIX	7.5	M3	498.75	7.5	4022425	498.75		
	04/02/2004	212305	DM0718/0028	23 CONCRETE 40/N/20 PUMPMIX	7.5	M3	498.75	7.5	4022425	498.75		
	04/02/2004	212346	DM0718/0028	22 CONCRETE 40/N/10 SLUMP 75MM	7.5	M3	495.75	7.5	4022425	498.75		
	04/02/2004	212370	DM0718/0028	23 CONCRETE 40/N/20 PUMPMIX	7.5	M3	498.75	7.5	4022425	498.75		
	04/02/2004	91207	DM0718/0028	23 CONCRETE 40/N/20 PUMPMIX	7.5	M3	498.75	7.5	4022426	498.75	2	Yes
	04/02/2004	91208	DM0718/0028	23 CONCRETE 40/N/20 PUMPMIX	7.5	M3	498.75	7.5	4022426	498.75		
	04/02/2004	91209	DM0718/0028	23 CONCRETE 40/N/20 PUMPMIX	7.5	M3	498.75	7.5	4022426	498.75		
	05/02/2004	212677	DM0718/0028	31 MORTAR TROWEL READY GREY	1	M3	83.00	1	4022425	83.00	1	No
	05/02/2004	213610	DM0718/0028	31 MORTAR TROWEL READY GREY	1	M3	83.00	1	4022425	83.00		
	06/02/2004	213880	DM0718/0028	21 CONCRETE 40/N/20 SLUMP 75MM	5	M3	320.00	5	4022425	320.00		
	06/02/2004	214703	DM0718/0028	21 CONCRETE 40/N/20 SLUMP 75MM	7.5	M3	480.00	7.5	4022425	480.00		
	06/02/2004	215069	DM0718/0028	21 CONCRETE 40/N/20 SLUMP 75MM	4	M3	256.00	4	4022425	256.00		
	07/02/2004	215193	DM0718/0028	23 CONCRETE 40/N/20 PUMPMIX	7.5	M3	498.75	7.5	4022426	498.75	2	Yes
	07/02/2004	215194	DM0718/0028	23 CONCRETE 40/N/20 PUMPMIX	7.5	M3	498.75	7.5	4022426	498.75		
	07/02/2004	215200	DM0718/0028	23 CONCRETE 40/N/20 PUMPMIX	7.5	M3	498.75	7.5	4022426	498.75		
	07/02/2004	215203	DM0718/0028	23 CONCRETE 40/N/20 PUMPMIX	7.5	M3	498.75	7.5	4022426	498.75		
	07/02/2004	215216	DM0718/0028	23 CONCRETE 40/N/20 PUMPMIX	7.5	M3	498.75	7.5	4022426	498.75		
	07/02/2004	215251	DM0718/0028	23 CONCRETE 40/N/20 PUMPMIX	7.5	M3	498.75	7.5	4022426	498.75		
	07/02/2004	215264	DM0718/0028	23 CONCRETE 40/N/20 PUMPMIX	7.5	M3	498.75	7.5	4022426	498.75		
	07/02/2004	215281	DM0718/0028	23 CONCRETE 40/N/20 PUMPMIX	7.5	M3	498.75	7.5	4022426	498.75		
	07/02/2004	215289	DM0718/0028	23 CONCRETE 40/N/20 PUMPMIX	7.5	M3	498.75	7.5	4022426	498.75		
	07/02/2004	215364	DM0718/0028	23 CONCRETE 40/N/20 PUMPMIX	2.5	M3	166.25	2.5	4022426	166.25		
	10/02/2004	218022	DM0718/0028	21 CONCRETE 40/N/20 SLUMP 75MM	4	M3	256.00	4	4022426	256.00		
	11/02/2004	219625	DM0718/0028	21 CONCRETE 40/N/20 SLUMP 75MM	3	M3	192.00	3	4022426	192.00		
	11/02/2004	220236	DM0718/0028	21 CONCRETE 40/N/20 SLUMP 75MM	2	M3	128.00	2	4022426	128.00		
	12/02/2004	220660	DM0718/0028	38 CONCRETE 10/N/20 BATCHED AGGREGATE 10mm	3	M3	36.00	3	4022426	36.00		
	12/02/2004	221186	DM0718/0028	21 CONCRETE 40/N/20 SLUMP 75MM	6	M3	384.00	6	4022426	384.00		
	12/02/2004	221580	DM0718/0028	21 CONCRETE 40/N/20 SLUMP 75MM	8	M3	512.00	8	4022429	512.00	3	Yes
	13/02/2004	222010	DM0718/0028	31 MORTAR TROWEL READY GREY	1	M3	83.00	1	4022429	83.00		
	16/02/2004	224220	DM0718/0028	21 CONCRETE 40/N/20 SLUMP 75MM	4	M3	256.00	4	4022429	256.00		

Table C.3.2. Extent of 100% matching of Supplier B account

EXTENT OF 100% MATCHING OF PURCHASE ORDERS, DELIVERY NOTES AND SUPPLIER INVOICES

Company A

CONTRACT: 0718 Stocking Lane

DELIVERY DATES: FROM 31/01/04 TO 01/05/2004

Supplier	Delivery Date	Ticket No	PO Number	Description	Quantity Delivered	Unit	Value	Quantity	Int Ref	Matching Amount	Invoice	100% Match
Supplier B	16/02/2004	224241	DM0718/0028	31 MORTAR TROWEL READY GREY	0.66	M3	54.78	0.66	4022429	82.18	3	No
	17/02/2004	225158	DM0718/0028	31 MORTAR TROWEL READY GREY	1	M3	83.00	1	4024478	83.00		
	18/02/2004	228212	DM0718/0028	31 MORTAR TROWEL READY GREY	1	M3	83.00	1	4024478	83.00		
	18/02/2004	228246	DM0718/0028	21 CONCRETE 40/N/20 SLUMP 75MM	7.5	M3	480.00	7.5	4024478	480.00		
	18/02/2004	228456	DM0718/0028	26 BLOCKS 100mm SOLID CONCRETE 5N/mm2 IS20	0.82	TH	350.88	0.82	4024478	350.88		
	18/02/2004	228456	DM0718/0028	28 BLOCKS 100mm SOAPBARS CONCRETE 5N/mm2 I.	0.38	TH	249.60	0.38	4024478	249.60		
	18/02/2004	228605	DM0718/0028	21 CONCRETE 40/N/20 SLUMP 75MM	7.5	M3	480.00	7.5	4024478	480.00		
	19/02/2004	229944	DM0718/0028	31 MORTAR TROWEL READY GREY	1	M3	83.00	1	4024478	83.00		
	20/02/2004	230854	DM0718/0028	25 CONCRETE 3:1 SAND & CEMENT	1	M3	74.00	1	4024478	83.00		
	20/02/2004	231459	DM0718/0028	21 CONCRETE 40/N/20 SLUMP 75MM	7.5	M3	480.00	7.5	4024478	480.00	4	Yes
	20/02/2004	231832	DM0718/0028	21 CONCRETE 40/N/20 SLUMP 75MM	3	M3	192.00	3	4024478	192.00		
	23/02/2004	233509	MT DM0718/0028	31 MORTAR TROWEL READY GREY	1	M3	83.00	1	4024478	83.00		
	24/02/2004	234577	DM0718/0028	31 MORTAR TROWEL READY GREY	1.33	M3	110.39	1.33	4024478	110.39		
	25/02/2004	235678	MT DM0718/0028	26 BLOCKS 100mm SOLID CONCRETE 5N/mm2 IS20	1.01	TH	433.44	1.01	4024478	433.44		
	25/02/2004	236517	MT DM0718/0028	21 CONCRETE 40/N/20 SLUMP 75MM	5	M3	320.00	5	4024478	320.00		
	25/02/2004	253592rh	MT DM0718/0028	31 MORTAR TROWEL READY GREY	1.66	M3	137.78	1.66	4024478	137.78		
	26/02/2004	237074	DM0718/0028	31 MORTAR TROWEL READY GREY	1.33	M3	110.39	1.33	4024478	110.39		
	26/02/2004	237354	DM0718/0028	27 BLOCKS 100mm SOLID CONCRETE 10N/mm2 I.S.	1.15	TH	610.56	1.15	4024478	334.08		
	26/02/2004	237354	DM0718/0028	28 BLOCKS 100mm SOAPBARS CONCRETE 5N/mm2 I.	0.77	TH	499.20	0.77	4024477	499.20		
	26/02/2004	237354	DM0718/0028	29 BLOCKS 65mm FILLER SOLID CONCRETE 5N/mm2	0.72	TH	208.80	0.72	4024477	423.36	5	No
	27/02/2004	238986	DM0718/0028	31 MORTAR TROWEL READY GREY	1.33	M3	110.39	1.33	4024477	110.39		
	27/02/2004	239209	DM0718/0028	21 CONCRETE 40/N/20 SLUMP 75MM	2	M3	128.00	2	4024477	128.00		
	01/03/2004	240662	DM0718/0028	31 MORTAR TROWEL READY GREY	1.33	M3	110.39	1.33	4032012	110.39		
	01/03/2004	241127	MT DM0718/0028	26 BLOCKS 100mm SOLID CONCRETE 5N/mm2 IS20	1.01	TH	433.44	1.01	4032012	433.44		
	02/03/2004	243656	DM0718/0028	25 CONCRETE 3:1 SAND & CEMENT	1	M3	74.00	1	4032012	83.00		
	02/03/2004	243792	DM0718/0028	13 CONCRETE 30/N/20 SLUMP 75MM	2	M3	119.00	2	4032012	123.04		
	03/03/2004	244078	DM0718/0028	31 MORTAR TROWEL READY GREY	1	M3	83.00	1	4032012	83.00		
	04/03/2004	245688	DM0718/0028	31 MORTAR TROWEL READY GREY	1.33	M3	110.39	1.33	4032012	110.39		
	04/03/2004	246284	DM0718/0028	26 BLOCKS 100mm SOLID CONCRETE 5N/mm2 IS20	1.06	TH	454.08	1.06	4032012	454.08		
	05/03/2004	247208	DM0718/0028	31 MORTAR TROWEL READY GREY	1.33	M3	110.39	1.33	4032012	110.39	6	No
	08/03/2004	248762	DM0718/0028	31 MORTAR TROWEL READY GREY	1.33	M3	110.39	1.33	4032012	110.39		
	08/03/2004	250157	DM0718/0028	26 BLOCKS 100mm SOLID CONCRETE 5N/mm2 IS20	0.6	TH	258.00	0.6	4032012	258.00		
	08/03/2004	250157	DM0718/0028	28 BLOCKS 100mm SOAPBARS CONCRETE 5N/mm2 I.	0.77	TH	499.20	0.77	4032012	499.20		
	09/03/2004	250499	DM0718/0028	31 MORTAR TROWEL READY GREY	1.33	M3	110.39	1.33	4032012	110.39		
	10/03/2004	252367	DM0718/0028	31 MORTAR TROWEL READY GREY	1.33	M3	110.39	1.33	4032012	110.39		
	10/03/2004	252469	MT DM0718/0028	26 BLOCKS 100mm SOLID CONCRETE 5N/mm2 IS20	1.06	TH	454.08	1.06	4032012	454.08		
	12/03/2004	255466	DM0718/0028	31 MORTAR TROWEL READY GREY	2.33	M3	193.39	2.33	4032012	193.39		
	15/03/2004	256662	DM0718/0028	31 MORTAR TROWEL READY GREY	2.33	M3	193.39	2.33	4035898	193.39	7	Yes
	15/03/2004	258049	DM0718/0028	26 BLOCKS 100mm SOLID CONCRETE 5N/mm2 IS20	0.5	TH	216.72	0.5	4035898	216.72		

Table C.3.3. Extent of 100% matching of Supplier B account

EXTENT OF 100% MATCHING OF PURCHASE ORDERS, DELIVERY NOTES AND SUPPLIER INVOICES
Company A
CONTRACT: 0718 Stocking Lane
DELIVERY DATES: FROM 31/01/04 TO 01/05/2004

Supplier	Delivery Date	Ticket No	PO Number	Description	Quantity Delivered	Unit	Value	Quantity	Int Ref	Matching Amount	Invoice	100% Match
Supplier B	15/03/2004	258049	DM0718/0028	28 BLOCKS 100mm SOAPBARS CONCRETE 5N/mm2 I.	0.58	TH	374.40	0.58	4035898	374.40	7	No
	15/03/2004	258049rh	MT DM0718/0028	29 BLOCKS 65mm FILLER SOLID CONCRETE 5N/mm2	1.15	TH	334.08	1.15	4035898	334.08		
	15/03/2004	258057	DM0718/0028	26 BLOCKS 100mm SOLID CONCRETE 5N/mm2 IS20	1.06	TH	454.08	1.06	4035898	454.08		
	16/03/2004	258360	DM0718/0028	31 MORTAR TROWEL READY GREY	2	M3	166.00	2	4035898	166.00		
	16/03/2004	258744	DM0718/0028	21 CONCRETE 40/N/20 SLUMP 75MM	2	M3	128.00	2	4035898	128.00		
	19/03/2004	260847	DM0718/0028	31 MORTAR TROWEL READY GREY	2	M3	166.00	2	4035898	166.00		
	19/03/2004	261119	DM0718/0028	26 BLOCKS 100mm SOLID CONCRETE 5N/mm2 IS20	0.82	TH	350.88	0.82	4035898	350.88		
	19/03/2004	261119	DM0718/0028	28 BLOCKS 100mm SOAPBARS CONCRETE 5N/mm2 I.	0.38	TH	249.60	0.38	4035898	249.60		
	23/03/2004	263491	DM0718/0028	31 MORTAR TROWEL READY GREY	2	M3	166.00	2	4035898	166.00		
	24/03/2004	265145	DM0718/0028	31 MORTAR TROWEL READY GREY	1.33	M3	110.39	1.33	4035898	110.39		
	24/03/2004	265864	DM0718/0028	21 CONCRETE 40/N/20 SLUMP 75MM	2.5	M3	160.00	2.5	4035898	160.00		
	24/03/2004	266446	DM0718/0028	26 BLOCKS 100mm SOLID CONCRETE 5N/mm2 IS20	1.01	TH	433.44	1.01	4035898	433.44		
	25/03/2004	266895	DM0718/0028	31 MORTAR TROWEL READY GREY	1.66	M3	137.78	1.66	4035898	137.78		
	26/03/2004	268267	DM0718/0028	31 MORTAR TROWEL READY GREY	0.66	M3	54.78	0.66	4035898	82.17		
	26/03/2004	268830	DM0718/0028	31 MORTAR TROWEL READY GREY	2	M3	166.00	2	4035898	166.00		
	27/03/2004	269174	DM0718/0028	26 BLOCKS 100mm SOLID CONCRETE 5N/mm2 IS20	0.58	TH	247.68	0.58	4035902	247.68	8	No
	27/03/2004	269174	DM0718/0028	29 BLOCKS 65mm FILLER SOLID CONCRETE 5N/mm2	2.3	TH	668.16	2.3	4035902	668.16		
	27/03/2004	269174	DM0718/0028	37 BLOCKS 140mm SOAPBAR CONCRETE 5N/mm2 IS2	0.14	TH	109.44	0.14	4035902	115.20		
	29/03/2004	270469	DM0718/0028	31 MORTAR TROWEL READY GREY	1.33	M3	110.39	1.33	4035902	110.39		
	30/03/2004	272205	DM0718/0028	26 BLOCKS 100mm SOLID CONCRETE 5N/mm2 IS20	1.06	TH	454.08	1.06	4035902	454.08		
	31/03/2004	272684	DM0718/0028	31 MORTAR TROWEL READY GREY	2.33	M3	193.39	2.33	4035902	193.39		
	20/04/2004	291778	DM0718/0028	26 BLOCKS 100mm SOLID CONCRETE 5N/mm2 IS20	1.06	TH	454.08	1.06	4043328	454.08	9	Yes
	21/04/2004	198497	DM0718/0028	21 CONCRETE 40/N/20 SLUMP 75MM	4	M3	256.00	4	4020703	256.00	10	Yes
	21/04/2004	292420	DM0718/0028	31 MORTAR TROWEL READY GREY	1.33	M3	110.39	1.33	4043328	110.39	9	Yes
	22/04/2004	294242	DM0718/0028	26 BLOCKS 100mm SOLID CONCRETE 5N/mm2 IS20	1.01	TH	433.44	1.01	4043328	433.44		
	23/04/2004	295388	DM0718/0028	31 MORTAR TROWEL READY GREY	1.66	M3	137.78	1.66	4044765	137.78	11	Yes
	26/04/2004	297473	DM0718/0028	31 MORTAR TROWEL READY GREY	2	M3	166.00	2	4044765	166.00		
	26/04/2004	297670	DM0718/0028	26 BLOCKS 100mm SOLID CONCRETE 5N/mm2 IS20	1.54	TH	660.48	1.54	4044765	660.48		
	28/04/2004	299505	DM0718/0028	31 MORTAR TROWEL READY GREY	2	M3	166.00	2	4044765	166.00		
	28/04/2004	301057	DM0718/0028	31 MORTAR TROWEL READY GREY	1.33	M3	110.39	1.33	4044765	110.39		
	30/04/2004	303936	DM0718/0028	26 BLOCKS 100mm SOLID CONCRETE 5N/mm2 IS20	0.98	TH	423.12	0.98	4044765	423.12		
										Total	11	5

Table C.3.4. Extent of 100% matching of Supplier B account

EXTENT OF 100% MATCHING OF PURCHASE ORDERS, DELIVERY NOTES AND SUPPLIER INVOICES

Company A

CONTRACT: 0718 Stocking Lane

DELIVERY DATES: FROM 31/01/04 TO 01/05/2004

Supplier	Delivery Date	Ticket No	PO Number	Description	Quantity Delivered	Unit	Value	Quantity	Int Ref	Matching Amount	Invoice	100% Match
Supplier C	02/02/2004	saz12005	DM0718/0238	EXPANDED METAL 100mm x 25M GALVANISED	7	RL	48.02	7	4021653	48.02	1	Yes
	02/02/2004	saz12006	DM0718/0244	CEMENT IRISH PORTLAND BAG 25kg	60	EA	161.40	60	4021651	173.97	2	No
	04/02/2004	saz11285	DM0718/0226	SAND WASHED BAG 50kg	40	EA	70.00	40	4021127	70.00	3	Yes
	04/02/2004	saz11285	DM0718/0226	CEMENT IRISH PORTLAND BAG 25kg	20	EA	53.80	20	4021127	53.80		
	05/02/2004	nrz26504	DM0718/0231	SERVICISED SERVISTRIP AH 205 20X5mm x 10	7	RL	425.74	7	4021144	425.74	4	Yes
	05/02/2004	saz11436	DM0718/0229	WHITEDEAL PAO 44x150mm	84	LM	152.04	84	4021140	126.71	5	No
	05/02/2004	saz11436	DM0718/0229	WHITEDEAL PAO 44x75mm	126	LM	114.66	126	4021140	63.35		
	05/02/2004	saz11436	DM0718/0229	WHITEDEAL ROUGH 44x100mm	16.8	LM	16.97	16.8	4021140	16.97		
	10/02/2004	sa857095	DM0718/0242	DPC HYLOAD FIXING STRIP 2.5M + PINS RUBE	6	EA	623.22	6	4021668	623.22	6	Yes
	10/02/2004	SAZ11843	DM0718/0242	DPC HYLOAD No1 600mm x 20m RUBEROID BBA9	84	M2	446.88	84	4021668	446.88		
	10/02/2004	saz262822	DM0718/0240	DPC HYLOAD FIXING STRIP 2.5M + PINS RUBE	6	EA	623.22	6	4022844	623.22	7	Yes
	13/02/2004	sa263183	DM0718/0248	NAILS ROUND WIRE 38MM 25kg Box	1	EA	19.05	1	4021627	19.05	8	Yes
	13/02/2004	sa263183	DM0718/0248	NAILS ROUND WIRE 50MM 25kg box	1	BX	13.97	1	4021627	13.97		
	13/02/2004	sa263183	DM0718/0248	NAILS ROUND WIRE 100MM 25kg box	1	BX	13.97	1	4021627	13.97		
	14/02/2004	saz12965	DM0718/0238	EXPANDED METAL 100mm x 25M GALVANISED	3	RL	20.58	3	4024238	20.58	9	Yes
	19/02/2004	nrz27872	DM0718/0253	MASTIC SILICONE SEALANT WHITE	48	EA	97.44	48	4023809	97.44	10	Yes
	23/02/2004	nwz20160	DM0718/0258	WHITEDEAL ROUGH 44x225mm	96.9	LM	218.99	96.9	4024279	253.88	11	No
	26/02/2004	nr513326	DM0718/0257	DPC HYLOAD No1 450 x 20m RUBEROID BBA95	234	M2	1010.88	234	4031496	1006.20	12	No
	27/02/2004	saz13425	DM0718/0262	DPC HYLOAD MASTIC 310ML TUBE RUBEROID	31	EA	241.80	31	4025840	187.20	13	No
	27/02/2004	saz13425	DM0718/0262	FELT TORCH ON SEAL TORCH 4mm x 1m x 10m	2	RL	58.00	2	4025840	58.00		
	27/02/2004	saz13425	DM0718/0262	PIPE STOPPER/TESTER 100mm+ ENDCAP/NIPPLE	13	EA	91.00	13	4025840	88.40		
	27/02/2004	saz13425	DM0718/0262	PIPE STOPPER/TESTER 150mm+ENDCAP/NIPPLE	15	EA	120.00	15	4025840	120.00		
	04/03/2004	nrz29445	DM0718/0267	DPC HYLOAD FIXING STRIP 2.0M + PINS RUBE	5	EA	459.95	5	4031693	459.95	14	Yes
	04/03/2004	saz13910	DM0718/0262	DPC HYLOAD MASTIC 310ML TUBE RUBEROID	20	EA	156.00	20	4031108	124.80	15	No
	04/03/2004	saz13910	DM0718/0262	PIPE STOPPER/TESTER 100mm+ ENDCAP/NIPPLE	17	EA	119.00	17	4031108	115.60		
	04/03/2004	saz13910	DM0718/0262	PIPE STOPPER/TESTER 150mm+ENDCAP/NIPPLE	5	EA	40.00	5	4031108	40.00		
	05/03/2004	nrz29595	DM0718/0276	BRUSH YARD C/W HANDLE (M14)	4	EA	27.20	4	4032310	27.20	16	Yes
	05/03/2004	nrz29595	DM0718/0276	BRUSH SOFT 300mm COMPLETE + HANDLE	6	EA	19.50	6	4032310	19.50		
	05/03/2004	nrz29595	DM0718/0276	LEVEL ALUMINIUM 1200mm TALA	1	EA	17.85	1	4032310	17.85		
	05/03/2004	nrz29622	DM0718/0280	DPC HYLOAD MASTIC 310ML TUBE RUBEROID	40	EA	312.00	40	4032307	312.00	17	Yes
	05/03/2004	nrz29622	DM0718/0280	HYLOAD RUBBERFLEX BITUMEN JOINT SEALENT	30	EA	49.50	30	4032307	49.50		
	05/03/2004	nrz29622	DM0718/0280	HYLOAD PRIMER SELFADHESIVE 1L	4	EA	13.68	4	4032307	13.68		
	06/03/2004	saz14935	DM0718/0294	HAMMERS LUMP 3LB PEDDINGHANAS / BULLOCK	2	EA	18.40	2	4033955	18.40	18	Yes
	06/03/2004	saz14935	DM0718/0294	CHISEL COLD 18x250mm ECLIPSE or SIMILAR	2	EA	9.90	2	4033955	9.90		
	06/03/2004	saz14935	DM0718/0294	TROWEL POINTING 150mm TALA	2	EA	8.20	2	4033955	8.20		
	06/03/2004	saz14935	DM0718/0294	TROWEL GAUGING 175mm	1	EA	6.10	1	4033955	6.10		

Table C.3.5. Extent of 100% matching of Supplier C account

EXTENT OF 100% MATCHING OF PURCHASE ORDERS, DELIVERY NOTES AND SUPPLIER INVOICES

Company A

CONTRACT: 0718 Stocking Lane

DELIVERY DATES: FROM 31/01/04 TO 01/05/2004

Supplier	Delivery Date	Ticket No	PO Number	Description	Quantity Delivered	Unit	Value	Quantity	Int Ref	Matching Amount	Invoice	100% Match
Supplier C	06/03/2004	saz14935	DM0718/0294	FLOAT STEEL - TROWEL 275mm RAGNI	2	EA	11.04	2	4033955	11.04	18	Yes
	06/03/2004	saz14935	DM0718/0294	SNIPS STEEL FIXERS "KNIPPEX"	1	EA	12.70	1	4033955	12.70		
	06/03/2004	saz14935	DM0718/0294	STANLEY KNIFE RETRACTABLE BLADE	2	EA	11.96	2	4033955	11.96		
	06/03/2004	saz14935	DM0718/0294	LEVEL ALUMINIUM 1200 RABONE STANLEY	1	EA	26.66	1	4033955	26.66		
	06/03/2004	saz14935	DM0718/0294	MASTIC GUN SKELETON	4	EA	18.40	4	4033955	18.40		
	06/03/2004	saz14935	DM0718/0294	LINE BUILDERS HD ORANGE 0.5kg ROLL 350ft	2	EA	15.24	2	4033955	15.24		
	06/03/2004	saz14935	DM0718/0294	FELT TORCH ON SEAL TORCH 4mm x 1m x 10m	6	RL	174.00	6	4033955	174.00		
	06/03/2004	saz14935	DM0718/0294	MEASURING TAPE 5M x 18mm BLADE STANLEY	3	EA	42.84	3	4033955	42.84		
	08/03/2004	saz14132	DM0718/0282	SHOVEL POINTED DARBY (LONG HANDLE TYPE)	6	EA	81.60	6	4032353	81.60	19	Yes
	09/03/2004	513788	DM0718/0267	DPC HYLOAD No1 600mm x 20m RUBEROID BBA9	36	M2	191.52	36	4033580	191.52	20	Yes
	09/03/2004	nrz29838	DM0718/0280	PAINT BRUSH 25mm STANDARD DOSCO	6	EA	6.24	6	4032334	6.24	21	Yes
	09/03/2004	nrz29838	DM0718/0280	PAINT BRUSH CLEANER 1LTR	1	L	6.85	1	4032334	6.85		
	09/03/2004	nrz29838	DM0718/0280	LOCKSET BASTA STANDARD HANDLES FOR LOCKS	6	EA	82.86	6	4032334	82.86		
	09/03/2004	nrz29839	DM0718/0279	NAILS BAT SQUARE TWISTED SHERADISED 32mm	2	EA	19.16	2	4032347	19.16	22	Yes
	09/03/2004	nwz21678	DM0718/0281	WHITEDEAL ROUGH 44x150mm STRUCTURAL GRAD	285.6	LM	431.26	285.6	4032315	430.80	23	No
	09/03/2004	nwz21678	DM0718/0281	WHITEDEAL ROUGH 44x150mm STRUCTURAL GRAD	122.4	LM	184.63	122.4	4032315	184.63		
	12/03/2004	saz15311	DM0718/0304	PIPE STOPPER/TESTER 100mm+ ENDCAP/NIPPLE	9	EA	63.00	9	4033518	63.00	24	Yes
	12/03/2004	saz15311	DM0718/0304	PIPE STOPPER/TESTER 150mm+ENDCAP/NIPPLE	8	EA	64.00	8	4033518	64.00		
	22/03/2004	saz15310	DM0718/0294	CHISEL BOLSTER 100mm ECLIPSE or SIMILAR	2	EA	21.50	2	4033519	21.50	25	Yes
	22/03/2004	saz15310	DM0718/0294	SNIPS TIN TYPE 10" TALA	1	EA	9.40	1	4033519	9.40		
	26/03/2004	saz15773	DM0718/0304	PIPE STOPPER/TESTER 100mm+ ENDCAP/NIPPLE	7	EA	49.00	7	4040408	47.60	26	No
	30/03/2004	nrz31968	DM0718/0316	DPC HYLOAD HOUSEBUILDER WIDTH 450x20M	90	M2	388.80	90	4040801	774.00	27	No
	30/03/2004	nrz31968	DM0718/0316	DPC HYLOAD MASTIC 310ML TUBE RUBEROID	20	EA	156.00	20	4040801	156.00		
	30/03/2004	nrz31969	DM0718/0316	EXPANDED METAL 100mm x 25M GALVANISED	30	RL	205.80	30	4040606	205.80	28	Yes
	30/03/2004	saz16058	DM0718/0313	DPC PVC 150mm x 30m to I.S. 57 PART 2 19	12	RL	30.36	12	4040590	30.36	29	Yes
	30/03/2004	saz16058	DM0718/0313	DPC PVC 100mm x 30m to I.S. 57 PART 2 19	18	RL	30.42	18	4040590	30.42		
	02/04/2004	nrz32465	DM0718/0322	SLATES TEGRAL SUPERCEM 300mm x 600mm	300	EA	292.50	300	4041287	292.50	30	Yes
	02/04/2004	nrz32465	DM0718/0322	CEMENT IRISH PORTLAND BAG 25kg	40	EA	107.60	40	4041287	107.60		
	02/04/2004	nwz24198	DM0718/0325	LEAD CODE 4 LB to B.S.1178 1982	275	KG	299.75	275	4043545	301.80	31	No

Table C.3.6. Extent of 100% matching of Supplier C account

EXTENT OF 100% MATCHING OF PURCHASE ORDERS, DELIVERY NOTES AND SUPPLIER INVOICES

Company A

CONTRACT: 0718 Stocking Lane

DELIVERY DATES: FROM 31/01/04 TO 01/05/2004

Supplier	Delivery Date	Ticket No	PO Number	Description	Quantity Delivered	Unit	Value	Quantity	Int Ref	Matching Amount	Invoice	100% Match
Supplier C	05/04/2004	saz16519	DM0718/0313	DPC PVC 150mm x 30m to I.S. 57 PART 2 19	6	RL	15.18	6	4041269	15.18	32	Yes
	05/04/2004	saz16519	DM0718/0313	DPC PVC 100mm x 30m to I.S. 57 PART 2 19	2	RL	3.38	2	4041269	3.38		
	06/04/2004	saz16626	DM0718/0329	NAILS ROUND WIRE 50MM 25kg box	1	BX	13.97	1	4041248	13.97	33	Yes
	06/04/2004	saz16626	DM0718/0329	NAILS ROUND WIRE 75MM 25kg box	1	BX	13.97	1	4041248	13.97		
	06/04/2004	saz16626	DM0718/0329	SCREWS SPAX 4x40mm Box 200	5	BX	14.30	5	4041248	14.30		
	06/04/2004	saz16626	DM0718/0329	SCREWS SPAX 4x50mm Box 200	5	BX	20.30	5	4041248	20.30		
	06/04/2004	saz16626	DM0718/0329	SCREWS SPAX 4x60mm Box 200	5	BX	31.75	5	4041248	31.75		
	06/04/2004	saz16626	DM0718/0329	SCREWS SPAX 4x70mm Box 200	5	BX	37.50	5	4041248	37.50		
	06/04/2004	saz17960	DM0718/0357	NAILS BAT SQUARE TWISTED SHERADISED 32mm	1	EA	9.58	1	4045428	50.79	34	No
	08/04/2004	294059	DM0718/0321	NAIL PLATES BAT 114x152mm	4	HN	224.00	4	4045437	224.00	35	Yes
	08/04/2004	nwz24203	DM0718/0325	NAILS BAT SQUARE TWISTED SHERADISED 32mm	9	EA	86.22	9	4043542	86.22	36	No
	08/04/2004	nwz24203	DM0718/0325	JOIST HANGERS BAT SPEEDY STANDARD WIDTH	53	EA	0.53	53	4043542	0.53		
	08/04/2004	nwz24203a	DM0718/0325	WHITEDEAL STRUCTURAL GRADED TIMBER C16	126	M	190.26	126	4043542	190.26		
	08/04/2004	nwz24203a	DM0718/0325	WHITEDEAL STRUCTURAL GRADED TIMBER C16	147	M	221.97	147	4043542	221.97		
	08/04/2004	nwz24203a	DM0718/0325	LEAD CODE 4 LB to B.S.1178 1982	328	KG	357.52	328	4043542	351.07		
	20/04/2004	sa858345	DM0718/0349	JOINT SEALANT RUBBERFLEX BITUMEN (TUBE)	25	EA	59.25	25	4045444	59.25	37	Yes
	20/04/2004	sa858345	DM0718/0349	DPC HYLOAD MASTIC 310ML TUBE RUBEROID	36	EA	280.80	36	4045444	280.80		
	20/04/2004	saz17487	DM0718/0342	POLYTHENE 1000GAUGE VERY HEAVY PROTECTIO	10	RL	140.00	10	4045449	140.00	38	Yes
	20/04/2004	saz17487	DM0718/0342	RIPPING BAR STANLEY 600MM	2	EA	21.60	2	4045449	21.60		
	20/04/2004	saz17487	DM0718/0342	HAMMER CLAW STEEL HANDLE - STANLEY 16oz	2	EA	20.96	2	4045449	20.96		
	26/04/2004	saz17961	DM0718/0353	DPC HYLOAD ADHESIVE 500ml RUBEROID	8	EA	47.20	8	4045427	47.20	39	Yes
	26/04/2004	saz18062	DM0718/0357	SPLICE PLATE BAT L61 18 x 16 x 400mm	8	EA	61.92	8	4045420	61.92	40	Yes
										Total	40	28

Table C.3.7. Extent of 100% matching of Supplier C account

APPENDIX D

QUESTIONNAIRE SURVEY 2

ICT Purchasing Awareness and Take-Up Study 2004
Irelands Top 100 Companies

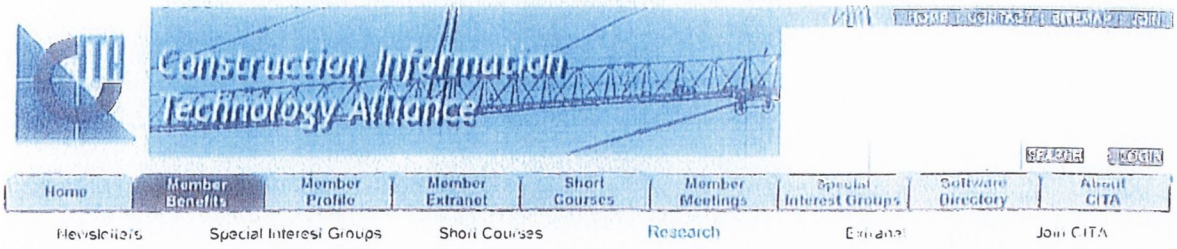
Appendix D.1 – The Online Survey

Appendix D.2 - Survey Sample

Appendix D.3 – Analysis and Presentation of Results

APPENDIX D.1

THE ONLINE SURVEY



ICT Purchasing Study 2004

Irelands 100 Top Companies Study 2004

Irelands 100 Top Companies
ICT Purchasing Awareness and Take-Up On-Line Study 2004

* Denotes required field, Please answer questions 1-14 below

Name *			
Position *			
Company *			
Nature of your business *	Architect		
Address *			
Phone *			
Fax *			
E-mail address *			
Please indicate company size by turnover *	Small < € 10m	Medium € 10-40m	Large > € 40m

For the purposes of this study ICT denotes any computer hardware or software that collects, processes, stores, analyses and disseminates information for a specific business purpose.

Return to Top

1. **In your opinion how would you rate the current level of ICT usage in your business sector?**

   Poor

   Satisfactory

   Good

   Very Good

Please provide commentary to justify your selection

2. Please indicate how you would rate the current level of ICT usage in your organisation's business-to-business purchasing transactions.

   No Use

   Little Use

   Some Use

   Moderate Use

   Regular or Constant Use

   Please give examples, if appropriate

3. Please indicate your willingness to consider applying existing technologies in your business-to-business transactions.
   For the purposes of this question "existing technologies" includes the Internet, Extranets, Electronic Catalogs, Bar Coding, Smart Cards, Radio Frequency ID, Enterprise Resource Planning Systems, Hand Held Computers, Electronic Data Interchange, Extensible Mark-Up Language and Electronic Funds Transfer.

   Unwilling to consider at present moment

   Willing to consider applying existing technologies

   Currently applying existing technologies in purchasing processes

   Please provide commentary to justify your selection

4. In your opinion, has eCommerce significantly affected the strategies of businesses in this country?

   Agree

   Disagree

   Please provide commentary to justify your selection

5. To what extent does you company make use of the following technologies in the sales/purchasing of materials?

	Always	Most times	Sometimes	Very little	Not yet used
Internet					
Extranets					
Electronic Catalogs					
Bar Coding					
Smart Cards					
Radio Frequency ID					

Enterprise Resource Planning Systems (ERP)

Hand Held Computers

Electronic Date Interchange (EDI)

Extensible Mark-Up Language (XML)

Electronic Funds Transfer (EFT)

Other Technologies or experiences with the above (please state below)

6. How is your company's involvement in eBusiness and the use of the Internet expected to change within the next 3 years?

   For the purposes of this question eBusiness denotes a broad definition of electronic commerce that refers not just to buying and selling, but also to servicing customers, collaborating with business partners, and conducting electronic transactions within an organisation.

   Great increase expected

   Little increase expected

   No increase expected

7. Does your company have concerns over adopting a web-based strategy for future business-to-business purchasing transactions?

   Yes

   No

   If Yes, what are / have been your company's concerns with regard to adopting a web-based strategy for business-to-business purchasing transactions?

	Most concerned	Moderately concerned	Not concerned
Lack of awareness or knowledge of Internet capabilities			
Customer / supplier may not possess adequate eBusiness capabilities			
Lack of available funding			
Total costs			
Security of sensitive data			
Interoperability between transaction parties			
Legal implications			
Training and inability to use technology			
Need for critical mass buy-in			

Other concerns (please state below)

Driving Forces

8. Please rank in order (1-10) the following factors which attract, or are likely to attract your organisations to apply existing technologies in purchasing.

Reducing paperwork (orders, invoices and delivery dockets)	1
Avoidance of re-keying information into computer systems	1
Saving manpower in processing invoices and other information	1
Fewer errors in recording and handling information	1
Reduced cost of capturing data	1
Improved accessibility to time and cost data: providing real time information	1
Ability to contribute to data interchange in a national standard format	1
Service differentiation from competitors	1
Clients who may encourage or stipulate the use of ICT in purchasing	1
Competitor organisations who may have applied ICT in purchasing processes	1

Other factors (please state and rank 1-10)

Barriers

9. Please rank in order (1-6) the barriers which undermine the use of ICT within your organisation.

A lack of awareness of ICT deployment in purchasing	1
Development costs are prohibitive (hardware, software and training)	1
Technology is not yet reliable enough for use in construction environment	1
Potential benefits of electronic purchasing are not likely to be sufficient to justify investments	1
Uncertainty about how to measure the costs and benefits of such investments	1
Employees are likely to resist the introduction of new technologies	1

Other concerns (please state below)

10. Please rank in order (1-6) the barriers, which undermine the use of ICT in your business sector.

There is a general lack of awareness of ICT capabilities in our industry and its potential benefits to the overall supply chain	1
There is a high incidence of technologically conservative organisations in our industry	1
The temporary nature of relationships between organisations results in an unwillingness to invest in ICT which may only be short lived	1
There is no motivation for organisations to apply ICT in purchasing	

when other parties will benefit	1
There are too many products and components to make the adoption of ICTs in purchasing widespread	1
There is a general lack of leadership from the government to actively promote the use of ICT in procurement	1

Other factors (please state and rank 1-6)

Future Developments

11. Please indicate your company's position in regard to the following statements

	Strongly Agree	Agree	No opinion	Disagree	Strongly Disagree
There is a general awareness in our company of the benefits of deploying existing technologies in purchasing processes					
A standard should be introduced for electronic data interchange in business-to-business transactions in our business sector					
There is an increase in IT literacy and familiarity of electronic purchasing in our company					
Longer term relationships between supply chain organisations, allow development costs and on-going advantages to be shared					
Closer collaboration is required between businesses in our business sector					
Business leaders should stipulate the use of electronic purchasing in future business-to-business transactions with suppliers					
Time consuming and inappropriate search methods for the mass of information available on the Internet, discourage one from making full of the technology					
Involvement in e-business is of vital importance for improving efficiency and effectiveness along the supply chain					
Customers/Manufacturers/Suppliers are very keen on doing business with our company electronically via the Internet					

Thank you for helping me in this research project

Click here to submit the survey

APPENDIX D.2
2004 ICT Construction Purchasing and Awareness and Take-Up Study
Top 100 Companies in Ireland by Turnover
Source: Business and Finance Top 1000 Companies in Ireland 2004

Company	Address	Contact	Role	Responded
Aer Lingus Group plc	Head Office, Dublin Airport, Dublin	Anne Bradley	IT Manager	Yes
Aer Rianta CPT	Dublin Airport, Dublin	Adrain Reid	MD	Yes
AGI - Media Packaging	9/10 Broomhill Rd, Tallaght, D24	Jimy Hegarty	IT Manager	Yes
AIBP	c/o 14 Castle St., Ardee, Co. Louth	Alan Scanlan	IT Manager	Yes
Ardagh plc	South Banck Rd, Ringsend, D4		IT Manager	
Ascon Ltd	Kill, Co. Kilare		IT Manager	Yes
Barlo Group plc	Alexandra Hse, Sweepstakes, Ballsbridge, D4		IT Manager	
Benchmark Electronics	Blanchardstown Ind. Pk, Blanchardstown, D15		IT Manager	
BMC Software	Ballymoss Hse, Carmen Hall Rd, Foxrock, D18		IT Manager	Yes
Bord na Mona plc	Main St, Newbridge, Co Kildare	Brendan Sheridan	IT Manager	Yes
Boston Scientific Ireland Ltd	Ballybrit Business Pk, Galway	Martin Anderson	IT Manager	Yes
BWG Foods Ltd	Greenhills Rd, Walkinstown, D12	Fergus O'Hehir	MD	Yes
Cadence Design Systems (Ireland) Ltd	Block P3, East Point Business Pk, Fairview, D3	Brendan Pollard	IT Manager	
Cantrell & Cochrane Group Ltd	Kylemore Park South, Ballfermot, D10	Pat Rowan	IT Manager	Yes
Clarity Distribution	Clarity Hse, Belgard Rd, Tallaght, D24	Seamus McArdle	IT Manager	
Coca-Cola Bottlers Ireland	Western Ind Estate, Naas Rd, D12	Eithne Shine	IT Manager	
Connacht Court	Henry St, Galway	Mary Hannelly	IT Manager	Yes
Connacht Gold Co-Op	Tubbercurry, Co.Sligo	Edmund Grey	IT Manager	Yes
Connect Electronics Ltd	Unit 2A, Century Business Pk, Finglas, D11	Sinead Doyle	IT Manager	
ConocoPhillips Whitegate Refinery	Whitegate, Midleton, Cork	Patrick Harris	IT Manager	
CRH plc	Belgard Castle, Belgard Road,Clondalkin, D2		IT Manager	Yes
Dairygold Co-Operative Society Ltd	Fermoy Rd,Mitchelstown, Cork	Bill O'Mara	IT Manager	
Dawn Farm Foods Ltd	The Mauldins, Naas, Co. Kildare	Kevin O'Neill	IT Manager	Yes
DCC plc	DCC House,Brewery Road, Stillorgan, Dublin	Donal Donnelly	IT Manager	
Dell Products Europe BV	Raheen Industrial Estate, Limerick	Maureen McNamar	IT Manager	Yes
Eason & Son Ltd	80 Middle Abbey St, D1	Terry Carberry	IT Manager	Yes
eircom	Corporate Head Office, St. Stephens Green, D2	Hanna Hartnett	IT Manager	
Elan Corporation plc	Lincoln Hse, Lincoln Place, D2	Owen O'Connor	IT Manager	
Esat BT	Grand Canal Plaza, Upper Grand Canal St, D4		IT Manager	
ESB International	Stephen Court,18-21 St Stephens Green, D2		IT Manager	
Frank Keane (Holdings)	John F Kennedy Drive, Naas Rd, D12	Paul Ancker	IT Manager	Yes
Fyffes Group Ireland plc	1 Beresford St., D7	Paddy Kenneally	IT Manager	
Glanbia plc	Glanbia House, Kilkenny	Fergal Boyle	IT Manager	Yes
Glenculien Holdings	Glenculien Hse, Kylemore Rd, D10		IT Manager	
Gowan Group	1 Herbert Avenue, D4	Paul Hamill	Director	Yes
Grafton Group plc	Heron Hse, Corrig Rd, Sandyford Ind Est, D18		IT Manager	Yes
Green Isle Ltd	IDA Ind Est, Monread Rd, Naas, Kildare	Richard Hoyle	IT Manager	
Greencore Group plc	St.Stephens Green Hse, Earlsfort Terrace, D2	Tom Tracey	IT Manager	Yes
Heiton Holdings Ltd	Ashfield, Naas Rd, Clondalkin, D22		IT Manager	Yes
IAWS Group plc	151 Thomas St., D8	Dennis Moran	IT Manager	
IBM Ireland Ltd	Oldbrook Hse, 24-32 Pembroke Rd, Ballsbridge, D4	Robert O'Boyle	IT Manager	
Independent News and Media plc	Independent Hse, 2023 Bianconi Avenue, Citywest Business P	Gerry Wild	IT Manager	
Intel Ireland Ltd	Collinstown Ind Pk, Leixlip, Co. Kildare	Shane Hogan	IT Manager	Yes
Irish Dairy Board	Grattan House, Lower Mount St, D2	John O'Moore	IT Manager	Yes
John Sisk & Son Ltd	Wilton Works, Naas Rd, Clondalkin, D22		IT Manager	
Johnson Bros Ltd	Ballmount Av, Walkinstown, D12	Ian Sheilds	MD	Yes
Johnsondiversey Ltd	Jamestown Rd, Finglas, D11	Brian O'Sullivan	Not Confirmed	Yes
Keelings Ltd	Roslin , St Margarets, County Dublin	Denis Boland	Not Confirmed	Yes
Kerry Group plc	Princes Street, Tralee, Co. Kerry	Conor Kavanagh	Not Confirmed	Yes
Lakeland DairiesCo-Operative Society Ltd	Killeshandra, Cavan	Turlock Farley	Sales	Yes
LM Ericsson Holdings Ltd	Beech Hill, Clonskeagh, D4		IT Manager	
Lucent Technologies Ltd	Blanchardstown Ind. Pk, Blanchardstown, D15	Philip Murtagh	IT Manager	Yes
McInerney Holdings plc	29 Kenilworth Sq, Rathgar, D6		IT Manager	
Medtronic Vascular Galway Ltd	Parkmore Business Pk West, Galway		QS	
Mercury Holdings plc	Mercury Hse, Sandyford Ind Estate, Foxrock, D18		IT Manager	
Microsoft Ireland (European OperationsCentre)	Blackthorn Road,Sandyford Industrial Estate, D18	Joe Byrne	Director	
Musgrave Group	Airport Road, Cork	Ger O'Flynn	Director	Yes
O2 Communications (Irl) Ltd	76 Baggot St. Lower, D2	Gary Hope	IT Manager	
Paddy Power plc	Airton Hse, Airton Rd, Tallaght, D24	Patricia Doran	IT Manager	Yes
Pfizer Island Pharmaceuticals	Ringaskiddy, API Plant, PO Box 140, Cork	Andrew Corbett	Gary Cathal	
Pierce Contracting Ltd	Birmayne Hse, Mullhuddart, D15		IT Manager	Yes
PJ Carroll & Co Ltd	Burton Hall Pk, Sandyford Ind Estate, D18	Brendan Long	IT Manager	
Ryanair plc	Corporate Head Office, Dublin Airport, Dublin	Bronagh Kernan	IT Manager	Yes
Smurfit Ireland	Ballmount Av, Walkinstown, D12	Paul Cash	Not Confirmed	Yes
Statoil Ireland plc	Unit 6, Georges Dock, IFSC, D1	Sean Dennsion	MD	Yes
Tedcastles Oil Products Ltd	TOP Hse, Promenade Rd, D3	Seamus McGovern	Not Confirmed	Yes
The Concentrate Manufacturing Co.of Ireland	Little Island Ind Estate, Little Island, Cork	Paul O'Callaghan	Director	
The Dawn Group	Grannagh, Waterford	Shane Slattery	TBA	
Thermo King Europe	Monivea Rd, Merview, Galway		Director	
Unilever Best Foods Ltd	Whitehall Rd, Rathfarnham, D14	Tom Rossiter	IT Manager	
UniPhar plc	Belgard Rd, Tallaght, D24	Eugene Connell	IT Manager	
United Drug plc	United Drug Hse, Belgard Rd, Tallaght, D24	Johnny Phillips	IT Manager	
Vodafone	Mountain View, Leopardstown, D18	Shane Colcough	IT Manager	
Waterford Wedgewood plc	Kilbarry, Waterford	Carl Phelan	IT Manager	Yes
Xilinx Ireland	Logic Drive, Citywest Business Campus, Saggart, D24	Martin Smith	IT Manager	

APPENDIX D.3
ICT PURCHASING AWARENESS AND TAKE-UP STUDY 2004
IRELANDS TOP 100 COMPANIES
ANALYSIS AND PRESENTATION OF RESULTS

	In your opinion how would you rate the current level of ICT usage in Irish construction industry?			
		Good	**Satisfactory**	**Poor**
Q1	Airline	100%	0%	0%
	Information Technology	100%	0%	0%
	Manufacturing	86%	14%	0%
	Warehousing & Distribution	76%	12%	12%
	Food & Drink processing	75%	25%	0%
	Construction	0%	60%	40%

Table D.3.1. Current level of ICT usage

	Please indicate how you would rate the current level of ICT usage in your organisations business-to-business purchasing transactions.			
		Regular/ Constant	**Some Use**	**No Use**
Q2	Airline	100%	0%	0%
	Information Technology	100%	0%	0%
	Warehousing & Distribution	75%	25%	0%
	Food & Drink processing	50%	50%	0%
	Manufacturing	49%	51%	0%
	Construction	20%	80%	0%

Table D.3.2. Current level of ICT usage in B2B purchasing transactions

	Please indicate your willingness to consider applying existing technologies in your business-to-business transactions.			
		Currently applying existing technologies	**Willing to consider applying existing technologies**	**Unwilling to consider at the present moment**
Q3	Airline	100%	0%	0%
	Warehousing & Distribution	75%	25%	0%
	Food & Drink processing	75%	25%	0%
	Information Technology	75%	25%	0%
	Manufacturing	57%	43%	0%
	Construction	20%	80%	0%

Table D.3.3. Willingness to consider applying existing technologies

	Would you agree that e-commerce has significantly affected the strategies of businesses in this country?		
		Agree	**Disagree**
Q4	Airline	100%	0%
	Information Technology	100%	0%
	Food & Drink processing	75%	25%
	Manufacturing	71%	29%
	Warehousing & Distribution	63%	37%
	Construction	60%	40%

Table D.3.4. Impact of e-commerce on business strategies

	To what extent does you company make use of the following technologies in the sales/purchasing of construction materials?						
	Existing Technology	**Always**	**Most Times**	**Sometimes**	**Very Little**	**Not yet used**	**Total**
Q5	Enterprise Resource Planning Systems (ERP)	45%	18%	8%	8%	21%	100%
	Bar coding	26%	26%	18%	16%	14%	100%
	Internet	26%	13%	37%	21%	3%	100%
	Electronic Date Interchange (EDI)	21%	26%	37%	11%	5%	100%
	Electronic Funds Transfer (EFT)	18%	37%	37%	3%	5%	100%
	Extranets	18%	11%	42%	16%	13%	100%
	Hand Held Computers	13%	16%	34%	13%	24%	100%
	Extensible Mark-Up Language (XML)	13%	11%	24%	18%	34%	100%
	Electronic Catalogs	11%	21%	42%	13%	13%	100%
	Radio Frequency ID	3%	8%	18%	11%	60%	100%
	Smart Cards	0%	8%	8%	34%	50%	100%

Table D.3.5. Overall use of technologies in sales/purchasing

	How is your company's involvement in eBusiness and the use of the Internet expected to change within the next 3 yrs?			
		Great increase	**Little increase**	**No increase expected**
Q6	Airline	100%	0%	0%
	Information Technology	75%	25%	0%
	Manufacturing	71%	29%	0%
	Construction	60%	40%	0%
	Warehousing & Distribution	50%	38%	12%
	Food & Drink processing	50%	25%	25%

Table D.3.6. Expectant change in the use of Internet and eBusiness over the next 3 years

	Does your company have concerns over adopting a web-based strategy for future business-to-business purchasing transactions?		
		Yes	**No**
Q7	Warehousing & Distribution	63%	37%
	Construction	60%	40%
	Airline	33%	67%
	Manufacturing	14%	86%
	Food & Drink processing	13%	87%
	Information Technology	0%	100%

Table D.3.7. Concern over a web-based B2B strategy

	If Yes, to question 7, what are / have been your company's concerns with regard to adopting a web-based strategy for business-to-business purchasing transactions?			
		% Overall		
	Cocern	**Most concerned**	**Moderately concerned**	**Not concerned**
Q7	Security of sensitive data	70%	15%	15%
	Need for critical mass buy-in	60%	10%	30%
	Inadequate eBusiness capabilities	50%	30%	20%
	Interoperability between transaction parties	30%	50%	20%
	Legal implications	30%	30%	40%
	Total costs	30%	10%	60%
	Lack of available funding	20%	40%	40%
	Training and inability to use technology	0%	30%	70%
	Lack of awareness	0%	40%	60%

Table D.3.8. Concerns over a web-based strategy

The figures presented in Table D.3.9 , D.3.10 and D.3.11 refer to the weighted number of responses and ranking from 1-10 selected by respondents.

Rank Correlation - Driving Forces to Adoption

		Please rank in order (1-10) the following factors, which attract or are likely to attract your organisations to apply existing technologies in B2B purchasing.																								
			1		2		3		4		5		6		7		8		9		10		Total			Ranking		
			Other Sectors	Construction	Other Sectors	Construction	Other Sectors	Construction	Other Sectors	Construction	Other Sectors	Construction	Other Sectors	Construction	Other Sectors	Construction	Other Sectors	Construction	Other Sectors	Construction	Other Sectors	Construction	Other Sectors	Construction	Overall	Other Sectors	Construction	Overall
Q8	a	Reducing paperwork (orders, invoices and delivery dockets)	5	0	8	2	12	0	12	0	15	5	24	6	21	14	8	0	18	9	0	10	123	46	169	6	9	6
	b	Avoidance of re-keying information into computer systems	1	0	4	0	27	0	24	8	15	5	18	6	0	0	8	8	9	9	10	0	116	36	152	5	5	5
	c	Saving manpower in processing invoices and other information	6	1	10	0	0	3	16	0	10	10	18	0	7	0	0	8	0	0	0	0	67	22	89	1	2	1
	d	Fewer errors in recording and handling information	3	1	14	4	0	0	16	0	30	0	12	0	7	0	8	16	9	0	10	0	109	21	130	3	1	3
	e	Reduced cost of capturing data	4	1	4	0	21	0	8	8	15	0	12	6	14	0	8	8	9	0	0	0	95	23	118	2	3	2
	f	Improved accessibility to time and cost data: providing real time information	2	1	4	0	6	3	4	0	15	0	36	6	21	7	8	0	18	0	0	10	114	27	141	4	4	4
	g	Ability to contribute to data interchange in a national standard format	2	0	2	0	3	0	8	4	0	0	0	0	21	14	48	0	18	9	70	10	172	37	209	8	7	8
	h	Service differentiation from competitors	2	0	2	0	0	0	4	0	5	0	6	0	49	7	56	16	9	0	30	20	163	43	206	7	8	7
	I	Clients who may encourage or stipulate the use of ICT in purchasing	1	0	0	2	3	3	4	0	5	0	12	0	42	0	64	16	45	9	10	0	186	30	216	9	6	9
	j	Competitor organisations who may have applied ICT in purchasing processes	1	0	4	0	0	0	0	4	0	0	6	0	14	7	8	8	72	18	80	10	185	47	232	10	10	10

Table D.3.9. Driving forces to the adoption of ICT in B2B purchasing

Rank Correlation - Inter-organisational Barriers to Adoption

		Please rank in order (1-6) the barriers which undermine the use of ICT in purchasing within your organisation														
			1		2		3		4		5		6		Total			Ranking		
			Other Sectors	Construction	Other Sectors	Construction	Other Sectors	Construction	Other Sectors	Construction	Other Sectors	Construction	Other Sectors	Construction	Other Sectors	Construction	Total	Other Sectors	Construction	Total
Q9	a	A lack of awareness of ICT deployment in purchasing	5	1	8	0	12	3	12	8	25	0	24	0	86	12	98	5	3	4
	b	Development costs are prohibitive (hardware, software and training)	7	2	10	4	21	3	8	0	0	0	6	0	52	9	61	2	1	2
	c	Technology is not yet reliable enough for use	2	0	8	2	6	0	20	0	25	15	24	0	85	17	102	4	5	5
	d	Potential benefits of electronic purchasing are not likely to be sufficient to justify investments	8	2	10	0	3	3	8	8	5	0	6	0	40	13	53	1	4	1
	e	Uncertainty about how to measure the costs and benefits of such investments	4	0	10	0	6	3	16	8	15	0	6	0	57	11	68	3	2	3
	f	Employees are likely to resist the introduction of new technologies	3	0	2	4	12	3	12	0	10	0	48	12	87	19	106	6	6	6

Table D.3.10. Inter organisational barriers to the aoption of ICT

Rank Correlation - Industry Barriers to Adoption

		Please rank in order (1-6) the barriers which undermine the use of ICT in construction purchasing in the your industry	1		2		3		4		5		6		Total			Ranking		
			Other Sectors	Construction	Other Sectors	Construction	Other Sectors	Construction	Other Sectors	Construction	Other Sectors	Construction	Other Sectors	Construction	Other Sectors	Construction	Total	Other Sectors	Construction	Total
Q10	a	There is a general lack of awareness of ICT capabilities and its potential benefits to the Irish supply chain	8	0	4	2	15	3	20	8	10	5	30	0	87	18	105	4	4	4
	b	There is a high incidence of technologically conservative organisations in the Irish business	5	2	12	0	12	6	8	0	25	5	24	0	86	13	99	3	2	2
	c	The temporary nature of relationships between organisations results in an unwillingness to invest in ICT which may only be short lived	5	0	6	4	24	3	16	4	10	5	24	0	85	16	101	2	3	3
	d	The is no motivation for organisations to apply ICT in purchasing transactions when other parties will benefit	9	1	12	2	6	0	16	4	15	5	12	0	70	12	82	1	1	1
	e	There are too many products and components to make the adoption of ICTs in purchasing widespread	3	0	8	0	15	6	12	0	30	10	24	6	92	22	114	5	5	5
	f	There is a general lack of leadership from the government to actively promote the use of ICT in procurement	3	0	6	0	6	0	8	0	15	10	60	18	98	28	126	6	6	6

Table 3.11. Industry barriers to the adoption of ICT

		Please indicate your position on the following statements	Strongly Agree	Agree	No Opinion	Disagree	Strongly Disagree	Total
Q11	a	Awareness of benefits	54%	32%	5%	9%	0%	100%
	b	Introduce data exchange standard	48%	36%	9%	5%	2%	100%
	c	Increase in IT literacy and familarity	41%	43%	9%	7%	0%	100%
	h	Improving efficiency and effectiveness	36%	52%	7%	5%	0%	100%
	f	Clients to stipulate use of ICT	36%	36%	11%	11%	6%	100%
	d	Need for longer term relationships	32%	43%	11%	14%	0%	100%
	e	Closer collaboration	27%	50%	11%	7%	5%	100%
	i	Supply chain keen to do business	18%	48%	7%	23%	4%	100%
	l	Mass of information on the internet	18%	48%	7%	23%	4%	100%

Table D.3.12. Future Directions

APPENDIX E

2004 Pilot Project

Electronic Proof of Delivery

Appendix E.1 – Schedule of Electronic Transactions

Appendix E.2 - Feedback Review and Evaluation

APPENDIX E.1

Construction IT Alliance

Schedule of Electronic Transactions on POD Pilot

Period - 16th July - 31st August 2004

Eden Quay Project

Contractor: Ascon Ltd

Supplier: Kilsaran Concrete Ltd

Date Created	Date Posted	Code	Billing Account	Delivery Account	Material ordered	Quantity	POD Ref	Visit Time	Time posted	Journey ID	Driver	Signed
16.07.04	16.07.04	31052	371813001	M3017/0021001	40N pump mix 10082	1	1—01	15.57	16.06	J1	JC	J Crum
16.07.04	16.07.04	31052	371813001	M3017/0021001	40N pump mix 10082	8	1—02	16.43	16.54	J1	JC	No signature available
16.07.04	16.07.04	31052	371813001	M3017/0021001	40N pump mix 10082	8	1—03	16.53	17.00	J1	JC	by joe (no sign)
16.07.04	16.07.04	31052	371813001	M3017/0021001	40N pump mix 10082	8	1—04	17.08	17.17	J1	JC	by joe
16.07.04	16.07.04	31052	371813001	M3017/0021001	40N pump mix 10082	8	1—05	17.29	17.35	J1	JC	by jim (unclear)
19.07.04	19.07.04	31052	371813001	M3017/0021001	40N pump mix 10082	7	1—06	09.20	09.27	J1	JC	by joe
19.07.04	19.07.04	31052	371813001	M3017/0021001	40N pump mix 10082	7	1—09	09.30	09.37	J1	JC	by conor
19.07.04	19.07.04	31052	371813001	M3017/0021001	40N pump mix 10082	7	1—10	10.59	11.07	J1	JC	by noel
21.07.04	21.07.04	49278-393	371813001	M3017/0021001	40N20P 200393	7	1—15	11.23	11.33	J1	JC	by noel
28.07.04	29.07.04	23728	371813001	M3017/0021001	Part load charge RMC	1	1—16	15.01	15.15	J1	JC	by conor
01.08.04	02.08.04	49278-393	371813001	M3017/0021001	40N20P 200393	7	1—16	10.33	10.40	J1	JC	by conor
01.08.04	02.08.04	49278-	371813001	M3017/0021001	0N20P 200393/Waiting tim	7/15	1—17	14.35	14.45	J1	JC	by conor
09.08.04	09.08.04	16421	371813001	M3017/0021001	Waiting time	1	1	17.13	17.14	J1	JC	by noel
16.08.04	16.08.04	48386	371813001	M3017/0021001	6:1 K - spread	1	1–1–04	02.21	14.30	J1	JC	unclear
16.08.04	16.08.04	49278-393	371813001	M3017/0021001	40N20P 200393	7	1–1–05	02.38	14.45	J1	JC	unclear
16.08.04	17.08.04	49278-393	371813001	M3017/0021001	40N20P 200393	7	1–1–06	22.25	10.33	J1	JC	unclear
16.08.04	17.08.04	48386	371813001	M3017/0021001	6:1 K - spread	0	1–1–08	23.02	11.09	J1	JC	signed mortar
16.08.04	17.08.04	49278-393	371813001	M3017/0021001	40N20P 200393	7	1–1–09	09.28	09.33	J1	JC	signed 7m
17.08.04	17.08.04	31052	371813001	M3017/0021001	40N pump mix 10082	9	1–1–01	00.09	12.25	J1	JC	No signature available
17.08.04	17.08.04	49278-393	371813001	M3017/0021001	40N20P 200293	7	1–1–02	00.19	12.25	J1	JC	by noel (unclear)
17.08.04	17.08.04	48386	371813001	M3017/0021001	6:1 K - spread	1	1–1–03	00.42	12.49	J1	JC	unclear
19.08.04	19.08.04	49278-393	371813001	M3017/0021001	40N20P 200393	7	1–1–10	11.49	12.16	J1	JC	No signature available
19.08.04	19.08.04	49278-393	371813001	M3017/0021001	40N20P 200393	8	1–1–11	14.43	14.50	J1	JC	signed 19th @2.45 (7.5m3)
19.08.04	19.08.04	49278-393	371813001	M3017/0021001	40N20P 200393	8	1–1–12	14.49	14.56	J1	JC	No signature available
19.08.04	19.08.04	49278-393	371813001	M3017/0021001	40N20P 200393	7	1–1–13	14.55	15.10	J1	JC	signed 14.57
19.08.04	19.08.04	49278-393	371813001	M3017/0021001	40N20P 200393	10	1–1–14	14.58	15.10	J1	JC	signed 9.5 @ 15.06
24.08.04	24.08.04	49278-393	371813001	M3017/0021001	40N20P 200393	3	1–1–15	08.23	08.31	J1	JC	unclear
24.08.04	24.08.04	48386	371813001	M3017/0021001	6:1 K - spread	2	1–1–15	08.47	08.52	J1	JC	signed DKT 421507
24.08.04	24.08.04	49278-393	371813001	M3017/0021001	40N20P 200393	7	1–1–16	08.57	09.02	J1	JC	igned 7m 40N20@Aug 24th 9ar
24.08.04	24.08.04	49286	371813001	M3017/0021001	40N20P250m- 398	8	1–1–17	11.00	11.03	J1	JC	signed DKT 421640
24.08.04	24.08.04	49286	371813001	M3017/0021001	40N20P250m- 398	1	1–1–18	14.49	14.53	J1	JC	signed DKT 422388
24.08.04	24.08.04	49286	371813001	M3017/0021001	40N20P250m- 398	8	1–1–19	14.55	14.57	J1	JC	signed DKT 422174
24.08.04	24.08.04	49286	371813001	M3017/0021001	40N20P250m- 398	8	1–1–20	15.03	15.05	J1	JC	unclear DKT 421787
27.08.04	27.08.04	492296-398	371813001	M3017/0021001	40N20P250m- 398	4	1–1–23	15.23	16.07	J1	JC	signed 3.5m3
31.08.04	01.09.04	492296-398 (5)	371813001	M3017/0021001	40N20P250m- 398	8/0x4	1–1–25	16.32	09.48	J1	JC	signed 31st Aug @10am
31.08.04	01.09.04	492296-398 (5)	371813001	M3017/0021001	40N20P250m- 398	8/0x4	1–1–26	16.35	09.48	J1	JC	signed 31st Aug @11am
31.08.04	01.09.04	492296-398 (5)	371813001	M3017/0021001	40N20P250m- 398	8/0x4	1–1–27	16.38	09.48	J1	JC	signed 31st Aug 8m3 @2pm
31.08.04	01.09.04	492296-398 (5)	371813001	M3017/0021001	40N20P250m- 398	3/0x4	1–1–28	16.42	09.48	J1	JC	unclear

Table E.1.1 . Schedule of electronic transactions - CITA P.O.D. pilot

APPENDIX E.2

ELECTRONIC PROOF OF DELIVERY PILOT PROJECT – PHASE 1

FEEDBACK REVIEW

Name	**Date**
Brendan Burke	16th October 2004
Position	
Site Administration Co-ordinator	
Company	
Ascon Construction Ltd	

1.	In your opinion how would you rate the overall management of the pilot project in Phase 1?				
	Poor	☐			
	Satisfactory	☐			
	Good	☐			
	Very Good	X			
2.	Do you feel that Phase 11 should be formally project managed?				
	Yes	X			
	No	☐			
	If Yes, to above please give your reasoning More complex More co's involved				
3.	Were you clear as to the specific objectives of Phase 1?				
	Yes	X			
	No	☐			
4.	If Yes to question 4 do you feel that the pilot objectives were realised in Phase 1?				
	Yes	X			
	No	☐			
5.	Do you feel that all the parties involved in Phase 1 were clear as to their role and responsibilites?				
	Yes X				
	No ☐				
6.	Are you agreeable to extending the use of electronic technology in the second Phase of the pilot 2?				
	Yes X		No ☐		
7.	If Yes to above, please select from below the areas that the technology should be applied to in Phase 2.				
	Demand Process (Ascon)		Supply Process (Kilsaran)		
	Sourcing	☐	Quotation	☐	
	Ordering	X	Confirmation	X	
	Receiving	X	Delivery	X	
	Payment	☐	Invoicing	☐	

8.	Is there in your opinion a need to introduce additional parties so as to make Phase 2 a success?										
	Yes X										
	No □										
	If Yes please identify parties Coins										
9.	Please rank in order (1-10) the following factors, which attract your organisation to apply electronic technologies in Phase 2.										
		1	2	3	4	5	6	7	8	9	10
	Reducing paperwork (orders, invoices and delivery dockets)		X								
	Avoidance of re-keying information into computer systems			X							
	Saving manpower in processing invoices and other information	X									
	Elimination of errors in recording and handling information			X							
	Reduced cost of capturing data		X								
	Improved accessibility to time and cost data: providing real time information			X							
	Ability to contribute to the adoption standard for data interchange									X	
	Service differentiation from competitors								X		
	Clients who may encourage or stipulate the use of ICT in purchasing									X	
	Competitor organisations who may have applied ICT in purchasing processes										X
	Other factors (please state and rank 1-10)										
10.	Please explain your ultimate reasoning for partaking in this CITA pilot? Test the technology To see if the technology could help reduce the time spent on missing dockets thus reducing costs and increasing costing accuracy										

Name Ger Murray		**Date** 16th October 2004	
Position Financial Controller			
Company Ascon			
1.	In your opinion how would you rate the overall management of the pilot project in Phase 1?		
	Poor	☐	
	Satisfactory	☐	
	Good	X	
	Very Good	☐	
2.	Do you feel that Phase 11 should be formally project managed?		
	Yes	X	
	No	☐	
	If Yes, to above please give your reasoning More complicated project (technically)		
3.	Were you clear as to the specific objectives of Phase 1?		
	Yes	X	
	No	☐	
4.	If Yes to question 4 do you feel that the pilot objectives were realised in Phase 1?		
	Yes	X	
	No	☐	
5.	Do you feel that all the parties involved in Phase 1 were clear as to their role and responsibilites?		
	Yes X		
	No ☐		
6.	Are you agreeable to extending the use of electronic technology in the second Phase of the pilot 2?		
	Yes X	No ☐	
7.	If Yes to above, please select from below the areas that the technology should be applied to in Phase 2.		
	Demand Process (Ascon)		Supply Process (Kilsaran)
	Sourcing	☐ Possible	Quotation ☐
	Ordering	X	Confirmation ☐
	Receiving	X	Delivery ☐
	Payment	☐ Possible	Invoicing ☐
8.	Is there in your opinion a need to introduce additional parties so as to make Phase 2 a success?		
	Yes ☐		
	No X		

	If Yes please identify parties										
9.	Please rank in order (1-10) the following factors, which attract your organisation to apply electronic technologies in Phase 2.										
		1	2	3	4	5	6	7	8	9	10
	Reducing paperwork (orders, invoices and delivery dockets)	X									
	Avoidance of re-keying information into computer systems	X									
	Saving manpower in processing invoices and other information	X									
	Elimination of errors in recording and handling information		X								
	Reduced cost of capturing data		X								
	Improved accessibility to time and cost data: providing real time information			X							
	Ability to contribute to the adoption standard for data interchange					X					
	Service differentiation from competitors								X		
	Clients who may encourage or stipulate the use of ICT in purchasing										X
	Competitor organisations who may have applied ICT in purchasing processes										X
	Other factors (please state and rank 1-10)										
10.	Please explain your ultimate reasoning for partaking in this CITA pilot? To seek savings in the administration of the purchasing process in our business.										

Name		**Date**	
John Crum		10th October 2004	
Position			
Operations Manager			
Company			
Kilsaran Concrete Limited			
1.	In your opinion how would you rate the overall management of the pilot project in Phase 1?		
	Poor	☐	
	Satisfactory	☐	
	Good	X	
	Very Good	☐	
2.	Do you feel that Phase 11 should be formally project managed?		
	Yes	X	
	No	☐	
	If Yes, to above please give your reasoning It will provide better focus and feedback.		
3.	Were you clear as to the specific objectives of Phase 1?		
	Yes	X	
	No	☐	
4.	If Yes to question 4 do you feel that the pilot objectives were realised in Phase 1?		
	Yes	X	
	No	☐	
5.	Do you feel that all the parties involved in Phase 1 were clear as to their role and responsibilites?		
	Yes X		
	No ☐		
6.	Are you agreeable to extending the use of electronic technology in the second Phase of the pilot 2?		
	Yes ☐ not decided yet	No ☐	
7.	If Yes to above, please select from below the areas that the technology should be applied to in Phase 2.		
	Demand Process (Ascon)		Supply Process (Kilsaran)	
	Sourcing	☐	Quotation	☐
	Ordering	☐	Confirmation	X
	Receiving	☐	Delivery	X
	Payment	☐	Invoicing	X
8.	Is there in your opinion a need to introduce additional parties so as to make Phase 2 a success?		
	Yes ☐		
	No X		

	If Yes please identify parties

9. Please rank in order (1-10) the following factors, which attract your organisation to apply electronic technologies in Phase 2.

	1	2	3	4	5	6	7	8	9	10
Reducing paperwork (orders, invoices and delivery dockets)		X								
Avoidance of re-keying information into computer systems	X									
Saving manpower in processing invoices and other information			X							
Elimination of errors in recording and handling information	X									
Reduced cost of capturing data						X				
Improved accessibility to time and cost data: providing real time information				X						
Ability to contribute to the adoption standard for data interchange					X					
Service differentiation from competitors					X					
Clients who may encourage or stipulate the use of ICT in purchasing									X	
Competitor organisations who may have applied ICT in purchasing processes									X	
Other factors (please state and rank 1-10)										

10. Please explain your ultimate reasoning for partaking in this CITA pilot?

To participate in the introduction of this technology to the industry which will move our organisation to a more efficient method of docket and system management.

Name	**Date**
Kevin McCambridge	13th October 2004
Position	
Financial Controller	
Company	
Kilsaran Concrete Limited	

1.	In your opinion how would you rate the overall management of the pilot project in Phase 1?	
	Poor	☐
	Satisfactory	☐
	Good	X
	Very Good	☐
2.	Do you feel that Phase 11 should be formally project managed?	
	Yes	X
	No	☐
	If Yes, to above please give your reasoning	
3.	Were you clear as to the specific objectives of Phase 1?	
	Yes	X
	No	☐
4.	If Yes to question 4 do you feel that the pilot objectives were realised in Phase 1?	
	Yes	X
	No	☐
5.	Do you feel that all the parties involved in Phase 1 were clear as to their role and responsibilites?	
	Yes X	
	No ☐	
6.	Are you agreeable to extending the use of electronic technology in the second Phase of the pilot 2?	
	Yes X	No ☐
7.	If Yes to above, please select from below the areas that the technology should be applied to in Phase 2.	

Demand Process (Ascon)		Supply Process (Kilsaran)	
Sourcing	☐	Quotation	☐
Ordering	☐	Confirmation	☐
Receiving	☐	Delivery	X
Payment	☐	Invoicing	X

8.	Is there in your opinion a need to introduce additional parties so as to make Phase 2 a success?	
	Yes X	
	No ☐	

	If Yes please identify parties Wider participation will enhance the project and it's lessons

9. Please rank in order (1-10) the following factors, which attract your organisation to apply electronic technologies in Phase 2.

	1	2	3	4	5	6	7	8	9	10
Reducing paperwork (orders, invoices and delivery dockets)	X									
Avoidance of re-keying information into computer systems		X								
Saving manpower in processing invoices and other information		X								
Elimination of errors in recording and handling information	X									
Reduced cost of capturing data		X								
Improved accessibility to time and cost data: providing real time information			X							
Ability to contribute to the adoption standard for data interchange					X					
Service differentiation from competitors								X		
Clients who may encourage or stipulate the use of ICT in purchasing				X					X	
Competitor organisations who may have applied ICT in purchasing processes										X
Other factors (please state and rank 1-10)										

10. Please explain your ultimate reasoning for partaking in this CITA pilot?

To be forward looking in term of technological innovations which can improve customer service and drive cost efficiencies.

CITA POD Pilot Feedback
Site Personnel Questionnaire

Date of Interview: **12th October 2004**
Interviewer: **Alan V Hore, CITA Director**
Interviewee: **Noel Fahy – Ascon Site Administrator**
Time: **12 noon**

Q. In your opinion how would you rate the overall performance of the technology used during the pilot phase?

A. Satisfactory. He would have been surprised if it worked perfectly.

Q. Do you feel you had sufficient training in the use of the technology for phase 1 of the pilot?

A. Yes eventually.

Q. What specific problems did you encounter during Phase 1 with the technology?

A. Set up of handheld device. Not sure what one was looking at on the screen. Lack of overview of transactions on screen. Noel gave example of Hilti a supplier who had a curiour on site earlier that day and when he was asked to sign the screen on the PDA he could see exactly what he was signing for.
Some problems with Internet access.
Noel recommended to look at a similar PDA to that used by UPS ie. a tablet with BIG keys with limited functionality. Too small for site. Keep PDA simply. Set it up so it is foolproof.
Teething problems with delivery listing left on the website.

Q. Where you aware of the overall purpose of the pilot project?

A. Yes.

Q. Do you believe the technology used during the pilot is a practical tool to use in your daily work?

A. Yes but only for projects of a particular magnitude. Not suitable for this site. The larger site larger number of the deliveries.

Q. Explain in your own words how you feel technology could make improvement to your daily workload?

A. If the technology could negate the need for me to re-key information into COINS by way of a GRN this would save a considerable degree of time. Also I have to approve all material invoices and match these to delivery notes. This is very time consuming and

could in my opinion by automated. Invoicing matching is the core issue that causes me problems on site. Noel explained that he has to GRN all delivery notes. He then checks these against all invoices. All invoices come to him on site although they are scanned at head office and are viewable on the Ascon Intranet.

Q. What suggestions would you make to improve, if any, a second phased pilot i.e. what lessons can we learn from Phase 1?

A. Noel suggested that the system needs to be simplified for Phase 11. The O2Instant product is NOT friendly to use. It should be adapted to suit the requirements of a construction company and supplier ie. it should be possible to be daily, weekly or project activity report with all fields relevant to both parties. He suggested that excel type reports need to be able to be created from this respository. The activity report should be presented as follows:

What was ordered?
What was delivered?
Was it signed for?
Who signed for it?
What time did truck arrived?
What time was signature made?
Etc....

Q. Do you feel that you role in data collection was made clear?

A. Yes.

Please rank in order (1-10) the following factors, which attract you to apply electronic technologies in Phase 2.										
	1	2	3	4	5	6	7	8	9	10
Reducing paperwork (orders, invoices and delivery dockets)			X							
Avoidance of re-keying information into computer systems	X									
Saving manpower in processing invoices and other information	X									
Elimination of errors in recording and handling information		X								
Reduced cost of capturing data							X			
Improved accessibility to time and cost data: providing real time information			X							
Ability to contribute to the adoption standard for data interchange	N/a									
Service differentiation from competitors	N/a									
Clients who may encourage or stipulate the use of ICT in purchasing	N/a									
Competitor organisations who may have applied ICT in purchasing processes	N/a									
Other factors (please state and rank 1-10)	N/a									

CITA POD Pilot Feedback
Site Personnel Questionnaire

Date of Interview: **12th October 2004**
Interviewer: **Alan V Hore, CITA Director**
Interviewee: **Damien Farrell – Kilsaran Shipper Hanover Quay**
Time: **12.45pm**

Q. In your opinion how would you rate the overall performance of the technology used during the pilot phase?

A. Satisfactory. I did not use it a much as I expected to use it. It was not user friendly, had to ring Sentrio regularly. Kilsaran system more user friendly.

Q. Do you feel you had sufficient training in the use of the technology for phase 1 of the pilot?

A. Yes.

Q. What specific problems did you encounter during Phase 1 with the technology?

A. Not user friendly on website. Damien had to ring Sentrio to put on a new mix. Creating new mixes on the web page every time was very time consuming.

Q. Where you aware of the overall purpose of the pilot project?

A. Yes.

Q. Do you believe the technology used during the pilot is a practical tool to use in your daily work?

A. Yes. If it was connected to our DMS system it would be great i.e. if it was running in the background it would be great. Noel explained that if his shipping sheet was in an electronic form this would also help as he has to complete this form by hand daily. Fields include

Order No.	Add Mixture
Client	Radial Miles
Job Address	Time and Arrival
Metres	Unloading Remarks
Mix	Mix Code
Slump	Product Code
Cement Type	Truck
Cement Content	Docket Number
Aggregate	

Q. Explain in your own words how you feel technology could make improvement to your daily workload?

A. I have far too much paper. I have to work into the evenings to clear the paperwork as I have no time during the day due to the constant use of the phone. All delivery notes need to go to head office. Many of the DD's come back from site destroyed and hardly readable. God knows what state the PDA's would come back!
Noel explains the level of paperwork by confirming the duplicate dockets

White – head office copy
Pink – Client copy
Yellow – Kilsaran batch copy
Blue – Kilsaran shipper copy
Green – Owner driver copy (Hacker!)

Q. What suggestions would you make to improve, if any, a second phased pilot i.e. what lessons can we learn from Phase 1?

A. Make the technology more user friendly. Noel illustrated to me the simplicity of the Kilsaran DMS system and how the information is automatically hosted on the Kilsaran ICT mainframe system. The pilot website took 3 to 4 minutes per transaction to access.

Q. Do you feel that you role in data collection was made clear?

A. Yes.

Please rank in order (1-10) the following factors, which attract you to apply electronic technologies in Phase 2.										
	1	2	3	4	5	6	7	8	9	10
Reducing paperwork (orders, invoices and delivery dockets)	X									
Avoidance of re-keying information into computer systems				X						
Saving manpower in processing invoices and other information	N/a									
Elimination of errors in recording and handling information			X							
Reduced cost of capturing data	N/a									
Improved accessibility to time and cost data: providing real time information			X							
Ability to contribute to the adoption standard for data interchange										
Service differentiation from competitors	N/a									
Clients who may encourage or stipulate the use of ICT in purchasing	N/a									
Competitor organisations who may have applied ICT in purchasing processes	N/a									
Other factors (please state and rank 1-10)	N/a									

APPENDIX F

2005 Pilot Project

CITA Electronic Purchasing Pilot Project

Appendix F.1 – Analysis of Existing Purchasing Process

Appendix F.2 - Open Order for Kilbeggan By-Pass

Appendix F.3 – Schedule of Electronic PODs

Appendix F.4 – Schedule and Sample of Electronic Transactions

Appendix F.5 – Feedback Questionnaires

Appendix F.6 - Productivity and Potential Savings for Contractor

APPENDIX F.1

ANALYSIS OF EXISITING PURCHASING PROCESS

One of the first steps in the re-engineering process was to map the existing business purchasing processes within the contractor's organisation. The purpose of this step in the process was to identify the inefficiencies in the process.

The process flow for requisitioning and ordering materials was almost identical to that presented in Chapter 5. The reason for this similarity was the fact that both contractors' used the same COINS software. As in Chapter 5, the contractor did not utilise the requisition functionality of the COINS software. Instead, the contractor relied on a paper-based material requisitioning process, where site personnel prepared the site requisition by hand in a duplicate booklet. This document, in turn, was faxed to the purchasing department and the hard copy posted to head office. The only purpose of the requisitioning was to give the purchasing department an indication of the material type required. It was not necessary to give specific details of the site requirements at this stage, as this would be decided by the buyer in consultation with the site and the supplier.

In respect to centrally purchased materials, site staff would raise requisitions to the purchasing department. This included the item description and the quantities required. The purchasing department checked the requisitions for completeness. If the item was on an existing price list, then the order would be raised in the COINS system against the current negotiated supplier price. If the item did not appear on the price list, then the purchasing department obtained quotes for that material. Once the supplier and details were negotiated, the purchase order details were inputted by the purchasing department into COINS and a hard copy was faxed and posted to the supplier. Each site was networked in order that they could gain access to particular modules of the COINS software.

The process flow chart for requisitioning and ordering materials is shown in Figure F.1.1. The process shows a total of 15 tasks in the creation of a purchase order. The most widely adopted observed route for processing the purchase order involved a minimum of 10 tasks. Table F.1.1 summaries the tasks that are carried out manually rather than

electronically in the material requisitioning and ordering process highlighted in process flow diagram (identified in red) in Figure F.1.1.

Typical tasks in creation of purchase order		Manual/ Handwriting	Photocopy/ Printing	Manual keying of Info.
1	Check if materials are centrally purchased	√		
2	Prepare material requisition	√		
3	Send requisition to Purchasing	√	√	
4	Check material requisition for correctness	√		
5	Check if item on price list			√
6	If item is on price list, check if up-to-date			√
7	Up-date price list on COINS			√
8	Select supplier on COINS			√
9	Enter order and price on COINS			√
10	Post / print out purchase order on COINS.	√	√	√
	Total	5	2	6

Table F.1.1. Tasks carried out manually rather than electronically in the material requisition and ordering process

It can be seen from both Figure F.1.1 and Table F.1.1 that considerable inefficiencies remained in the creation of the purchase order. There was an over-dependency on the manual creation of the purchase requisition, notwithstanding the fact that the COINS software had additional functionality to cater for this purchasing phase. A great deal of time and effort was required to be inputted by the purchasing department in the interpretation of the site requirements, and in the keying in of the purchase order details on the COINS system.

Head office personnel were of the opinion that site staff should not be expected to create a purchase order free of errors and this would in any case require an intervention by the purchasing department to verify its accuracy. As there was no connectivity between the contractor and supplier's ICT systems, it was necessary to fax and post a hard copy of the purchase order to the supplier.

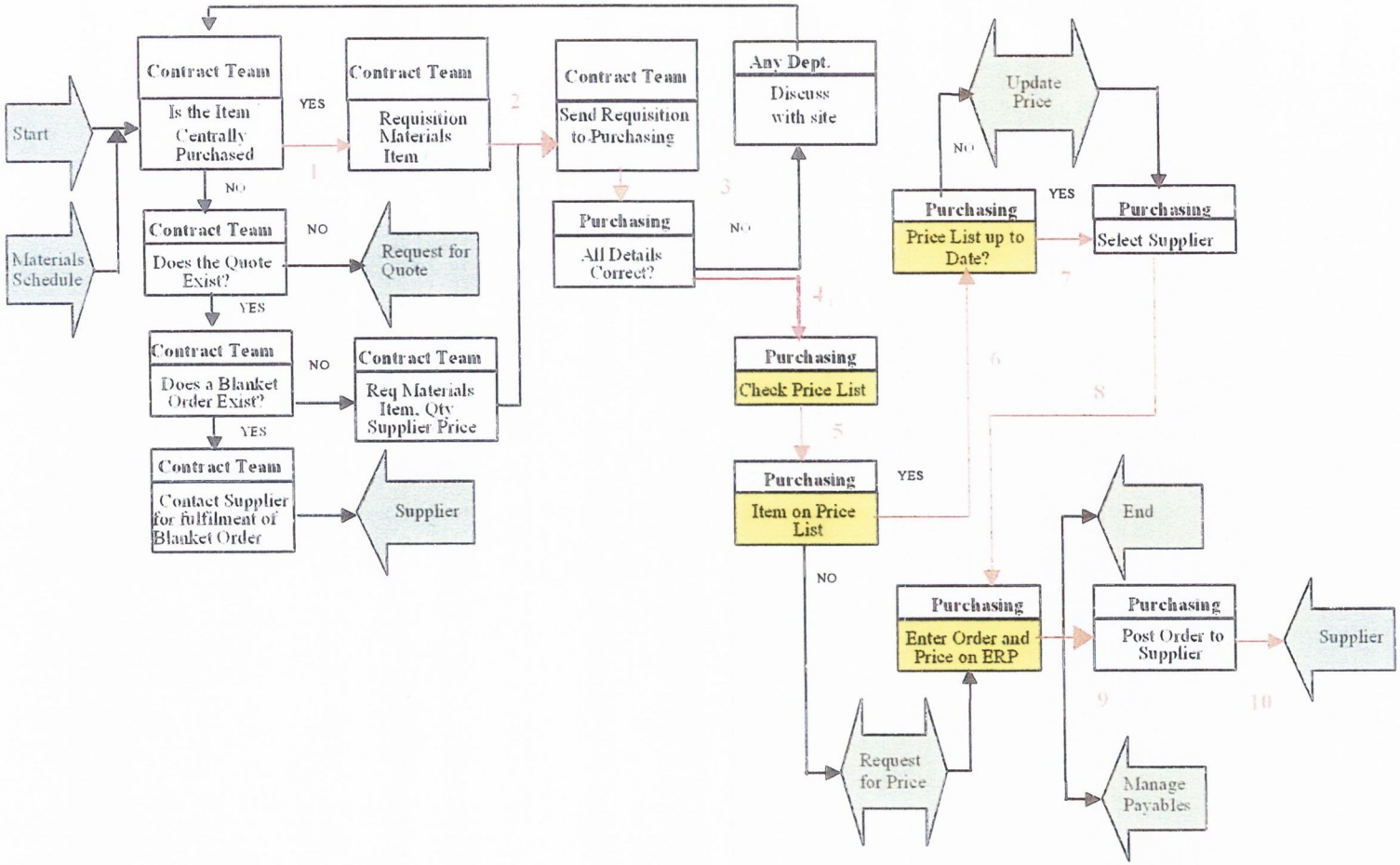


Figure F.1.1. Material requisitioning and ordering process map for Ascon Ltd – 2005 pilot project

In respect to receiving materials, every site had an authorised signature list, which formed part of the company Quality Assurance procedures. Only people named on that list were entitled to sign for materials delivered to site. All deliveries received on site were checked against the delivery docket and any shortages, damage, or inconsistencies were noted on the delivery docket before signing. If detected at the time of delivery, any incorrect or damaged goods were returned with the carrier and the delivery docket was noted with the details before signing

The signed delivery dockets were left in a tray provided in the site office on a daily basis. The dockets were then coded by the quantity surveyor/engineer and passed to the site administrator in order for the GRNs to be entered into COINS. The site administrator entered the GRNs in COINS on a daily basis. This involved entering in the delivery docket number, a brief description of the materials, the quantity, date and Work Breakdown Code (WBS) for all deliveries. All delivery dockets were filed on site in alphabetical order.

The process flow chart for receiving materials is shown in Figure F.1.2. The process shows a total of 6 individual tasks in the creation of the GRN. The most widely adopted observed route for processing the delivery notes involved a minimum of 5 tasks. Table F.1.2 summaries the tasks that are carried out manually rather than electronically in the receiving material delivery process highlighted in the process flow diagram (identified in red) in Figure F.1.2.

	Typical tasks in receiving materials process	**Manual/ Handwriting**	**Photocopy/ Printing**	**Manual keying of Info.**
1	Nominate receiving personnel	√		
2	Receive materials	√		
3	Inspect material against delivery dockets	√		
4	Sign delivery dockets	√		
5	GRN of materials on COINS			√
	Total	4	0	1

Table F.1.2. Tasks carried out manually rather than electronically in the receiving materials process

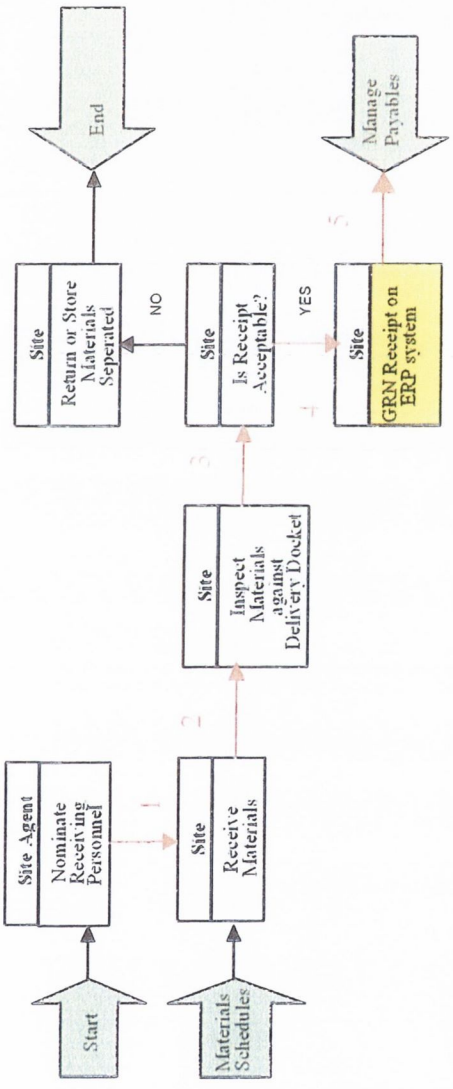


Figure F.1.2. Receiving material process map for Ascon Ltd – 2005 pilot project

All invoices received by the company were date stamped and scanned using the COINS Image Manager (CIM) software. Each invoice was registered into COINS by head office accounts. This involved keying in the purchase order number. This in turn allowed for the invoice details to be compared with the original purchase order on COINS. The COINS system generated a unique number for each invoice, which was called a "voucher", or "internal reference" number. After registering, the invoices were sorted into jobs and were posted out to the various sites to be cleared or costed. Invoices for some of the smaller sites were costed in head office. All costed invoices were filed on site in alphabetical order.

The invoice details were in turn checked against the GRN entries on the COINS system, as part of the three-way matching process. If the materials invoiced did not have an accompanying GRN in COINS, the invoice could not be processed.

The process flow chart for managing payables is shown in Figure F.1.3. The process shows a total of 15 individual tasks in the management of the payables process. The most widely adopted observed route for processing the delivery notes involved a minimum of 7 tasks. Table F.1.3 summaries the tasks that are carried out manually rather than electronically in the manage payables process highlighted in the process flow diagram (identified in red) in Figure F.1.3.

	Typical tasks in managing payables	**Manual/ Handwriting**	**Photocopy/ Printing**	**Manual keying of Info.**
1	Receive invoice	√		
2	Scanning of invoice on CIM software	√		
3	Enter details onto ERP system			√
4	Release payment		√	√
5	Print cheque and remittance advice		√	
6	Collate cheque and remittance	√	√	
7	Post to the supplier	√	√	
	Total	4	4	2

Table F.1.3. Tasks carried out manually rather than electronically in the managing payables

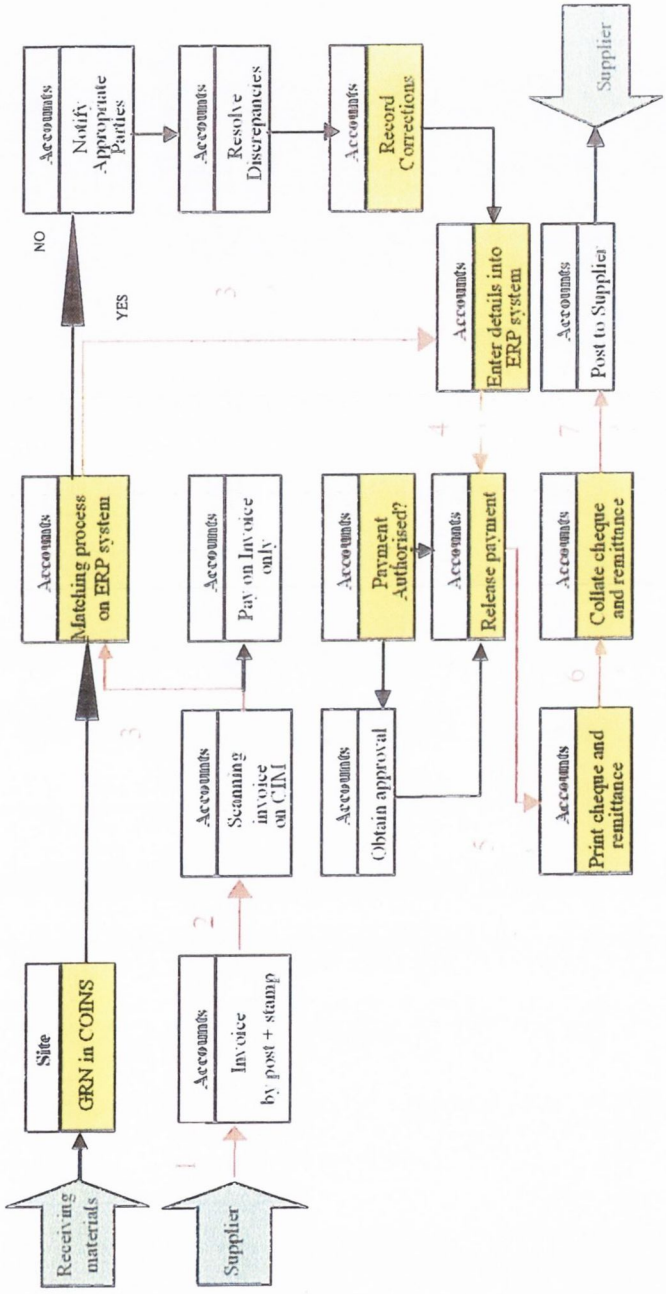


Figure F.1.3. Managing payable process map for Ascon Ltd – 2005 pilot project

It can be readily seen from mapping of the processes that a great deal of inefficiencies existed in the current purchasing process adopted by the contractor. Table F.1.4 summaries the overall extent of the inefficiencies present in the contractor's purchasing process. The figures are extracted from Tables F.1.1, F.1.2 and F.1.3.

Business Process	**Manual/ Handwriting**	**Photocopy/ Printing**	**Manual keying of Info.**
Material Requisitioning & Order Processing	5	2	6
Receiving and storing materials	4	0	1
Managing payables	4	4	2
Total	13	6	9

Table F.1.4. Extent of inefficiencies present in contractor's purchasing process

APPENDIX F.2

Open Order for PVF Limited - Reference M5046/0114
Period - October/December 2005
Kilbeggan By-Pass
Contractor: Ascon Ltd
Supplier: PVF Limited

Item	WBS Code	Code	Description	Quantity	UN	Unit Price	Discount	Nett Total	Total
1	DR05	pipukdpe	Ridgidrain Junction - 300mm x 300mm x 45Deg	1	IT	417.62	45.00%	229.69	277.92
2	DR05	pipukdpe	Ridgidrain Double Socket Bend 300mm x 90mm Deg I	1	IT	117.57	45.00%	64.66	78.24
3	DR05	pipukdpe	Ridgidrain Double Socket Bend 300mm x 45Deg	1	IT	117.57	45.00%	64.66	78.24
4	DR05	pipukdpe	Ridgidrain Junction - 225mm x 225mm x 45Deg	1	IT	137.36	45.00%	75.55	91.41
5	DR05	pipukdpe	Ridgidrain Junction - 225mm x 90Deg Bend	1	IT	67.80	45.00%	37.29	45.12
6	DR05	pipukdpe	Ridgidrain Junction - 255mm c 45Deg Bend	1	IT	67.80	45.00%	37.29	45.12
7	DR05	pipukdpe	Ridgidrain Sealing Rings - 300mm	5	IT	8.66	45.00%	23.81	28.81
8	DR05	pipukdpe	Ridgidrain Sealing Rings - 225mm	5	IT	5.87	45.00%	16.13	19.52
9	DR05	pipukdpe	Ridgi Gully Multiadaptor - 150mm Flexi Pipe	12	IT	11.18	45.00%	73.79	89.28
10	DR05	pipuwmain 150	160mm 16bar HEP30 Pipe 6m	110	LTH	48.75		5362.50	6488.63
11	DR05	pipuwmain 150	160mm x 45 deg. l/r bend HEP30	2	EA	23.40		46.80	56.63
12	DR05	pduc fitting	150mm Flg Blank Flang Stanton PN16	5	EA	10.69		53.45	64.67
13	DR05	pduc fitting	6"/160mm UPVC Tail	2	EA	24.00	25.00%	36.00	43.56
14	DR05	pduc fitting	6"/150mm EPDM Rubber Gasket	2	EA	1.78		3.56	4.31
15	DR05	pduc fitting	M20X70 Z/P Nut & Bolt	16	EA	0.39		6.24	7.55
16	DR05	pipukdpe	Polypipe 300mm x 87.5 rigidrain t/w d/s Bend	40	EA	64.66		2586.40	3129.54
17	DR05	pipukdpe	Polypipe RD450x6 450mm	40	EA	531.77	45%	11698.94	14155.72
18	DR05	pipukdpe	Polypipe SRD450 450mm	40	EA	18.82	45%	41404.00	50098.84
19	DR05	pipukdpe	Polypipe CRD450DS 450mm	50	EA	48.01	45%	1320.28	1597.53
20	DR05	pipuwmain 200	HEP30 160mm X 6m Blue 16 Bar Pipe	200	LTH	55.00		11000.00	13310.00
21	DR05	pipuwmain 200	HEP30 200mm 16 Bar 22.5Deg L/R Bend	1	EA	58.50		58.50	70.79
22	DR05	pipuwmain 200	HEP30 200mm 16 Bar 90Deg L/R Bend	1	EA	82.88		82.88	100.28
26	DR05	pipuwmain 200	HEP30 200mm 16 Bar 45Deg L/R Bend	6	EA	67.28		403.68	488.45
27	DR05	pduc SS 80	HEP30 110mm X 6m Blue 16 Bar Pipe	12	LTH	23.74		284.88	344.70
28	DR05	pduc SS 80	STANTON P8 54 80mm X 5.5m Tyton Pipe CML/ES S	9	LTH	80.00		720.00	871.20
29	DR05	pduc fitting	200mm X 80mm Flg. Branch Tee	5	EA	62.29		311.45	376.85
30	DR05	pduc fitting	200mm X 150mm Flg. Branch Tee	2	EA	71.02		142.04	171.87
31	DR05	pduc fitting	200mm Flg. Equal Tee	4	EA	76.07		304.28	368.18
32	DR05	pduc fitting	300mm X 200mm EO561 A/F Tee	2	EA	133.88		267.76	323.99
33	DR05	pduc fitting	150mm X 100mm Flg. Con Taper	1	EA	19.62		19.62	23.74
34	DR05	pduc fitting	200mm X 150mm Flg. Con. Taper	2	EA	26.09		52.18	63.14
35	DR05	pduc fitting	108mm/130mm Mech. Coupler	2	EA	31.56		63.12	76.38
36	DR05	pduc fitting	159mm/179mm Mech. Coupler	2	EA	37.41		74.82	90.53
37	DR05	pduc fitting	315mm/335mm Mech. Coupler	4	EA	102.74		410.96	497.26
38	DR05	pduc fitting	80mm Flg. Puddle Flange	5	EA	23.75		118.75	143.69
39	DR05	pduc fitting	Flange adapter 108mm	10	EA	44.10	25%	330.75	400.21
40	DR05	pduc fitting	Mech. Coupler 218mm/236mm	34	EA	62.38		2120.92	2566.31
41	DR05	pduc fitting	Flg. Adaptor 315mm-355mm	4	EA	102.74		410.96	497.26
42	DR05	valvar	100mm Gate Valve CC R/S C/W Cap	1	EA	69.42		69.42	84.00
43	DR05	valvar	150mm Gate Valve CC R/S C/W Cap	13	EA	183.75	25%	1791.56	2167.79
44	DR05	valvar	200mm Gate Valve CC R/S C/W Cap	8	EA	362.00	25%	2172.00	2628.12
45	DR05	valvar	80mm Type 2 Hydrant BS750	5	EA	61.73		308.65	373.47
46	DR05	pduc fitting	80mm X 225mm D/F Dl Riser	5	EA	13.54		67.70	81.92
47	DR05	pduc fitting	80mm Blank Flange	4	EA	5.34		21.36	25.85
48	DR05	pduc fitting	100mm Blank Flange	75	EA	5.43	25%	305.44	369.58
49	DR05	pduc fitting	150mm Blank Flange	5	EA	10.69		53.45	64.67
50	DR05	pduc fitting	200mm Blank Flange	8	EA	14.96		119.68	144.81
51	DR05	pduc fitting	8"/200mm EPDM Gasket	34	EA	1.96		66.64	80.63
52	DR05	pduc fitting	6"/150mm EPDM Gasket	200	EA	1.25	25%	187.50	226.88
53	DR05	pduc fitting	4"/100mm EPDM Gasket	3	EA	1.00		3.00	3.63
54	DR05	pduc fitting	3"/80mm EPDM Gasket	5	EA	0.93		4.65	5.63
55	DR05	pduc fitting	Nuts and bolts M16 x 65m	3000	EA	0.32	25%	720.00	871.20
56	DR05	pduc fitting	M16 X6 5mm Z/P Nut/Bolt	75	EA	0.21		15.75	19.06
57	DR05	pipumain misc	160mm Dia 22.5 Deg Bends	14	EA	24.00		336.00	406.56
58	RW12	Street furn	BROXAP REF. 47008900FT GR. 304 S/S Circular Flat	44	EA	198.00	7.50%	8058.60	9750.91
59	RW12	Street furn	BROXAP S/S Circular Skirt Predrilled 170mm x 91mm	44	EA	29.50	7.50%	1200.65	1452.79
								Total	115942.98

APPENDIX F.3

Schedule of Electronic PODs on Electronic Purchasing Pilot - Phase 2
Period: October/December 2005
Contractor: Ascon Ltd
Supplier: PVF Ltd

Date Created	Date Posted	Code	Billing Account	Delivery Account	Material ordered	Quantity	POD Ref	Visit Time	Time posted	Journey ID	Driver	Signed
14.10.05	14.10.05	pduc fitting	371813001	66/013713	Polypipe RD450x6 450mm	10	1 - 04	15.25	15.45	J1	KAK	Brendan Burke
14.10.05	14.10.05	pduc fitting	371813001	66/013713	Polypipe SRD450 450mm	20	1 - 04	15.25	15.45	J1	KAK	Brendan Burke
14.10.05	14.10.05	pduc fitting	371813001	66/013713	Polypipe CRD450DS 450mm	10	1 - 04	15.25	15.45	J1	KAK	Brendan Burke
14.10.05	14.10.05	pduc fitting	371813001	66/013850	HEP30 PMU160I1oB60 160	100	1 - 02	15.25	15.35	J1	KAK	Brendan Burke
14.10.05	14.10.05	pduc fitting	371813001	66/013850	200mm gate valve acc	4	1 - 02	15.25	15.35	J1	KAK	Brendan Burke
14.10.05	14.10.05	pduc fitting	371813001	66/013850	Nuts and bolts M16 x 65m	1500	1 - 02	15.25	15.35	J1	KAK	Brendan Burke
14.10.05	14.10.05	pduc fitting	371813001	66/013850	Flange adapter 108mm	10	1 - 03	15.25	15.32	J1	KAK	Brendan Burke
14.10.05	14.10.05	pduc fitting	371813001	66/013850	150mm gate valve cc	6	1 - 03	15.25	15.32	J1	KAK	Brendan Burke
14.10.05	14.10.05	pduc fitting	371813001	66/013850	PVF BF100 100mm b/c	25	1 - 03	15.25	15.32	J1	KAK	Brendan Burke
14.10.05	14.10.05	pduc fitting	371813001	66/013850	EPDM rubber gasket 6/1	50	1 - 04	15.25	15.32	J1	KAK	Brendan Burke
21.10.05	21.10.05	pduc fitting	371813001	66/013850	250mm flanged radial	2	1 - 05	15.44	15.51	J1	KAK	Brendan Burke
21.10.05	21.10.05	pduc fitting	371813001	66/013850	Flex-seal SC335	2	1 - 05	15.44	15.51	J1	KAK	Brendan Burke
21.10.05	21.10.05	pduc fitting	371813001	66/013850	Flex-seal SC425	2	1 - 05	15.44	15.51	J1	KAK	Brendan Burke
21.10.05	21.10.05	pduc fitting	371813001	66/013850	225mm half perf twin	37	1 - 07	15.44	15.51	J1	KAK	Brendan Burke
09.11.05	09.11.05	pduc fitting	371813001	66/013850	150mm double flanged	1	1 - 07	10.21	10.35	J1	KAK	Brendan Burke
09.11.05	09.11.05	pduc fitting	371813001	66/013850	225mm corrie twinwall	14	1 - 07	10.21	10.35	J1	KAK	Brendan Burke
09.11.05	09.11.05	pduc fitting	371813001	66/013850	300mm corrie twinwall	10	1 - 07	10.21	10.35	J1	KAK	Brendan Burke
09.11.05	09.11.05	pduc fitting	371813001	66/013850	225mm half perf twin	13	1 - 06	10.21	10.35	J1	KAK	Brendan Burke
09.11.05	09.11.05	pduc fitting	371813001	66/013713	225mm half perf twin	25	1 - 06	10.21	10.35	J1	KAK	Brendan Burke
16.11.05	16.11.05	pduc fitting	371813001	66/013713	Polypipe RG450750	258	1 - 06	10.11	10.21	J1	KAK	Brendan Burke
16.11.05	16.11.05	pduc fitting	371813001	66/013713	Klargester class 1	2	1 - 06	10.11	10.21	J1	KAK	Brendan Burke
16.11.05	16.11.05	pduc fitting	371813001	66/013713	Flex-seal SC335 305	15	1 - 06	10.11	10.21	J1	KAK	Brendan Burke
16.11.05	16.11.05	pduc fitting	371813001	66/013713	Flex-seal SC425 400	20	1 - 09	10.11	10.21	J1	KAK	Brendan Burke
25.11.05	25.11.05	pduc fitting	371813001	66/013850	250mm all flanged radi	4	1 - 09	09.45	10.10	J1	KAK	Brendan Burke
25.11.05	25.11.05	pduc fitting	371813001	66/013850	200mm gate valve acc	4	1 - 09	09.45	10.10	J1	KAK	Brendan Burke
25.11.05	25.11.05	pduc fitting	371813001	66/013850	Flange adapter 108mm	10	1 - 08	09.45	10.10	J1	KAK	Brendan Burke
06.12.05	06.12.05	pduc fitting	371813001	66/013713	PVF DFB30090 300mm c/l	10	1 - 08	10.44	10.51	J1	KAK	Brendan Burke
06.12.05	06.12.05	pduc fitting	371813001	66/013713	150mm double flanged 9	10	1 - 08	10.44	10.51	J1	KAK	Brendan Burke
06.12.05	06.12.05	pduc fitting	371813001	66/013713	Polypipe RG450750 450	30	1 - 10	10.44	10.51	J1	KAK	Brendan Burke
12.12.05	12.12.05	pduc fitting	371813001	66/015125	HEP30 PMU160I1oB60 160	100	1 - 02 - 06	10.42	11.03	J1	KAK	Brendan Burke
12.12.05	12.12.05	pduc fitting	371813001	66/015125	Nuts and bolts M16 x 65m	1000	1 - 02 - 06	10.42	11.03	J1	KAK	Brendan Burke
12.12.05	12.12.05	pduc fitting	371813001	66/015125	150mm gate valve cc	6	1 - 02 - 06	10.42	11.03	J1	KAK	Brendan Burke
12.12.05	12.12.05	pduc fitting	371813001	66/015126	PVF BF100 100mm b/c	50	1 - 02 - 07	10.42	11.05	J1	KAK	Brendan Burke
12.12.05	12.12.05	pduc fitting	371813001	66/015126	EPDM rubber gasket 6/1	100	1 - 02 - 07	10.42	11.05	J1	KAK	Brendan Burke
12.12.05	12.12.05	pduc fitting	371813001	66/015121	Polypipe RD450x6 450mm	10	1 - 02 - 02	10.42	10.37	J1	KAK	Brendan Burke
12.12.05	12.12.05	pduc fitting	371813001	66/015121	Polypipe CRD450DS 450mm	10	1 - 02 - 02	10.42	10.37	J1	KAK	Brendan Burke
12.12.05	12.12.05	pduc fitting	371813001	66/015121	Polypipe SRD450 450mm	20	1 - 02 - 02	10.42	10.37	J1	KAK	Brendan Burke

Table F.3.1. Schedule of ePODs - CITA Electronic Purchasing Pilot Phase 2

APPENDIX F.4

Schedule of Electronic Transactions
Period: October/November 2005
Contractor: Ascon Ltd
Supplier: PVF Ltd

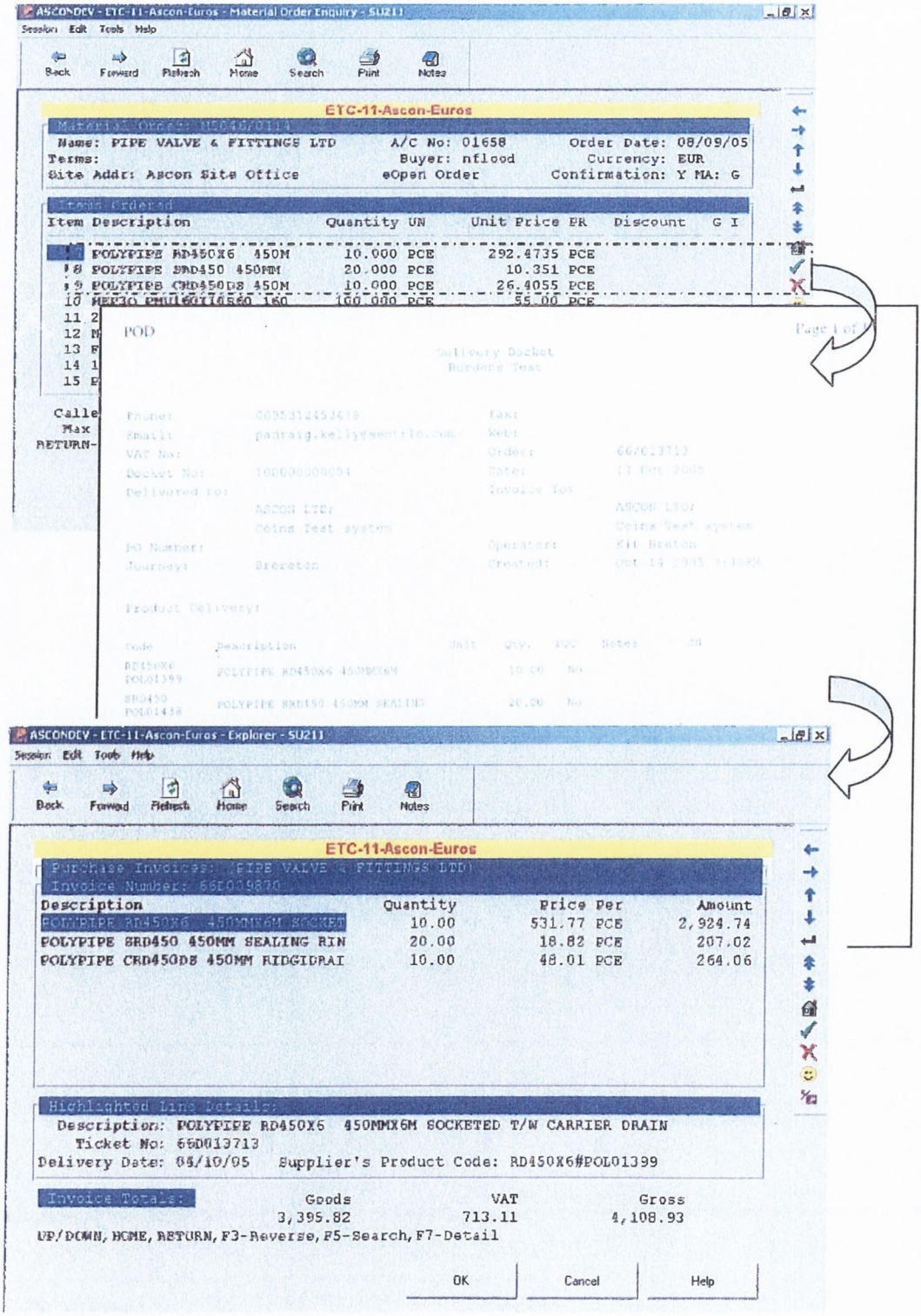
Delivery Date	Ticket No	PO Number	Description	Quantity Ordered	Unit	Value	Quantity Delivered	Int Ref	Matching Amount	Invoice	100% Match
14.10.05	1 - 04	M5046/0114	Polypipe RD450x6 450mm	10	nr	292.4735	10	DR05	2924.74	2924.74	YES
14.10.05	1 - 04	M5046/0114	Polypipe SRD450 450mm	20	nr	10.35	20	DR05	207.02	207.02	YES
14.10.05	1 - 04	M5046/0114	Polypipe CRD450DS 450mm	10	nr	26.4055	10	DR05	264.06	264.06	YES
14.10.05	1 - 02	M5046/0114	HEP30 PMU160l1oB60 160	100	nr	55.00	100	DR05	5500.00	5500.00	YES
14.10.05	1 - 02	M5046/0114	200mm gate valve acc	4	nr	271.50	4	DR05	1086.00	1086.00	YES
14.10.05	1 - 02	M5046/0114	Nuts and bolts M16 x 65m	1500	nr	0.24	1500	DR05	360.00	360.00	YES
14.10.05	1 - 03	M5046/0114	Flange adapter 108mm	10	nr	33.075	10	DR05	330.75	330.75	YES
14.10.05	1 - 03	M5046/0114	150mm gate valve cc	6	nr	137.8125	6	DR05	826.88	826.88	YES
14.10.05	1 - 03	M5046/0114	PVF BF100 100mm b/c	25	nr	4.0725	25	DR05	101.81	101.81	YES
14.10.05	1 - 04	M5046/0114	EPDM rubber gasket 6/1	50	nr	0.9375	50	DR05	46.88	46.88	YES
21.10.05	1 - 05	M5046/0114	250mm flanged radial	2	nr	49.50	2	DR05	99.00	99.00	YES
21.10.05	1 - 05	M5046/0114	Flex-seal SC335	2	nr	60.45	2	DR05	120.90	120.90	YES
21.10.05	1 - 05	M5046/0114	Flex-seal SC425	2	nr	78.24	2	DR05	156.48	156.48	YES
21.10.05	1 - 07	M5046/0114	225mm half perf twin	37	nr	22.00	37	DR05	814.00	814.00	YES
09.11.05	1 - 07	M5046/0114	150mm double flanged	1	nr	32.00	1	DR05	32.00	32.00	YES
09.11.05	1 - 07	M5046/0114	225mm corrie twinwall	14	nr	35.78	14	DR05	500.92	500.92	YES
09.11.05	1 - 07	M5046/0114	300mm corrie twinwall	10	nr	56.75	10	DR05	567.50	567.50	YES
09.11.05	1 - 06	M5046/0114	225mm half perf twin	13	nr	33.84	13	DR05	439.92	439.92	YES
09.11.05	1 - 06	M5046/0114	225mm half perf twin	25	nr	33.84	25	DR05	846.00	846.00	YES
16.11.05	1 - 06	M5046/0114	Polypipe RG450750	258	nr	34.88	258	DR05	8999.04	8999.04	YES
16.11.05	1 - 06	M5046/0114	Klargester class 1	2	nr	1770.00	2	DR05	3540.00	3540.00	YES
16.11.05	1 - 06	M5046/0114	Flex-seal SC335 305	15	nr	60.45	15	DR05	906.75	906.75	YES
16.11.05	1 - 09	M5046/0114	Flex-seal SC425 400	20	nr	78.24	20	DR05	1564.80	1564.80	YES
25.11.05	1 - 09	M5046/0114	250mm all flanged radi	4	nr	49.50	4	DR05	198.00	198.00	YES
25.11.05	1 - 09	M5046/0114	200mm gate valve acc	4	nr	271.50	4	DR05	1086.00	1086.00	YES
25.11.05	1 - 08	M5046/0114	Flange adapter 108mm	10	nr	33.07	10	DR05	330.70	330.70	YES
06.12.05	1 - 08	M5046/0114	PVF DFB30090 300mm c/l	10	nr	98.94	10	DR05	989.40	989.40	YES
06.12.05	1 - 08	M5046/0114	150mm double flanged 9	10	nr	32.00	10	DR05	320.00	320.00	YES
06.12.05	1 - 10	M5046/0114	Polypipe RG450750 450	30	nr	34.88	30	DR05	1046.40	1046.40	YES
12.12.05	1 - 02 - 06	M5046/0114	HEP30 PMU160l1oB60 160	100	nr	55.00	100	DR05	5500.00	5500.00	YES
12.12.05	1 - 02 - 06	M5046/0114	Nuts and bolts M16 x 65m	1000	nr	0.24	1000	DR05	240.00	240.00	YES
12.12.05	1 - 02 - 06	M5046/0114	150mm gate valve cc	6	nr	137.81	6	DR05	826.86	826.86	YES
12.12.05	1 - 02 - 07	M5046/0114	PVF BF100 100mm b/c	50	nr	5.43	50	DR05	271.50	271.50	YES
12.12.05	1 - 02 - 07	M5046/0114	EPDM rubber gasket 6/1	100	nr	1.25	100	DR05	125.00	125.00	YES
12.12.05	1 - 02 - 02	M5046/0114	Polypipe RD450x6 450mm	10	nr	292.47	10	DR05	2924.70	2924.70	YES
12.12.05	1 - 02 - 02	M5046/0114	Polypipe CRD450DS 450mm	10	nr	48.01	10	DR05	480.10	480.10	YES
12.12.05	1 - 02 - 02	M5046/0114	Polypipe SRD450 450mm	20	nr	18.82	20	DR05	376.40	376.40	YES

Table F.4.1. Schedule of electronic transactions - CITA Electronic Purchasing Pilot Phase 2

APPENDIX F.4

SAMPLE THREE-WAY ELECTRONIC MATCHING

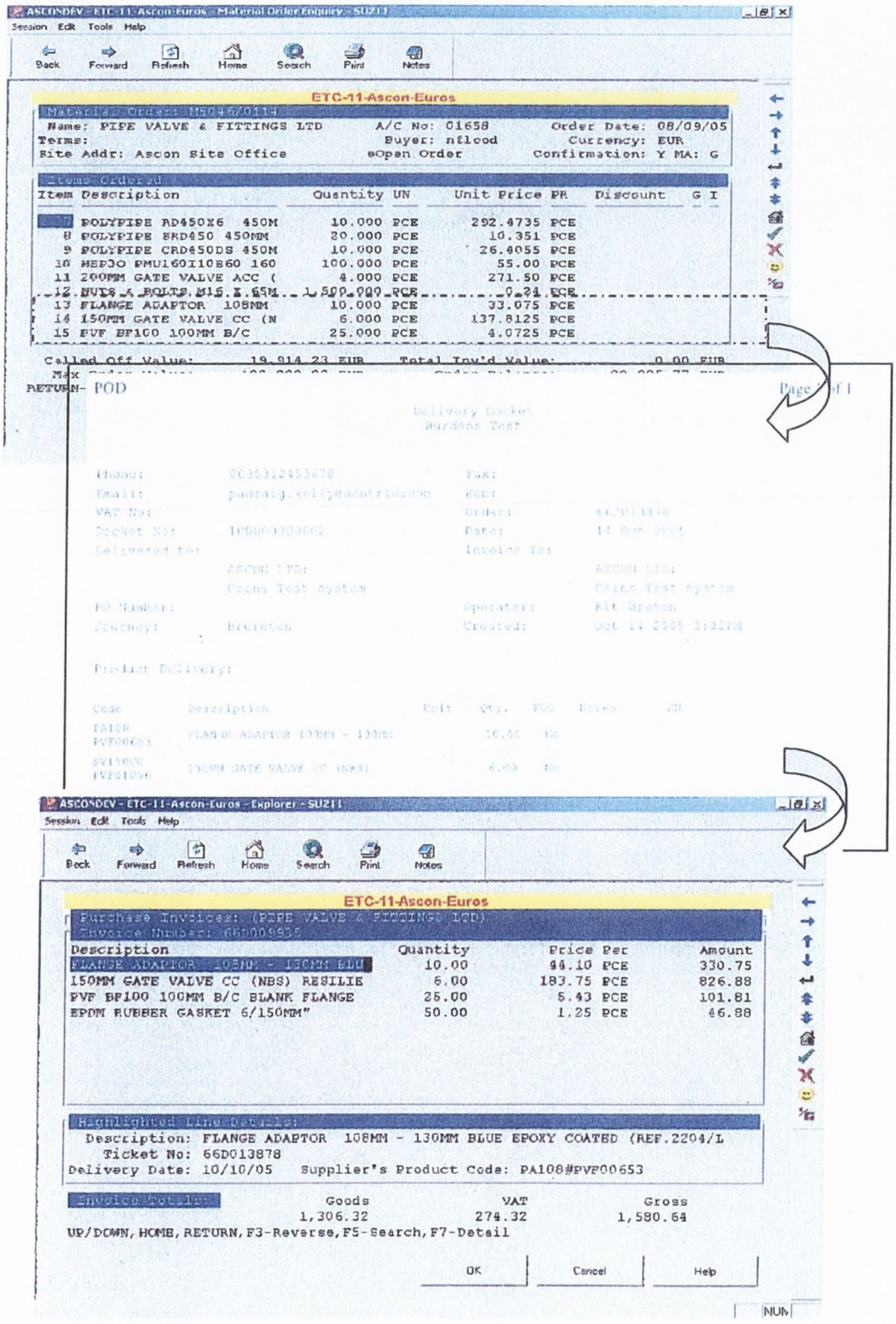
TRANSACTION 1



APPENDIX F.4

SAMPLE THREE-WAY ELECTRONIC MATCHING

TRANSACTION 3



APPENDIX F.5

CITA ELECTRONIC PURCHASING PILOT PROJECT – PHASE 2

FEEDBACK REVIEW

Name Brendan Burke			**Date** 6th December 2005	
Position Site Administration Co-Ordinator				
Company Ascon Limited				
1.	Were you satisfied with the outcome of the CITA Phase 2 ePurchasing pilot project?			
	Yes	X		
	No	☐		
	Please provide a brief commentary to justify your response The three-way match was achieved and the POD was available to view online.			
2.	What are the core problems / inefficiencies that your company is experiencing at present, in regard to the purchasing processes adopted in your organisation?			
	Please provide commentary below Keying of initial order information Keying of additional order lines. Descriptions on order and PODs / invoices different. Missing POD's Site not following company procedures Re-keying of POD information when GRn'ing			
3.	Please indicate the extent to which the following pilot goals were achieved?			
		Not Achieved	Partially Achieved	Fully Achieved
	Create a paperless purchasing process.		X	
	Ensure a high level of integration between site and head office procedures.		X	
	Maintain a sophisticated level of integration between the ICT tools deployed.			X
	Ensure there is no mislaid documentation.			X
	Introduce only a limited degree of re-keying of information by the contractor's staff during the matching process.			X
	Achieve a three-way electronic match of the purchase order, delivery note and the supplier information.			X
	Ensure a high level of satisfaction with the ICT deployed by the trading parties.			X
	Confirm productivity improvements and potential savings for the contractor as a direct result of Phase 2.		X	

	Please provide any comments below	
4.	What lessons, if any, can be taken from the pilot project?	
	Please provide commentary below R&D in ICT can lead to more efficient and accurate ways of doing business.	
5.	Are you considering implementing the ICT solution utilised in the pilot project commercially?	
	Yes	X
	No	☐
6.	If you answered Yes to Question 5, are there any prerequisites to making that decision to adopt the ICT solution?	
	Please provide commentary below A sufficient number of our suppliers must be willing to become involved.	
7.	If you answered No to Question 5, can you please state you reasoning for not investing in this technology?	
	Please provide commentary below	
8.	Do you fell that investment in the re-designed ICT infrastructure is a commercially viable option at the present moment?	
	Yes	X
	No	☐
9.	If you answered No to Question 8, please state your reasoning below.	
	Please provide commentary below	
10.	What recommendations, if any, would you make to encourage the wider construction industry in Ireland to adopt electronic purchasing, such as that achieved in Phase 2?	
	Please provide commentary below There are always better ways to conduct business and electronically is quicker, more accurate and therefore more economical.	

Name Ger Murray	**Date** 8th December 2005
Position Financial Controller	
Company Ascon Limited	

1. Were you satisfied with the outcome of the CITA Phase 2 ePurchasing pilot project?

Yes	X
No	☐

Please provide a brief commentary to justify your response
All objectives were achieved.

2. What are the core problems / inefficiencies that your company is experiencing at present, in regard to the purchasing processes adopted in your organisation?

Please provide commentary below
Inefficiencies in general processing: duplications, lack of accurate data/information, timing of data/information, controls in the process.

3. Please indicate the extent to which the following pilot goals were achieved?

	Not Achieved	Partially Achieved	Fully Achieved
Create a paperless purchasing process.		X	
Ensure a high level of integration between site and head office procedures.		X	
Maintain a sophisticated level of integration between the ICT tools deployed.			X
Ensure there is no mislaid documentation.			X
Introduce only a limited degree of re-keying of information by the contractor's staff during the matching process.			X
Achieve a three-way electronic match of the purchase order, delivery note and the supplier information.			X
Ensure a high level of satisfaction with the ICT deployed by the trading parties.			X
Confirm productivity improvements and potential savings for the contractor as a direct result of Phase 2.			X

Please provide any comments below

4. What lessons, if any, can be taken from the pilot project?

Please provide commentary below

The proper implementation and use of proven technology and revised systems based on current and up to date technology, allows for improvements in the processing and management of data/information.

5. Are you considering implementing the ICT solution utilised in the pilot project commercially?

	Yes	X
	No	☐
6.	If you answered Yes to Question 5, are there any prerequisites to making that decision to adopt the ICT solution?	
	Please provide commentary below A high number of suppliers buy-in.	
7.	If you answered No to Question 5, can you please state you reasoning for not investing in this technology?	
	Please provide commentary below	
8.	Do you fell that investment in the re-designed ICT infrastructure is a commercially viable option at the present moment?	
	Yes	X
	No	☐
9.	If you answered No to Question 8, please state your reasoning below.	
	Please provide commentary below	
10.	What recommendations, if any, would you make to encourage the wider construction industry in Ireland to adopt electronic purchasing, such as that achieved in Phase 2?	
	Please provide commentary below Sell the idea that there are Better, Faster, and Cheaper ways of doing things.	

Name Derek Morrin	Date 9th December 2005
Position Business Manager	
Company PVF Burdens - Dublin	

1. Were you satisfied with the outcome of the CITA Phase 2 ePurchasing pilot project?

Yes	X
No	☐

Please provide a brief commentary to justify your response
After a number of initial problems, the trial showed that the information could be sent and received electronically – reducing re keying and therefore saving time and potential errors.

2. What are the core problems / inefficiencies that your company is experiencing at present, in regard to the purchasing processes adopted in your organisation?

Please provide commentary below
As the keying in will be done by our people anyway, there will be no advantage to ourselves. The real time saving is the reduction of errors, and the matching of GRN to P/O and on to invoice.

3. Please indicate the extent to which the following pilot goals were achieved?

	Not Achieved	Partially Achieved	Fully Achieved
Create a paperless purchasing process.		X	
Ensure a high level of integration between head office and delivery fleet.			X
Maintain a sophisticated level of integration between the ICT tools deployed.			X
Ensure there is no mislaid documentation.			X
Achieve a three-way electronic match of the purchase order, delivery note and the supplier information.			X
Ensure a high level of satisfaction with the ICT deployed by the trading parties.		X	

Please provide any comments below

4. What lessons, if any, can be taken from the pilot project?

Please provide commentary below
The electronic side works, its ensuring everyone does what they are supposed to do.

5.	Are you considering implementing the ICT solution utilised in the pilot project commercially?	
	Yes	X
	No	☐
6.	If you answered Yes to Question 5, are there any prerequisites to making that decision to adopt the ICT solution? The	
	Please provide commentary below. No it's already in our system, there will be a new system trailed which will also have the basics required – handheld units are the only thing to be sourced.	
7.	If you answered No to Question 5, can you please state you reasoning for not investing in this technology?	
	Please provide commentary below	
8.	Do you fell that investment in the re-designed ICT infrastructure is a commercially viable option at the present moment?	
	Yes	X
	No	☐
9.	If you answered No to Question 8, please state your reasoning below.	
	Please provide commentary below There is a start up cost, and as more get involved there will be more of a necessary to be involved.	
10.	What recommendations, if any, would you make to encourage the wider construction industry in Ireland to adopt electronic purchasing, such as that achieved in Phase 2?	
	Please provide commentary below. From a customer point of view there is no loss of control in the process, what they gain is reduced re keying and elimination of different descriptions and entry errors. From suppliers point of view there is less queries and faster payment.	

APPENDIX F.6
CITA ELECTRONIC PURCHASING PILOT PHASE 2

PRODUCTIVITY AND POTENTIAL SAVINGS FOR CONTRACTOR

One of objectives of the Phase 2 pilot project was to measure and report upon the productivity improvements and potential savings accruing to the contractor as a direct result of the re-engineered process. It is important to stress that any productivity improvements and savings reported in this Appendix only refers to those accruing to the contractor in their B2B trading relationship with the pilot supplier Pipes Valves and Fittings Limited.

Productivity Improvements

It was evident in Chapter 8 that there was a significant improvement in the re-designing purchasing process (see Table 8.4). In order to verify if these improvements would materialise, the author asked the pilot contractor to record the average time taken to carry out particular tasks associated with the currently operating purchasing process with the pilot supplier. Table F.5.1 summaries the contractor's estimates on the time expended on creating a purchase order. Table F.5.1 shows an average of 20 minutes is spent by contracting personnel in creating a single purchase order for the pilot supplier.

Typical tasks in creation of a purchase order		**Time**
1	Check if materials are centrally purchased	1
2	Prepare material requisition	
3	Send requisition to Purchasing	5
4	Check material requisition for correctness	3
5	Check if item on price list	3
6	If item is on price list, check if up-to-date	
7	Up-date price list on COINS	
8	Select supplier on COINS	3
9	Enter order and price on COINS	
10	Post / print out purchase order on COINS.	5
	Total in minutes per typical transaction	20

Table F.5.1. Time associated with the creation of a purchase order in the existing B2B purchasing process between pilot contractor and supplier

In the production of the average times, the contractor was briefed by the author to assume a typical purchase order of 5-10 lines for pilot supplier. The contractor reported that the main time-consuming aspect of the purchase order creation is when amendments have to be made to the purchase order in COINS. The contractor expanded on this point by explaining that, when the initial purchase order information was keyed into COINS by the contractor's purchasing personnel, this was then the definitive document against which all GRNs and supplier invoices were benchmarked.

The quantities inserted in the COINS system were maximum permitted quantities within that order. If the summation of deliveries for a particular product exceeded this quantity, the purchasing department was the only department that had authority to amend the order quantities. Similarly, if the product description did not match the original order information in COINS, the transaction could not be processed until the purchasing department amended the order. The contractor reported that, on average, one hour per day is spent by each of the purchasing personnel in amending purchase orders. In chapter 7 it was reported that the contractor in 2004 reported in excess of 10,000 order amendments. The cost to the contractor of amending purchase orders was significant.

Tables F.5.2 summaries the contractor's estimates on the time expended on processing a delivery for the pilot supplier. Table F.5.2 shows an average of 35 minutes is spend by contracting personnel in processing a delivery for the pilot supplier.

Typical tasks in receiving materials		**Time**
1	Nominate receiving personnel	0
2	Receive materials	
3	Inspect material against delivery dockets	15
4	Sign delivery dockets	
5	GRN of materials on COINS	20
	Total in minutes per typical transaction	35

Table F.5.2. Time associated with the receipt of material in the existing B2B purchasing process between pilot contractor and supplier

The contractor once again was briefed by the author to assume a 5-10 line description for the products delivered. The contractor reported that the average period of 15 minutes was dependent on the process working effectively. For example, if the

supplier delivery note contained the correct purchasing order number and if the product description did not match the original purchase order information in COINS, site personnel would be required to contact the purchasing department and request that the purchase order information in COINS is amended. Without this amendment the site administrator could not complete the GRN process. If there was no purchase order number, the time taken to resolve the process would be more time consuming. In chapter 7 it was reported that the contractor had in excess of 390,000 GRNs in 2004 that were re-keyed into the COINS system by site administrators. The cost to the contractor of completing the GRN process was significant.

Tables F.5.3 summaries the contractor's estimates on the time expended on processing an invoice for the pilot supplier. Table F.5.3 shows an average of 21 minutes is spend by accounts personnel in processing a pilot supplier's invoice.

Typical tasks in managing payables		**Time**
1	Receive invoice	11
2	Scanning of invoice on CIM software	
3	Enter details onto ERP system	
4	Release payment	8
5	Print cheque and remittance advice	2
6	Collate cheque and remittance	
7	Post to the supplier	
	Total in minutes per typical transaction	21

Table F.5.3. Time associated with managing payables in the existing B2B purchasing process between pilot contractor and supplier

The contractor once again was briefed by the author to assume a 5-10 line supplier invoice. The contractor reported that the average period of 21 minutes was dependent on the process working effectively. As stated earlier, if the invoice did not correspond to the original purchase order or, if no GRN was completed by site, the accounts personnel were unable to process the invoice. Accounts would need to ask the purchasing department to amend the purchase order and COINS, and await site to GRN the delivery before the payment could be processed. In chapter 7 it was reported that the contractor had in excess of 78,000 invoices with an average of 5 lines per invoice.

It was shown in Tables F.5.1, F.5.2 and F.5.3 that a total of 76 minutes was spent by the contractor on processing paperwork for a single invoice.

Tables F.5.4 summarises the contractor's estimate of the time expended on the newly design purchasing process with the pilot supplier.

Typical tasks in newly designed purchasing process		**Time**
1	Create Open Order in Coins*	0
2	Receipt of fax confirmation by site	0
3	Call-off material order by site	2
4	Verification of ePO from supplier	2
5	Receive materials	15
6	Inspect material against delivery dockets	
7	Sign delivery dockets	
8	GRN of materials on COINS – use of eGRN process	1
9	Verification of eInvoice from supplier	5
10	Release payment	3
11	Print cheque and remittance advice	2
12	Collate cheque and remittance	
13	Post to the supplier	
	Total in minutes per typical transaction	30

Table F.5.4. Time associated with newly design purchasing process between pilot contractor and supplier

**Note – The time expended in the production of the Open Order information is a one-off process that will need to be done for each supplier on a particular contact and thus does not figure in the calculations*

Table F.5.4 shows an average time period of 30 minutes to process a single transaction from the receipt of the ePOs to the final payment of the supplier invoice. The contractor estimated that the newly designed process could result in a 60% reduction in the time spent, on average, processing an entire transaction from purchase order stage through to final payment. The average time anticipated by the contactor for the newly designed process was 30 minutes, thus causing an overall potential saving of 46 minutes per transaction. This equates to a significant productivity improvement.

Figure F.5.5 summaries the overall productivity improvements in the purchasing process as a direct result of the re-designed purchasing process. It can be seen that savings were realised in all stages of the purchasing process.

Process	**Current Process**	**Re-designed Process**	**Savings in Time**
Ordering	20	4	16
Receiving/GRN	35	16	19
Invoicing	21	10	11
Total in minutes per transaction	76	30	46

Table F.5.5. Overall productivity improvements as direct result of the re-designing B2B purchasing process between the pilot contractor and the supplier.

Potential Savings for the Contractor

The calculation of savings for ordering, receiving and invoicing should, in theory, be based on the earlier calculated productivity improvements summarised on Tables F.5.1, F.5.2, F.5.3 and F.5.4. However, where the contractor will experience improved productivity levels, this will mean that the company will become more efficient and employees will be better deployed in their job roles to carry out more value-added tasks. Therefore, it would not be a correct approach by the author to solely multiply the time saving by appropriate hourly rates to determine the process savings.

The savings presented in Tables F.5.6 and F.5.7 was agreed with the contractor's financial controller. Table F.5.6 shows the average cost per transaction associated with the current purchasing process between the pilot contractor and supplier.

Process	Annual Cost per Annum €	Weeks per Annum	Hours per Week	Time per Transaction	Cost per Transaction €
Purchase Order	60,000.00	52	37	20/60	10.39
Delivery	35,000.00	52	37	35/60	10.61
Invoice	35,000.00	52	37	21/60	6.36
				Total	27.36

Table F.5.6. Cost per transaction associated with current purchasing process between the pilot contractor and the supplier

Table F.5.7 shows the potential cost per transaction should the contractor purchase the technology. The findings show a significant saving of over 60% on the original cost per transaction.

Process	Annual Cost per Annum €	Weeks per Annum	Hours per Week	Time per Transaction	Cost per Transaction €
Purchase Order	60,000.00	52	37	4/60	2.08
Delivery	35,000.00	52	37	16/60	4.85
Invoice	35,000.00	52	37	10/60	3.03
Cost of IT	€4,500/10,000 transactions				0.45
				Total	10.41

Table F.5.7. Cost per transaction associated with the re-designed purchasing process between the pilot contractor and the supplier

It is important to highlight at this point that the contractor would be expected to pay in the region of €22,500 to purchase the COINS ETC solution. Thereafter, the contractor would be charged on a sliding scale per transaction (purchase order creation). At the time of writing this thesis, this would equate to €7,125 per 20,000 transactions per annum and €4,500 per 10,000 transactions per annum. It can be seen in Table F.5.7 that the initial cost is not included, as this is a once-off payment. However the €4,500 per 10,000 transactions equates to €0.45 per transaction.

The contractor reported, that in 2004, there were 596 separate purchase orders created by Pipes Valves and Fittings Limited and that this 2005 volume was unlikely to change significantly. Thus the potential savings per annum could amount to as much as €10,000 per annum. It is, however, important to appreciate that this is only one of many suppliers that the contractor trades with annually. Therefore, if the contractor could encourage other suppliers to trade electronically, the potential annual savings would be very significant.

NOTES