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Enabling the Re-engineering of Material Purchasing in the Construction industry by the Effective Use of Information Technology

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A Re-Engineered Solution for Purchasing Materials in the Irish Construction Industry by the Effective Use of Integrated Technologies

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Abstract

The current methods of ordering, delivering and invoicing of materials in the construction industry is enormously inefficient, with vast quantities of paperwork, duplication of effort, scanning, re-keying and resolving mismatches between invoices, delivery dockets and purchase orders. This paper sets out the results of a successful 2005 pilot project which achieved a three-way electronic match of the purchase order, delivery note and supplier invoice information. The paper goes on to describe the opportunities and challenges of introducing such a system in the Irish construction industry.

Key words:- Purchasing, Materials, re-engineering, construction.

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 Communications Technology (ICT) (Thomas and Hore, 2003; Gunnigan et al., 2004; Hore and West, 2005a).

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).

This paper will present the methodology and results of a pilot project which sought to re-engineer the purchasing process, by seeking to adopt a fully integrated ICT solution, which achieved a dramatic improvement in the overall levels of productivity with subsequent cost reduction. The paper goes on to describe the benefits and challenges of introducing such a system in the Irish construction industry.

Traditional Construction Material Purchasing Procedures

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

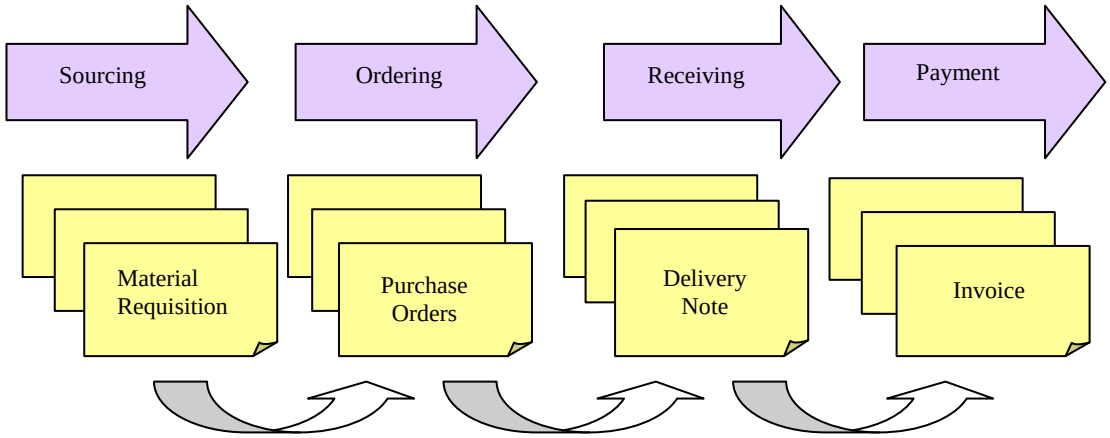

Figure 1.1. Traditional material procurement process

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 (PO) 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.

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 (Hore and West, 2005b). 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).

The Use ICT in Achieving Business Processing Re-Engineering

Business Process Re-Engineering (BPR) represents an effort to redesign and re-organise business processes, such as the material purchasing process outlined earlier, in order for an organisation to obtain dramatic improvement in process performance (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."

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).

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.

However, the re-engineered process presented will not be a "slash and burn" approach as advocated by Hammer and Champy (1993). 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 (Hore and West, 2005c).

The Pilot Project

The overall aim of the 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.

Pilot Project Team

The authors sought to secure the participation of trading parties together with ICT vendor providers. Figure 1.2 illustrates the relationships or links between the key participants on the pilot project.

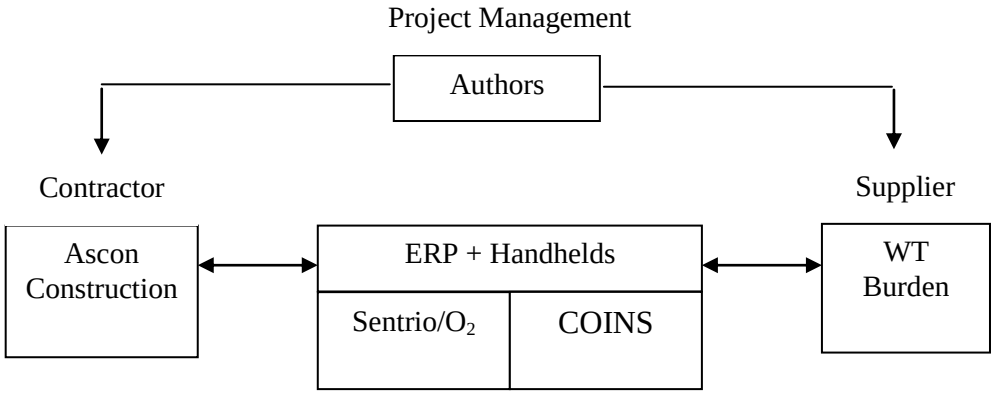

Figure 1.2. 2005 pilot project team

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 1.3.

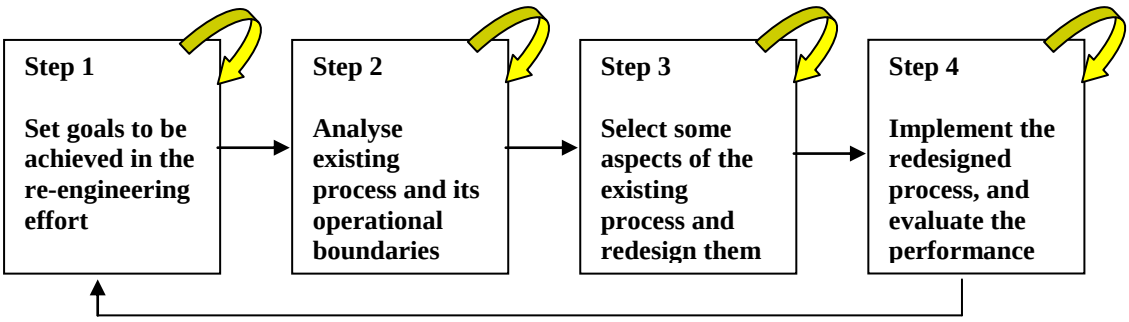

Figure 1.3. Re-engineering methodology adopted in 2005 pilot project (Li, 1996)

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.

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.

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, the focus was the source of the PO information was singled out in re-designing the process. In addition 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.

Stage 1 - Set goals for re-engineering

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. The specific goals identified by the pilot team included:

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.

Stage 2 - Analysis of Existing Processes and Operational Boundaries

The author carried out a detailed examination of the contractor's existing purchasing process. This involved mapping the process flow charts for the material ordering, material receiving and invoice processing. Following the completion of this exercise it was evident that many inefficiencies existed in the current process adopted by the contractor.

Table 1.1 summaries the overall number of non valued-added tasks associated from the receipt of the PO to the final payment of the supplier's invoice.

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 1.1. Extent of non-value tasks within a typical purchasing transaction present in contractor's purchasing process

The contractor had in recent years invested in Enterprise Resource Planning (ERP) software that integrated the various facets of their business activities including purchasing processes. Figure 1.4 illustrates diagrammatically the operational boundaries of the ERP system and its use in the pilot project.

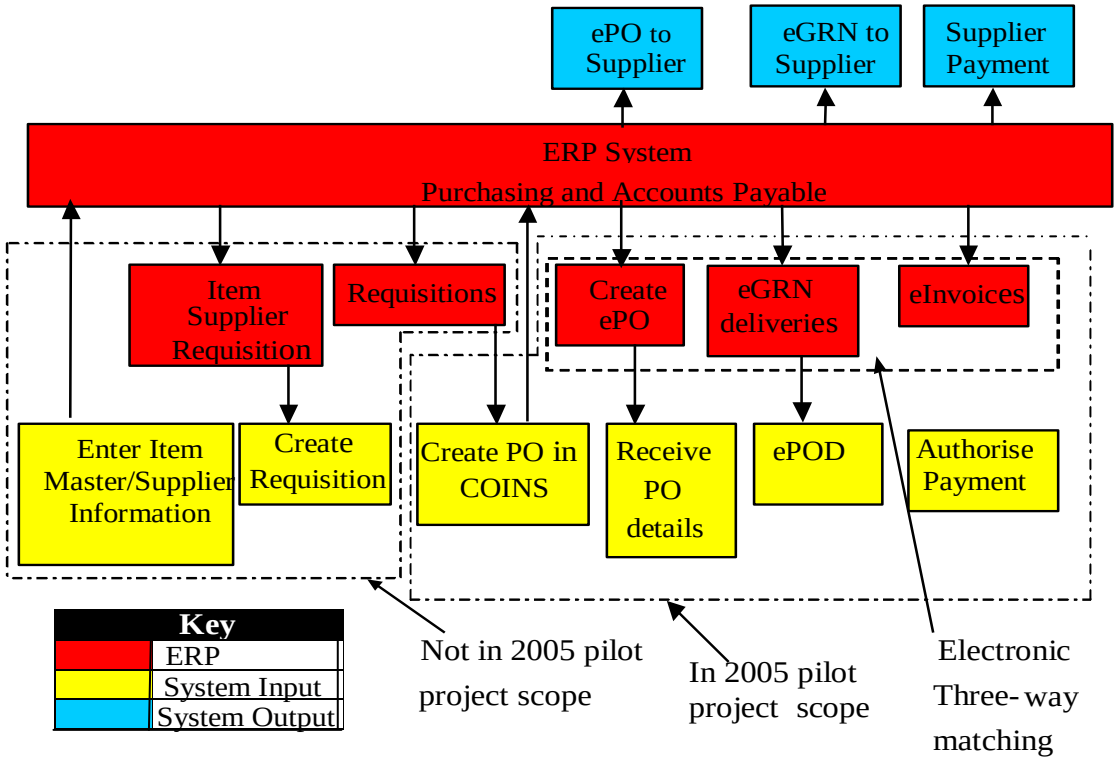

Figure 1.4. Operational boundaries of 2005 pilot project

It can be seen from Figure 1.4 that the contractor retained the requisitioning of materials outside the scope of the project. In the case of a bulk order, site personnel

requisitioned 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.

Stage 3 - Select aspects of the existing process to redesign

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. Figure 1.5 outlines a high level view of the re-engineered purchasing process adopted by the project team.

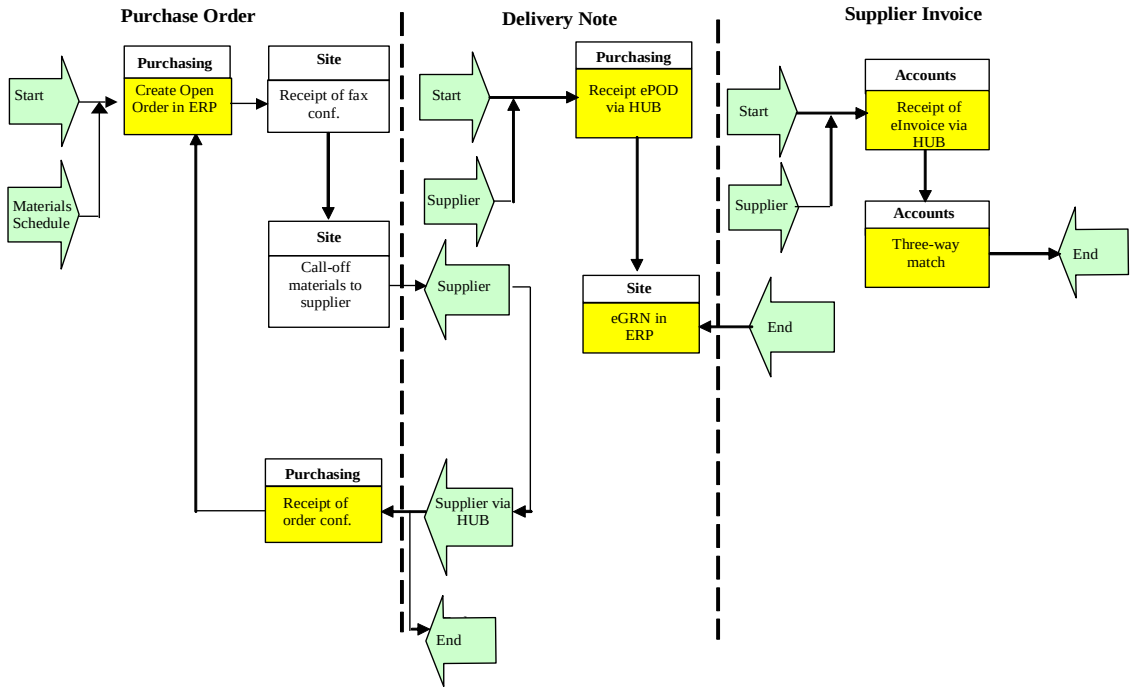

Figure 1.5. Re-engineered purchasing process

The process commences with the contractor consulting the material schedule for the project and creating an Open Order in their ERP software. This triggers an automatic facsimile to the site, which in turn provide site personnel with the authorised PO number from which to order the materially verbally from the supplier. The supplier will in turn create the ePO and send this information to the contractor via the HUB directly into the contractors PO workbench in their ERP system. The material is then dispatched and delivered to site. On arrival on site the material is checked and signed for electronically using a handheld device such as a Personal Digital Assistant (PDA). This in turn creates an Electronic Goods Received Note (eGRN), which is sent to the contractor via the HUB directly into the GRN workbench in their ERP system. The ePOD information will then allow the supplier to

create an Electronic Invoice (eInvoice) which is sent to the contractor via the HUB directly into the invoice workbench in their ERP system. The contractor should now have a three-way electronic match of the PO, eGRN and eInvoice. Table 1.2 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 1.2. 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, the necessity to approve the PO Confirmation and the electronic signature of the handheld device. There will be no necessity to photocopy extensively or print documentation other than to receive the Open Order details initially. There will be a requirement to allow interrogation of the ERP system with limited re-keying of information with respect to PO, delivery note and invoice confirmations.

Stage 4 - Implement and evaluate the new process

The proposed ICT infrastructure to be adopted involved the electronic transfer of PO, delivery notes and invoices via a central web-based repository as mentioned previously, the HUB. Figure 1.6 illustrates the ICT infrastructure.

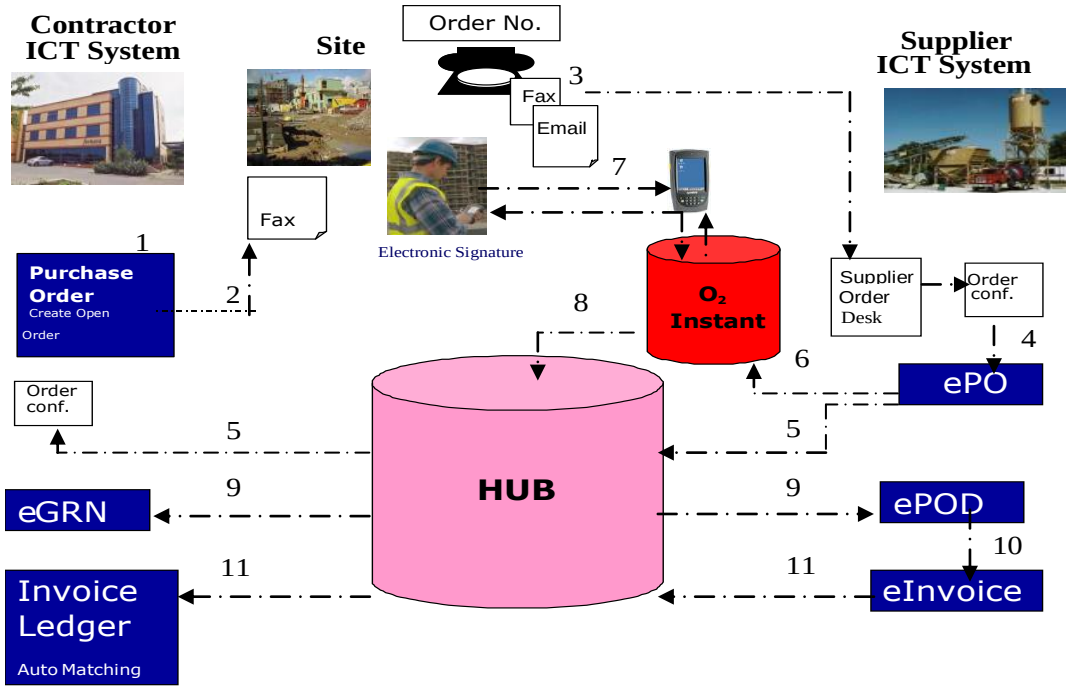

Figure 1.7. Proposed trading process and ICT infrastructure

The HUB is able to convert any incoming EDI, XML or spreadsheet documents from either the contractor's ERP system or the supplier ERP system into a format suitable to the particular receiving ICT system.

The proposal adopted involved the trading parties creating an Open Order in the contractors ERP system (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 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 HUB. The HUB converted the data into a 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 ePO created by the supplier was dispatched to the O_2 Instant repository, which, in turn, routed the message to a handheld computer (Step 6). The supplier delivered the material to site and the contractor electronically signed the PDA. The ePO is routed back to the O_2 Instant repository (Step 7) and onto the 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 an 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 HUB to the contractor's invoice workbench on the ERP software (step 11).

Evaluation of Pilot

While it is clear that the re-designed process has potential to remove the inefficiencies highlighted earlier, it was, nevertheless essential to test the process in a live site environment.

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. The decision to invest in the technology by the contractor, however, will depend on a sufficient number of their suppliers investing in the use of this technology also. 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 Table 1.36. It was shown that approximately 45 minutes could be saved per transaction by adopting the re-engineered solution.

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 1.3. Overall time improvements as direct result of the re-designing B2B purchasing process between the pilot contractor and the supplier

The authors found 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 the pilot supplier was a relative small volume supplier to contractor, in comparison to others. The contractor reported 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.

The vast majority of original objectives, identified earlier, were fully achieved. Table 1.4 summarises the achievements of the pilot project objectives.

Pilot Project Objectives	**Observations**
To document the current trading procedures utilised within the contractor's organisation.	This was the first step in the re-engineering process This involved mapping the process flow charts for the material ordering, material receiving and invoice processing.
To identify the inefficiencies that currently exist within the contracting organisation.	Table 1.1 outlined the inefficiencies present in the existing purchasing process. This principally involved manual work, re-keying of information and extensive photocopying.
To re-design the purchasing process with a view to addressing the inefficiencies that currently exist.	The focus for re-designing the process was the source of the PO information. The logic involved maintaining a single original sources for all purchasing document which would in turn allow for an electronic matching of the original PO, GRN and supplier invoice.
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.	The proposed ICT infrastructure to be adopted involved the electronic transfer of PO, delivery notes and invoices via a central web-based repository.
To execute the proposed re-engineering process on a live project.	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.
To measure and report upon the productivity improvements and potential savings accruing to the contractor as a direct result of the re-engineered process.	The contractor reported potential annual savings but concluded that they needed a larger number of their supply chain to implement the technology for it to be commercially viable.

Table 1.3. Achievement of the 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.

Conclusion

The overall aim of the 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 (Hore, West and Gunnigan, 2004).

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