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A PROPOSAL FOR RE-ENGINEERING THE PROCUREMENT OF BUILDING MATERIALS BY EFFECTIVE USE OF ICT

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Abstract. This paper seeks to establish the case for re-engineering the procurement of materials in the Irish construction industry. The authors make their observations from witnessing, first-hand, the operation of a purchasing function in a large contracting organisation in the Republic of Ireland. The authors identify the core problems that exist in the current mainly paper-based process and present a strong case for the re-engineering of the process by the adoption of a fully integrated Information Communications Technology (ICT) solution.

1. Introduction

E-commerce (EC) technologies can significantly contribute to increased transparency, productivity and competitiveness, as already demonstrated by other sectors (DoE and LG, 2002). Despite over two decades of significant advancements in ICT, the adoption of such technology in the Irish construction industry, particularly in small enterprises, has been largely piecemeal (Forfas, 1999). Recent figures estimate that the value of output for the Irish construction sector is €20.1 billion accounting for up to 21% of Gross National Product (DoE and LG, 2002). Despite the rapid development of ICTs, the Irish construction industry profits from it insufficiently (Forfas, 1999).

It is generally accepted that building materials account for up to 50% of all construction costs. In this 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 Electronic Data Interchange (EDI) into its purchasing system. The cost of processing an invoice was found to be SEK 300 (approximately US\$45). 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 information technology in the 1980's delivered disappointing results, largely because companies tended to use technology to mechanise old ways of doing business.

In 1990, Hammer concluded that it is not enough to simply impose isolated software packages or systems to address a specific 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 (based on a wide knowledge of ICT)), must be fully understood and this re-engineering must be founded on a complete re-appraisal and re-design of the entire purchasing process, from sourcing to final payment of suppliers.

The purpose of this paper is to share the experience gained by the authors in carrying out an observation study in 2002 and to identify the main problems that exist with the currently mainly paper-based process adopted in the purchasing of materials in the Irish Construction Industry. The authors conclude that the re-engineered solution will be enabled by the adoption of a fully integrated ICT solution, which will explicitly deal with all the problems that currently exist.

2. Traditional construction material procurement

Purchasing procedures typically involve a paper-based communication process between the purchaser and supplier. Evidence shows that the construction industry is lagging behind other industries globally in adopting new technologies (Kong et al, 2001). The process invariably commences with the sourcing of the materials. This typically involves site personnel requisitioning the project material requirements on a daily basis. 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 is made following the matching of the invoice to the original purchase order and signed delivery docket. Kong et al (2001) identified the limitations of the traditional material procurement process. As every step is reliant on input from one or more individuals, there are frequently problems in the process. For example, the requirements of the contractor are misinterpreted by the supplier, a docket goes missing, transcription errors occur, the invoice is not correct, the goods are not all delivered at the same time, the delivery docket does not match the order, payment is held pending matching of documents, etc. Any of these problems can add significant delay and cost to the process.

3. Observation Study

The purpose of the observation study was to investigate the current level of inefficiencies present in the ordering, receipt and payment of building materials in a large contracting organisation. The project selected for observation and analysis was a mixed development consisting of a basement incorporating a public house and nightclub; retail outlets on the ground floor level; five floors of apartments and a five storey office block with a total floor area of approximately 55,000m².

It was decided that three supplier accounts would be monitored. Table 1 summarises the mixture of transaction types observed. Each of the selected supplier accounts was tracked over a defined period. The observation study included matching the selected number of invoices back to the initial site requisitions, purchase orders and delivery dockets. The study specifically identified the relative success of matching purchase orders, delivery dockets and supplier invoices which had an influence on the payment periods achieved.

TABLE 1. Summary of supplier accounts investigated.

Suppliers Selected for Observation	Nature of Materials Supplied	Period of Observation	Supplier Type
Supplier A	Multiple low volume transactions for specialist fixings, for concrete and blockwork.	November 2001 to August 2002	Specialist Concrete Fixings
Supplier B	Bulk supplies of in-situ concrete of varying specifications	November 2001 to March 2002	Ready-Mixed Concrete
Supplier C	Mixture of low and high volume general building materials	November 2001 to February 2002	General Building Supplies

3.1. PAYMENT PERIODS OBSERVED

An obvious extraction from the data was to examine if the supplier was receiving payment within their standard 60 day credit period. Table 2 summarises the periods of payment (from receipt of invoice to issuing payment) for suppliers A, B and C. In the case of Supplier A, 64% of invoices observed were paid in excess of the 60 day credit terms agreed with the supplier, although only 12% of invoices were paid in excess of 80 days. For Supplier B, 76% of invoices were paid in excess of the 60-day credit terms agreed with the supplier, while only 3% of invoices were paid in excess of 80 days. The majority of invoices for Supplier B, however, were

paid only marginally over the 60 days credit period. In respect to Supplier C, 100% of invoices were paid in excess of the 80 days. When further investigated, the reason for this delay was generally due to queries on invoice prices not matching those on the original purchase orders.

From the observation study it can be concluded that the period of payment is largely dependent on the nature of the material supplied. In respect to supplier B, the average payment period was 66 days, which was only marginally above the 60 day credit terms agreed with the supplier. The main reason for this is that bulk supplies, such as concrete, can be administered by simply "calling-off" deliveries from a single purchase order. The management of payables for building suppliers such as Suppliers A and C, required multiple paper transactions involving many small items that needed to be matched successfully in order that payment could be authorised.

TABLE 2. Payment Periods achieved during observation study.

Supplier	Total number of Invoices	Invoice payment period			Average time in days
		Less than 60 days	Between 60-80 days	More than 80 days	
A	17	6	9	2	62
B	34	2	31	1	66
C	41	0	0	41	113

3.2. MATCHING PURCHASE ORDERS, DELIVERY DOCKETS AND SUPPLIER INVOICES

The next stage of the observation study involved the process of matching site requisitions, purchase orders, delivery dockets and supplier invoices. A number of discrepancies were identified, in particular between site requisitions and purchase orders and also between purchase orders, delivery dockets and supplier invoices. The extent of discrepancies between these documents made the problem of matching difficult and time consuming. The role of the purchaser involved receiving site requisitions forms, from which they prepared multiple purchase orders for different suppliers. Completeness of information on the initial site requisition form was an issue in both Supplier A and C accounts. Invariably there was a considerable degree of discussion between site personnel and purchasing before the official purchase order could be dispatched to the supplier. This typically involved the purchasers ringing up site personnel and clarifying the particular requirements of the site. This was mainly due to the fact that there was insufficient information on the initial site requisition to prepare a

specific purchase order. It also involved the purchasing department ringing the supplier and confirming the order verbally. Occasionally, the supplier would confirm that they did not have the particular materials, suggesting alternatives to the original site requisition. It was also typical that personnel on site would ring up purchasing and request additional materials verbally. In response to this, purchasing would add this additional request for materials onto a purchase order, without the receipt of a site requisition.

The above problems in communication were especially evident in Supplier A's account. The main reason for this was the highly technical and specialist nature of the material ordered. The information provided by the site was most likely to have been extracted from an out-of-date on-site supplier catalogue. Of the 17 transactions observed, no single original written site requisitions mirrored exactly the formal purchase order and, in many instances, were quite different in regard to quantity and specification of materials finally ordered. The conclusion that can be drawn from these findings is that the site requisition was only an initiator of the purchase order and should not be expected to match the exact details of the purchase order.

The exercise of matching purchase orders, delivery dockets and supplier invoices involved manually retrieving the paper copies of the purchase orders from filing, entering these details into a AS400 binary operating system and inputting the internal registration number allocated by the accounts department for that particular invoice. Then it was 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. These seldom matched, a problem compounded by the extent of missing documentation. The main problem identified in the matching process (which delayed the issuing of an instruction to proceed to payment) was the low level of success achieved in matching purchase orders to supplier invoices (Table 3).

TABLE 3. Matching purchase orders to supplier invoices.

Supplier	Purchase Orders	Invoices	Successful Matching
A	24	17	4
B	2	28	2
C	23	35	1

In the case of Supplier A, only 4 purchase orders were successfully matched in regard to quantity and price against supplier invoices (17% success rating). There was no matching problem encountered with Supplier B due to the nature of the material being supplied and the relatively few purchase orders issued. Supplier C's success rating was the least impressive, with only 1 successful match of a purchase order to a supplier invoice. In all

cases, the delivery docket matched the details of the invoice, as the supplier controlled this process.

In this case study only 3 suppliers were selected for observation. Clearly there were many suppliers transacting with the contractor during the period of the 23-month project. For example, during the period between the 1st November 2002 and 1st February 2003, some 53 individual suppliers made 1,170 individual supplies, concluding with the issuing of 485 supplier invoices. Added to the fact that this project was only one of many projects currently on site within a single region of the observed company, illustrates that the full extent of the problem is enormous.

3.3. SUMMARY OF FINDINGS

The results of the observation study underpin the contention that the current traditional paper-based approach to material procurement is enormously inefficient. There are too many pieces of paper, there are too many people involved in the process and there is not sufficient IT investment to automate much of the paper-based audit trail. In summary, the following problems need to be addressed by any re-engineered solution:

- Manual reliance - Most (if not all) of the purchasing process is manual, with little to no reliance on technology.
- Matching inefficiency - Two/three way matching of items leads to re-handling of paperwork many times until matching occurs, which increases the probability of errors occurring between the various documents for single transactions
- Deficient supplier information - Personnel can only collect a limited amount of information about suppliers and their products through the collection of physical catalogues. The catalogues, in turn, are cumbersome to use, require large storage areas and can quickly become out-of-date.
- Poor integration - The paper-based system is also dependent on ensuring that all appropriate departments obtain copies of the documents necessary to do their job. If a small percentage of those documents are delayed, lost or misplaced, there will be delays in the payment process as a whole.

4. Technologies available

There are established technology tools used in everyday business purchasing processes, including fax machines, fax/modem cards, Internet fax and e-mail. Leenders et al (2001) described a number of "off-the-shelf" purchasing software packages available in the market. Notwithstanding the software selected by the main contractor, behind the scenes of today's construction purchasing departments, there is a consortium of individual suppliers that

use different software applications, characterised by poorly synchronised electronic information handling (IT WG, 2002).

EDI has become the preferred way of compressing and transmitting data between a buying firm and its suppliers in many sectors (Leenders et al, 2001). There are however, many limitations in the use of EDI such as cost, the width of connectivity with a business supply-chain, by use of Value-Added Networks (VANs) and dedicated EDI servers. In the early twenty-first century, one dilemma for those with well-developed EDI systems is whether or not they should migrate to a Web-based system. The growing use of eXtensible Mark-Up Language (XML) technologies will enable automated electronic communication between the buyer and supplier in transmitting order, receipts and payments. XML received WWW recognition in February 1998 (Leenders et al, 2001). Other technologies that will play a key role in the re-engineered process includes Enterprise Resource Planning (ERP) software such as that provided by SAP and Oracle; Auto-ID Technologies such as bar-coding; On-line supplier catalogue capability and Pen computers or Personal Digitiser Assistants (PDAs).

5. Matching IT to Problems

It is important that any re-engineered solution addresses explicitly the problems identified earlier in this paper. Table 4 links the proposed technological solutions to the problems identified in the observation study.

TABLE 4. Matching problems to technologies.

Problems	Technology
Manual reliance	The combined use of XML messaging, the Internet, Auto-ID technologies, PDA's and ERP software will provide the integrated solution which will minimise the need for manual administration.
Matching inefficiency	Use of bar-coding capability integrated into a hand-held device will allow for data to be captured and transmitted for matching electronically.
Deficient supplier information	Use of on-line catalogues will alleviate the need to maintain large volumes of physical supplier catalogues.
Poor integration	ERP functionality will allow for a corporate wide integration between the various departments in a contracting company.

The authors are not proposing that particular software applications solve individual, unilateral problems but that the re-engineered solution collectively addresses all the above problems. The solution will enable a level of integration between a handheld application with an electronic

signature capture capability; wireless transmission of Proof of Delivery (POD) from the point of activity to the suppliers ICT system; to the contractors ICT system and to an independent central Web-based server. The Web-based solution will provide on-line access to an image of the POD, which will allow for automated matching of the order, the delivery record and the supplier invoice.

6. Conclusion

From the observation study it is evident that the significant reason for the delay in payment of supplier invoices was the absence of appropriate integrated technology. As a consequence of the lack of successfully matching and payment delays experienced during the observation study, there is a strong case to re-engineer the process in order to overcome the problems that currently exist in the process. This re-engineered solution is founded on an integrated ICT solution with each of the proposed technologies compatible with the ability to exchange information freely between applied technologies. The benefits that will accrue from the re-engineered solution are reduced costs; reduced administration; reduced risk from unsigned PODs; improved tracking; prompter payment; improved reporting and increased control.

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