

The use of electronic information exchange on construction alliance projects

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Abstract

Several methods of electronic data transfer are available to construction organisations and their clients. These technologies are collectively called Information Exchange (IE). This paper reviews partnering, alliances and Information Exchange. A case study involving a major industrial project constructed under an alliance agreement was used to highlight the important issues relating to these areas of study. This study also provided the focus for a survey of 67 major construction organisations. The findings of this survey confirmed that construction alliance and IE have reciprocating benefits which together produce a significant impact on the project. © 1999 Elsevier Science B.V. All rights reserved.

Keywords: Alliances; EDI; Electronic information exchange; Partnering; Electronic commerce

1. Introduction

The construction industry does not have a good record of completing projects on time [1]. With such a poor record it is not surprising that a recent survey [2], found that in UK 52% of all construction projects end with some type of claim. The construction industry is renowned for the adversarial nature of the relationship between the parties concerned. Tired of the traumas of litigation, construction clients have sought ways of preventing and resolving construction disputes. Their aim has been to find new forms of agreement to secure the delivery of the facilities they require on time, at cost and to the specification required without the threat of claims and arbitration.

One such technique is partnering. Partnering is essentially a consensus building process that re-orientates the parties from a ‘them and us’ mentality to a ‘we’ mentality [3]. Partnering may be ‘strategic’, or ‘project’ based. The latter is also known as an alliance: several organisations aligned with each other for mutual benefit on a project basis, sharing the risks and rewards and eliminating the adversarial relationships normally found on construction projects. The introduction of such new business processes has required construction organisations and their clients to review existing business methods and evaluate new techniques and new technologies. Construction organisations have sought to discover how this form of agreement may best be used on construction projects. This debate still continues and focuses on such issues as: suitable types of project; the roles of the key personnel; contractual arrange-

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ments; and implications for the supply chain [4]. The writers contend that added to these issues should be that of information exchange and information management.

From the inception of the construction project through its design, construction, mobilisation, operation and demolition all parties involved with the project are dependant upon information. The information may be commercial, such as a purchase order, financial, such as an instruction for payment or technical, such as graphical information on a drawing [5]. Experts have estimated that if this information could be managed effectively then savings of up to 25% in the cost of construction could be achieved [6]. Parallel to the emergence of new methods of procurement has been the development of new technologies for electronic data transfer. These include Electronic Data Interchange (EDI), Electronic mail (E-mail), Document Image Processing, and CAD Data Exchange. These are known collectively as Information Exchange (IE). In some industries, these technologies have had a considerable impact upon the business processes and have resulted in new ways of working. Our research has found that few construction organisations are currently using IE on a regular basis, either internally or with their business partners [7]. This is in direct contradiction to those who argue that, in the current construction market, organisations need to share or exchange information quickly within their own organisations, and to and from their business partners anywhere in the world, and that the latest communication technologies should be applied [5].

This paper focuses on this important issue of IE within projects constructed under alliance agreements. Following a review of the background to IE and partnering a case study where IE was used to facilitate information sharing is described. Details of this case study are reviewed and the benefits of the IE assessed. This is followed by summary results from a questionnaire survey undertaken to obtain a better overall view of the use of IE on other projects constructed under alliance agreements.

2. Information exchange

This section summarises Electronic Data Interchange (EDI), Information Exchange (IE), and Multi

Format Exchange (MFE), and discusses their application within the construction industry.

2.1. Electronic Data Interchange, EDI

EDI has been defined as “the transmission in a standard syntax of unambiguous information of business or strategic significance between computers of independent organisations” [8]. The essential feature of EDI is the structured nature of the data transfer, enabling the data to be integrated into the recipient’s internal database system with no manual intervention. A number of standards exist to ensure the integrity of the data, and its presentation in a universally acceptable format, including the three major EDI standards utilised for the transfer of commercial data in the UK: Tradacoms; ANSI X12; and EDIFACT [9].

EDI has had considerable impact on the banking, manufacturing and retailing industries. The benefits of this technology have been readily acknowledged in these industries since the 1980s and the use of EDI is now a prerequisite for industry participation. The main benefits from EDI have been stated as: reductions in paper handling and clerical costs; elimination of data re-keying; reductions in data processing errors; savings in mail costs; increased production efficiency; and a reduction in supply and distribution cost [10].

A number of messages (particular structures of data for exchange between trading partners conforming to EDI standards) are available for use in the construction industry covering all aspects of the trading cycle. For construction, a number of industry specific messages have also been designed to augment those adopted from other sectors. These include the transfer of bills of quantities, tenders and valuations [11]. These have been developed by EDICON, the industry group established in the UK to promote EDI and develop appropriate message standards.

EDI is only one form of electronic data exchange. Whilst the existence of other technologies is indisputable, how they inter-relate and their potential and anticipated use in construction is widely debated. In this paper these issues are discussed under the sub-headings of Multi Format Exchange (MFE), and Information Exchange (IE).

2.2. Multi Format Exchange, MFE

MFE is the name given to EDI where additional data are appended to the main EDIFACT message either by embedding the data or by attaching the data via another linked transmission. Whilst the electronic transfer of drawings has become widely accepted by the use of standards such as DXF, these formats are not particularly suitable for the ordering of materials where, in addition to purchase order information, there is a requirement to include a simple sketch showing the dimensions of the materials item (these sketches are less formal than construction drawings, and may not be produced on CAD workstations). This can be achieved by attaching a graphics file to the main message. EDICON and other European organisations are currently surveying users to identify the formats used for the transmission of such information and how the data is combined [12].

2.3. Information Exchange, IE

The simplest form of IE is the exchange of text files, usually in the standard ASCII format, using floppy disks. This type of data transfer originated on an informal basis but has become accepted practice in many parts of the industry. Examples located in our industry search included the experience of some Local Authorities for tender bid submissions [13].

E-mail is another form of IE, and may become one of the core technologies for data exchange and sharing in the future [14]. E-mail enables informal communications within and between organisations, with advanced systems providing workflow applications which can organise the transition of data through an organisation and keep track of its progress [15]. To date, the use of E-mail in construction has been predominantly by the larger construction organisations who have sought to link personnel in their offices over Local and Wide Area Networks. A survey undertaken by the Construction Industry Computing Association (CICA) [16], anticipated a rapid growth in the use of E-mail within UK construction which was expected to increase to 41% of the companies surveyed by the end of 1995.

2.4. Lack of use of EDI in the construction industry

Our research revealed that few construction organisations are currently using any form of EDI on a

regular basis. Despite the attractions of EDI to the construction industry and the energies of EDICON, construction organisations have failed to adopt the technology as anticipated at the start of the decade. Surveys such as those instigated by the CICA and Peat Marwick McLintock [16,17], forecast some 15% of construction organisations would be using EDI by 1995. These forecasts have proved to be optimistic with the current level of EDI use in construction reported by Akintoye and McKellar [18] as 8% for contractors and 11% for subcontractors, although more organisations are considering implementation. The findings of other researchers [19], indicate that the EDI applications that do exist are generally concentrated between builders' merchants and their suppliers, and are restricted to the receipt and approval of invoices.

It is significant that at this point in time the CITE (Construction Industry Trading Electronically) group, which includes all the major UK construction organisations and representatives of the major QS practices have, whilst recognising the importance of the transfer of Bill of Quantities Data, shunned the EDIFACT message standard and the use of EDI, preferring to adopt their own standard for BoQ data using floppy disks [20].

3. Partnering and the construction alliance

3.1. Definition

Partnering is "A relationship based upon trust, dedication to common goals and an understanding of each other's individual expectations and values. Expected benefits include improved efficiency and cost-effectiveness, increased opportunity for innovation and the continuous improvement of quality products and services" [21].

There are two different partnering options: strategic partnering, where organisations work together over a series of projects; or project partnering, where companies work together on a one-off basis for a single project [22]. Such relationships may involve only two parties or may be extended to include any number of organisations. The strategic approach may extend to aiming to become acknowledged world

leaders in a particular field of construction services [23].

One common form of partnering is known as an alliance. The dictionary defines an alliance as “a union or association formed for mutual benefit” [24]. Another definition is “several organisations aligned with each other for mutual benefit on a project basis, sharing the risks and rewards and eliminating the adversarial relationships normally found on construction projects” [25].

An alliance is therefore a particular form of partnering which may include the client organisation and several others including contractors, suppliers, etc. The aim is to secure partnership in the provision of all the functions necessary from initial design through to construction and maintenance. An alliance may include several contractors who would normally be considered as competitors, but have joined together as each can supply specialist services for the project. The aim is therefore to produce a business relationship where: all parties seek win–win solutions; value is placed on long term relationships; trust and openness are norms; all are encouraged to openly address any problems; all understand that no one benefits from the exploitation of others; innovation is encouraged; each partner is aware of the other’s needs, concerns, and objectives, and is interested in helping their partner to achieve their aims [26].

3.2. *The benefits of partnering*

The main objective of partnering is to meet the client’s requirements in the most cost effective way [27]. Partnering brings substantial cost savings to the client. The ‘Trusting the Team’ report states that in project partnerships companies can expect to see savings of 10%. In strategic partnerships savings of 30% are achievable over time [22]. The benefits however go beyond cost savings. In both strategic and project partnering there is the opportunity to increase profitability and competitiveness. Partnering can deliver better designs, avoid defects, make the construction process safer, reduce claims and result in a project team that genuinely enjoy the experience of working together. For those contractors and suppliers engaged in strategic partnering, the benefits are continuity of work, the ability to plan resources, better control of quality, and the ability to train staff

[27]. It should be noted however that all these benefits are not achieved instantaneously. The ‘Trusting The Team’ report [22], stresses that it takes time to accrue the full benefits of partnering.

3.3. *The case study*

The project studied was the construction of an offshore oil installation. The entire project was let on an alliance basis with ten major partners. The client’s economic analysis of the oil-field showed it to be marginal, so a reduction in cost in the order of 50% from the original cost estimates was required to make it a viable investment. An alliance including Brown and Root, the design engineering management organisation was formed to design and construct the installation. The contract provided bonuses or penalties to all the partners, awarded proportionally according to the risk each organisation faced in the project. To facilitate a rapid completion at such a reduced cost, the partners had to be entirely committed to providing each other with all the data they required, and in a timely manner, and work closely to realise mutual benefits. A good illustration of this was in the design of the pipework on the platform. On previous projects, the design engineer would produce a ‘design’ drawing, and send it to the fabrication yard. The fabricator would then re-draft and amend the drawing to produce a construction or ‘fabrication’ drawing. On this project, a small team from the fabrication yard was situated in the design engineers’ offices. Working with the designers, a complete set of fabrication drawings were produced directly from the 3D CAD model, with the minimum of work required at the fabrication yard. This provided more accurate data, and reduced the overall cost and time of the drawing stage.

4. **The application of IE in construction alliances**

4.1. *IE as a core element in alliances*

This research sought to investigate the role of IE in partnering and alliance projects. There did not appear to be any extensive research into the use of IE on these types of project. The basis of any partnering arrangement is openness and the sharing

of information between the business partners. How was this achieved on a typical alliance project? Given the lack of enthusiasm for IE amongst the major construction organisations, was partnering a catalyst for a change in attitude? Could IE enhance and extend the basis of partnering agreements by providing a platform for more efficient working and new services to the client? Could partnering and IE produce a symbiotic relationship that brought about benefits far above those that may be achieved separately? These were some of the questions that this research sought to investigate through the case study and then the subsequent survey.

4.2. The IE infrastructure on the Andrew Project

The use of IT in the process industry is considerably more widespread than in the general construction industry. Greater investment in technology has generally provided access to computing facilities for all staff, and they are therefore more familiar with the application of technology than those in general construction. This provides a platform on which project communications can be considerably improved without prohibitive training costs. On the Andrew Project, for example, everyone in the design organisation has access to E-mail, and most partners have at least some E-mail links.

This ability to communicate effectively with other organisations has been developed further, with the implementation of a central server to receive and distribute project communications. The server is based on a conventional EDI system from a major VAN (Value Added Network) service supplier, General Electric Information Services (GEIS). The system provides a complete audit trail of all communications sent within the Andrew alliance, with controlled security and access.

On the Andrew Project the system was introduced, albeit not in its final form, to assist with the design and fabrication of the pipework on the platform. Representatives from the fabrication yard, Trafalgar House Offshore Engineering, worked in the design office with Brown and Root. Fabrication drawings were produced directly from the 3D CAD model and were later printed remotely at the fabrication yard over a network link. This obviously improves the speed and reliability of drawing delivery.

However, this is only a small improvement on a conventional drawing exchange process, which can be achieved in several ways. The major development on the Andrew Project was the extraction of data from Brown and Root's 3D CAD system. These data was sent to the fabricators in Teesside over a Megastream link. A program received and checked the contents of the transmission for integrity of the data. It was then mapped directly into the Trafalgar House database. This automatically provided a number of data fields, such as the drawing names and numbers, the type and number of welds in a pipe, its length, size and details of fittings. Previously, these data would have been taken manually from isometric drawings produced by the fabricators draughting team. With the provision of this data in electronic format the effort of re-keying is removed, and obviously the quality of the data is improved. The IE system ensured that the transfer of this data was carried out in a controlled manner, to guarantee the security of both organisations systems, and satisfied both parties requirements for improved data delivery without sacrificing quality.

The long-term objective of this development work was to set up an electronic network, which will connect all the suppliers and partners to the client and the rig, for use throughout the operational life of the installation. This would then remove a complete commercial interface from the procurement process, and assist with cost savings.

4.3. The benefits of IE on the Andrew Project

The case study identified the following benefits of using IE: guaranteed delivery of data; improved quality of data; reduced data handling; improved communication between the alliance partners; and reduced risk of project delay. Through the use of IE data delivery was guaranteed. The system provided automatic data management and a full audit trail. It was possible to ensure that pipeline details and drawings had been received by the contractor and to provide a record of the time and date of transmission. The quality of data received by the fabricators was enhanced as there was no risk of transcription errors through the re-keying of data. Communication links between the parties concerned were improved and the inefficiencies of waiting for information to

be delivered via other members of the alliance or third parties (e.g., courier companies), were removed. The risk of delay to the project was reduced because the improved communication ensured that data were delivered quicker. If after design checks revisions were required, these could be obtained from the design team at very short notice.

These benefits resulted in not only shorter delivery times but also improved general communications and teamwork between the personnel involved. Once the inevitable technical ‘teething troubles’ had been overcome and the procedures for transmission and receipt of information agreed, then the information exchange facilities improved not only the productivity of individuals, but also helped to contribute to the overall team-spirit. The receipt of data earlier rather than later meant more time to check the correctness of the proposed design. Any amendments became carefully considered solutions to the problem, not quick ‘fixes’ to problems necessitated by fear of delaying the construction team. This meant less changes and less frustration to all parties concerned.

5. The questionnaire survey

To augment the findings from the ‘Andrew Project’ it was decided to survey representatives of the member organisations of the European Construction Institute (ECI), to obtain their views of the use of IE on Partnering/Alliance Projects. The ECI is a research organisation whose member organisations comprise some of the largest client, engineering and construction organisations within the UK and Europe. The ECI was selected for the survey sample because of the range of construction projects with which the member organisations are involved. In addition, a previous meeting held by the ECI on the subject of Partnering had attracted considerable debate. Therefore, a good response to the survey could be anticipated.

Two copies of a three page questionnaire survey document were forwarded to each of the member organisations with a request that two senior project managers complete and return the document. The survey document was designed to obtain responses not only from those who had experience of partner-

ing projects but also those who did not. In this way it would be possible to ascertain whether senior managers’ experiences of project partnering met their expectations. To ensure a high response rate the survey document was prepared with the adoption of the best practice identified by Hoinville et al. [28], Fowler [29], and Prescott [30]. It comprised both closed and open questions. The respondents were invited not only to confirm specific statements but also to indicate their strength of feeling and to expand on their statements with appropriate comments. A draft version of the questionnaire was tested by inviting an independent party to review the questions and identify any part of the questionnaire that was ambiguous.

6. The analysis of the survey data

One hundred and twenty questionnaire documents were issued. Sixty-three responses were received of which four were incomplete. This gave a response rate of 49%. The responses were almost evenly divided between those that had experience of project partnering and those that did not. All the respondents were senior managers or project managers within their respective organisations. The majority of them were employed by contractors or design and construct organisations. When analysed by industry sector there was a predominance of organisations involved with offshore construction. This was confirmed with an analysis of the type of projects in which those with project partnering experience had taken part. The majority of these were large construction projects valued between £50 million and £500 million. The distribution of the respondents by type of organisation and industry sector is shown in Figs. 1 and 2.

The survey focused on the following issues: major organisations views on project partnering; whether Electronic Information Exchange (EIE) is essential for successful partnering; the different types of EIE currently being used; the functions within an organisation that benefit most from IE; and the organisational changes that result from the introduction of IE. Each of these issues is considered below together with a summary of the findings.

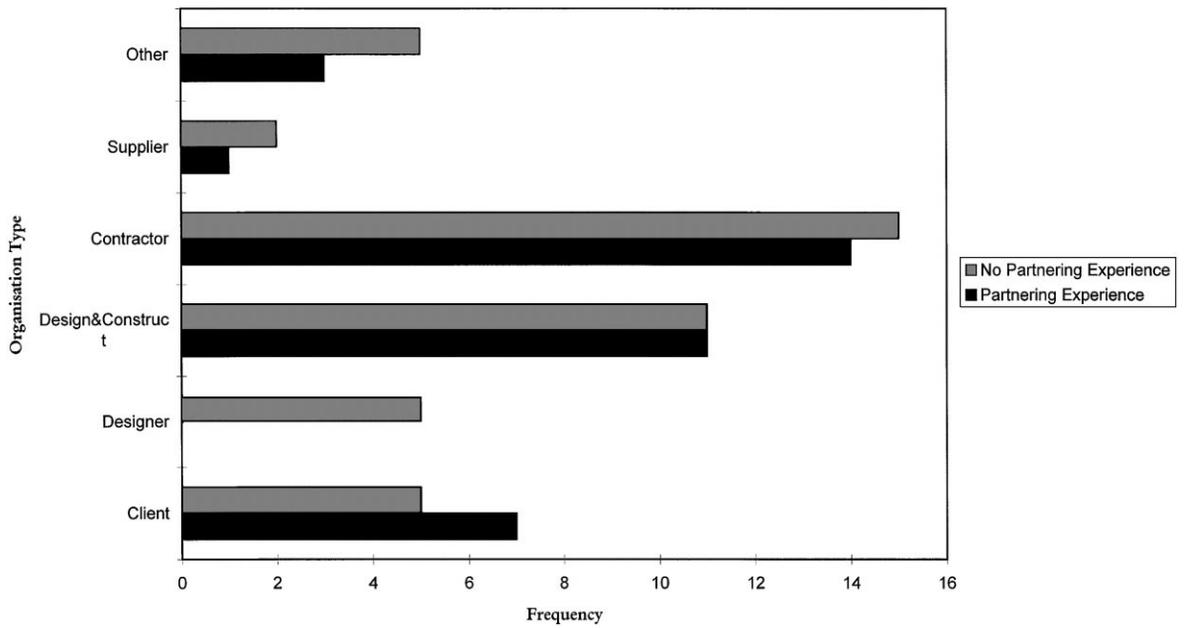


Fig. 1. Distribution of respondents by type of organisation.

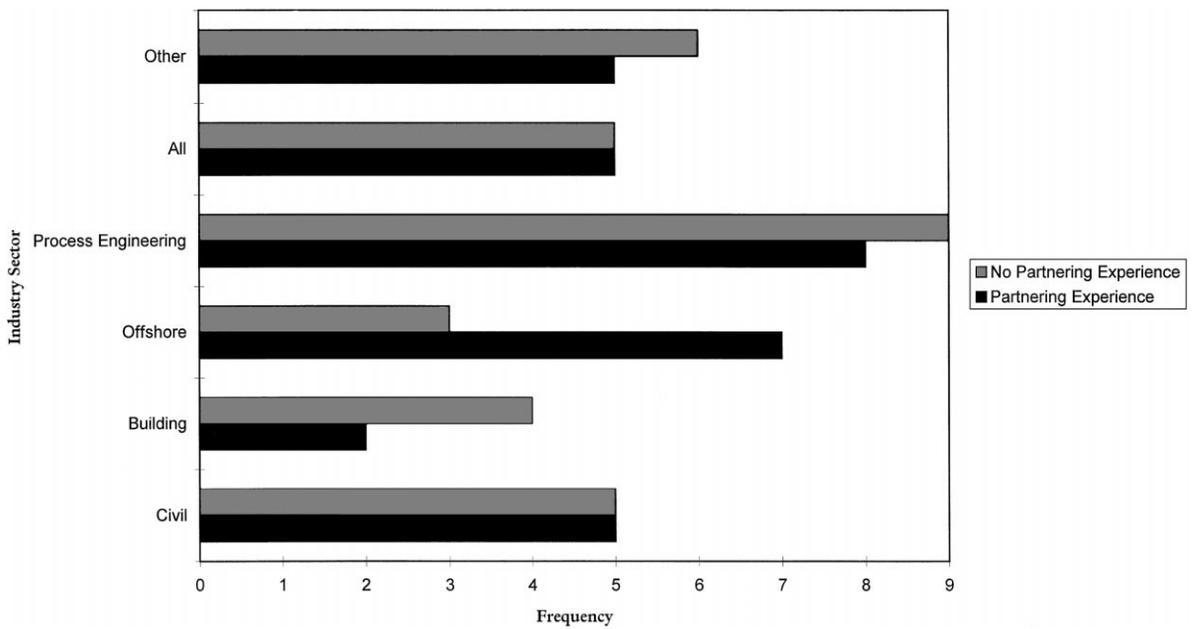


Fig. 2. Distribution of respondents by industry sector.

6.1. Major organisations' views on project partnering

Fifty-eight percent of the respondents considered that project partnering was the *only* way to obtain the cost savings currently required by construction clients. Forty percent considered that it was only by entering project partnering agreements that construction organisations would survive the current economic recession. These results indicate how important project partnering is viewed by both those with direct experience of this type of project and those who were only aware of this form of procurement through industry journals or their colleagues within the industry. Several respondents indicated that an option such as project partnering could never be considered the *only* way to obtain cost savings but that project partnering was probably the *best* way to reduce costs.

6.2. Was IE essential for successful partnering?

Given that alliances were extremely important to construction organisations, was IE essential for effective partnering? Eighty-two percent of the respon-

dents who had no experience of project partnering thought that fast effective IE would facilitate project partnering. Ninety-four percent of the respondents who had experience of project partnering considered EIE to be essential. Therefore, it was widely recognised that project partnering can only succeed with the sharing of project information. Any information relating to the project must be distributed quickly, efficiently and accurately. EIE was clearly the most appropriate medium for the distribution of project information.

6.3. What types of IE were currently being used?

What types of IE were currently being used? The results, (displayed in Fig. 3), show that a number of different IE technologies exist but no one technology predominates. Organisations select the forms of exchange most suitable for the style of the project, the level of communication required, and appropriate to their business partners. The respondents to the survey identified (in descending order of importance), CAD, E-mail and ASCII file transfer to be the most important. To the proponents of other technologies such as Document Imaging or EDI these results

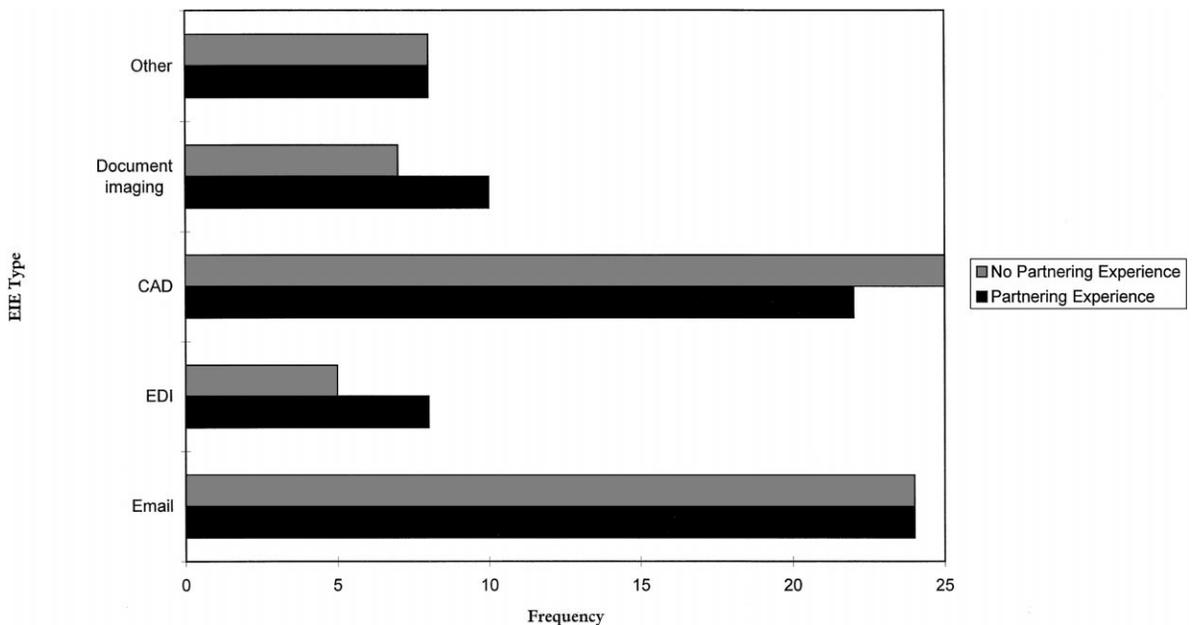


Fig. 3. Current EIE in use.

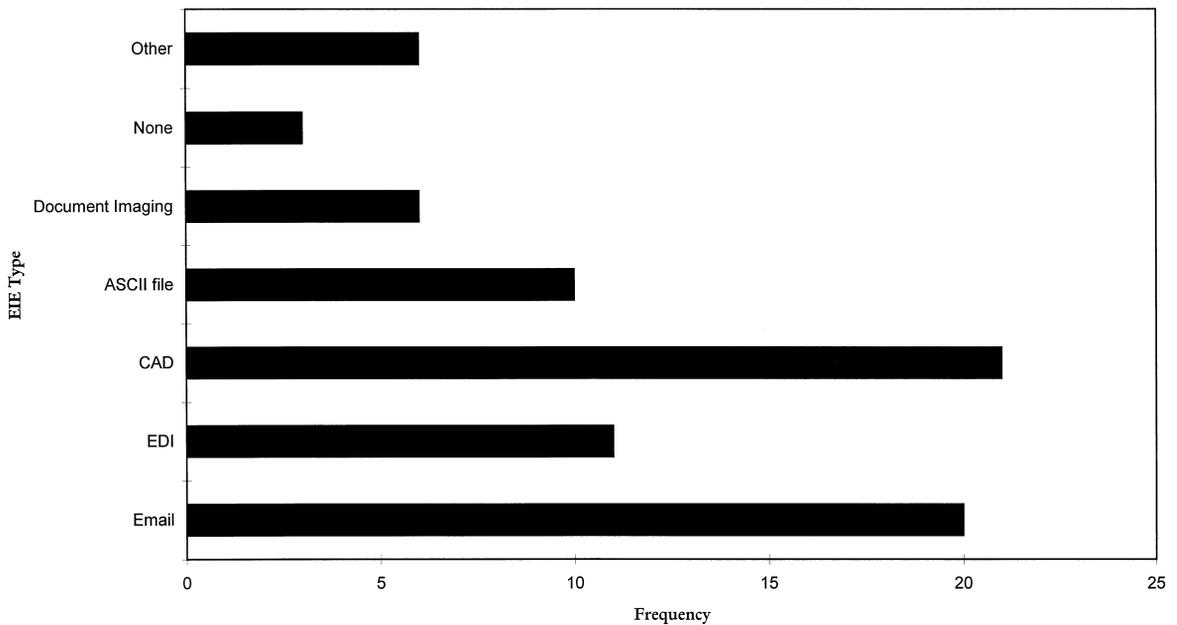


Fig. 4. Essential EIE for project partnering.

would appear disappointing with simple established technologies being adopted. The findings complement those of Graham et al. [31], who indicate that organisations adopting these technologies in other business sectors favour an incremental approach. The results emphasise the need for agreed standards and simple solutions to the problem of data exchange. Fig. 4 shows the forms of IE considered essential for effective partnering.

6.4. The functions within an organisation that benefit most from IE

The functions to benefit most from IE are represented in Fig. 5. The organisations who had used IE on partnering projects stated that Project Management, Materials Procurement and Cost Control were the functions that benefited most from IE. The limited space afforded to this question in the survey document did not allow a detailed analysis of these responses. The written comments added by the respondents do however indicate that when anticipating the benefits of EIE it is important not to focus attention on the traditional application functions

within organisations. Project partnering changes the way organisations work. Hence the use of EIE for Project Partnering reflects not a predominant preference for formal Project Management systems, rather the use of EIE for the general collation and distribution of management information.

6.5. The organisational changes resulting from IE

None of the respondents involved with project partnering had instigated organisational changes as a direct result of IE. Several organisations had however instigated organisational changes (such as team working), to meet the requirements of this new way of working.

The results of this part of the survey are best illustrated by typical comments from those received:

There were no specific organisational changes, only a wider understanding of key issues across the organisation.

There was a willingness to agree to mutually acceptable standards of practice and systems.

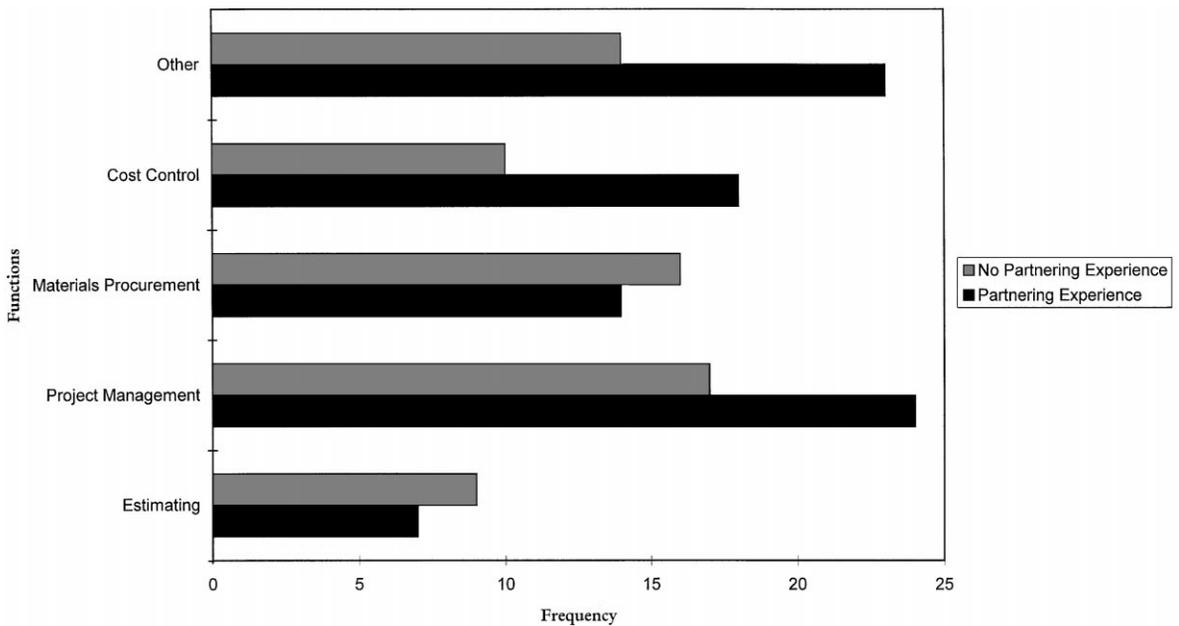


Fig. 5. Functions to benefit from EIE.

The result was a ‘mushrooming’ of IT support requirements of a quantum proportion.

Communication changes included single person reporting and stronger inter-company relationships.

Project partnering results in organisations creating the project teams and structures required to meet the demands of the project, not to facilitate IE. Nevertheless, several respondents indicated that although there were no organisational changes as a result of IE this was only ‘to date’. This indicates that, as experience of IE develops, it may result in changes to the organisational structure and more distributed working.

6.6. Client demands for contract documentation in electronic format

This question in the survey was a direct result of the experience of the ‘Andrew Project’ case study where the client had requested that all project documentation should be supplied to them in electronic form. Sixty-nine percent of the respondents with

project partnering experience indicated that the client had requested contract records in such a form presumably to facilitate ongoing maintenance. This shows the importance of such systems to those client organisations seeking to enter this form of procurement. Clearly construction organisations must be prepared to meet these demands with new ways of working. This should be viewed as a business opportunity not an obligation.

7. Conclusions

This paper has reviewed the introduction of IE on a typical alliance project. This case study identified the following benefits of using IE: guaranteed delivery of data; improved quality of data; reduced data handling; improved communication between the alliance partners; and reduced risk of project delay. The findings have been supported by data from a questionnaire survey. These results show many construction organisations consider that project partnering is the *only* way to obtain the level of cost savings currently expected by construction clients. It was widely recognised that project partnering can

only succeed with the sharing of project information. Any information relating to the project must be distributed quickly, efficiently and accurately. IE was clearly the most appropriate medium for the distribution of project information. The respondents to the survey identified CAD data transfer, E-mail and ASCII file transfer to be the most important forms of IE. Project Management, Materials Procurement and Cost Control were the main functions to benefit most from IE. None of the respondents involved with project partnering had instigated organisational changes as a direct result of IE. However, as experience of IE develops, it may result in changes to the organisational structure and more distributed working.

The research has shown the potential of the extended use of IE. Since conducting the original survey the term Electronic Commerce has become more widely accepted as representing this group of technologies. Irrespective of the name used it is apparent that, given the lack of enthusiasm for these technologies amongst the major construction organisations, partnering is a catalyst for a change in attitude towards IE. The use of IE or Electric Commerce on such projects is seen by the writers as an important aspect of the development of the relationships between the alliance partners. With the commitment of all the alliance partners these technologies can enhance and extend the basis of partnering agreements by providing a platform for more efficient working and new services to the client. With the increasing trend for the client to demand comprehensive information relating to the design, construction and maintenance of construction projects this form of IE will form the only viable method of data collection, storage and retrieval.

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