THE DEVELOPMENT OF ELECTRONIC TRADING BETWEEN CONSTRUCTION FIRMS

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ABSTRACT

Electronic Trading is a business relationship that relies upon the use of computer and telecommunication technology for information exchange. In order to understand the development of electronic trading between construction firms, the CONNET model was developed. This model identifies the factors and variables determining whether firms adopt electronic trading systems, and its configuration. The model is grounded in the relationship perspective and network approach, and assumes that there is mutual commitment and an economic rationale behind the development of electronic trading.

The CONNET model explains that electronic trading systems emerge from the complex interplay of three major factors. These are: *a*) the relationship between the two firms, i.e. what is exchanged (information, product, financial, social) and how (power/dependence, co-operation, closeness, mutual expectations); *b*) the business and IS/IT strategies, and the organisational and IT infrastructures and processes of each of the firms; and *c*) the characteristics of the web of relationships - production network, in which the firms are embedded, i.e. interconnections, input-output structure, governance structure and territoriality.

In order to validate the model, six case studies were conducted in construction situations and four in automotive and retailing situations. Analysis of the data collected concluded that some variables have a more important role in the adoption decision, e.g. social contacts, business strategies or territoriality. Other variables are influential on the adoption but more important on the configuration of the systems, e.g. IT strategies and organisational and IT infrastructures. Most variables have an influence on both the adoption decision and the configuration of systems, e.g. information and finance exchanges, co-operation, individual interconnections, or governance structure, though the importance of their influence varies.

It was concluded that, in general, electronic trading and sophisticated systems emerge where there is a higher concentration of enabling factors. The implications of the validated model lie in its potential use in explaining when and how electronic trading is likely to occur in construction. By exerting influence over variables in the model it can be used by construction organisations to create an environment to encourage electronic trading to take place.

CHAPTER 1

INTRODUCTION

1.1 - Background study

1.1.1 - The need to improve construction information management systems

1.1.1.1 - Construction productivity

The construction industry is one of the most important industries in the UK, and across the EU, Japan and US. In the UK, the construction industry had in 1997 an annual turnover around nearly £60 billion, representing approximately 7,2% (net value) of the Gross Domestic Product and about 10% of employment (Office of National Statistics, 1997).

It is widely recognised that the construction industry has a clear performance problem. Indeed, in the US it is reported that between 1970 and 1995 the construction industry decreased its productivity at an average rate of -1.3% per year. This contrasts with the increase of +3.5% per year by the manufacturing industries, in the same period of time (Teicholz, 1997). In the UK, the report *Building Britain 2001* found British construction productivity inferior to its foreign competition, both in absolute terms and in its rate of increase (Centre for Strategic Studies in Construction, 1988). It also stressed that the British construction industry would require to improve its productivity by nearly 4% per year between 1995 and 2000 (Centre for Strategic Studies in Construction, 1988). The Latham report and its recommendations for the improvement of the construction industry sets as one of its main objectives the increased productivity target of 30% real cost reduction over a period of five years until the year 2000 (Latham, 1994).

1.1.1.2 - Fragmented information systems

A widely acknowledged cause for construction's productivity problems is its fragmented nature, with the traditional separation between design and construction functions, the extensive use of subcontracting, and the large number of small firms (CSSC, 1988). Regarding construction information management, fragmentation implies that different firms participating in the design and construction of buildings have developed disparate ways to acquire, generate, organise, analyse and disseminate information, i.e. information management systems. Construction information management has become highly fragmented (Brandon and Betts, 1995; Dupagne, 1991).

Thus, fragmentation produces substantial volume and complexity of information flows between the various parties during the whole life-cycle of the construction process (Atkin, 1995; Dupagne, 1991). Also, information flows have poor timeliness, quality and accuracy, and usability. These factors contribute to professionals involved on construction site activities spending too much time in generating, processing and exchanging large volumes of information, which was identified as a major problem and contributing to low construction productivity (Murray and Thorpe, 1996). Distinct types of information require different management criteria (Atkin, 1995). Commercial information - e.g. accounts, payroll, shareholders reporting, statutory requirements, plant accounting, etc., must be extremely accurate, is by necessity historical, should permit auditing, but it is not time critical. Technical information - engineering calculations, environmental impact analyses, functional specifications, detailed design specifications, bills of quantities, computer-draft drawings, etc., should be very accurate, follow rigid procedures, needs to be available reasonably on time, but does not necessarily require auditing. Managerial information - time, cost, quality and feasibility aspects of the project, must be reasonably accurate but be on time, be able to forecast the future, and little auditing requirements are needed.

Some authors believe that there is scope for construction to achieve dramatic improvements in performance in productivity through the improvement of information flows. It is estimated that between 15% and 20% of the total cost of a building could be eliminated by improved and ideally optimised information flow (New Civil Engineer, 1991).

1.1.2 - Developments in Information Technology

1.1.2.1 - Technology trends

Rapid developments in the last thirty years have resulted in a increasing convergence of hardware, software, networking, multimedia, and subjects like information, data, knowledge. Information Technology (IT) is the term often chosen to designate this bewildering and rapidly changing variety of technologies (Keen, 1991). IT has had an important and far-reaching impact on the production, co-ordination and control of companies' business processes and activities, both internally and externally.

Information Technology (IT) is now a crucial tool for construction information collecting, storage, distribution, processing, and retrieval. Software applications like word-processing, spreadsheets, presentation, CAD, project management, databases, accounting, etc., and networking capabilities like LANs for integration of their internal applications are now used by most construction firms, whether they be consultants, contractors, subcontractors, builders' merchants, or manufacturers (Murray and Thorpe, 1996; CICA and KPMG Peat Marwick, 1993).

1.1.2.2 - Failure of IT

The use of IT may have improved information processing and storage considerably but contrary to expectations, it has brought about, in general, little improvement of information flows. The main reason for this is that IT has increased the level of paper use in construction, as it has become easier, cheaper and faster to produce paper-based information (Atkin, 1995). The point is that most non-verbal communications between firms still remains paper-based. The report *Investing in Building 2001* (Centre for Strategic Studies in Construction, 1989:8) states that:

> *"the architectural-engineering-construction industry is still exchanging data and design decisions much as it did a century ago, with paper drawings and reports. Introducing computers into the process has changed the means of generating the paper, but it has not fundamentally changed the methods of sharing data across organisational boundaries".*

As it seems, IT has not yet fully delivered the desired benefits. According to Murray and Thorpe (1996) in order to take the full benefits from the use of IT it is inter-company beyond intra-company communication that must be improved. The scope for improvement is clear since the source of most information exchange is computer generated, and the receiver is likely to re-key part or all of it to another computer application. The aim is to migrate from paper-based communications to automate electronic exchange of commercial, managerial and technical information, using disparate technologies like e-mail, EDI, interactive and on-line databases, and the Internet.

1.1.3 - Development in business attitudes

The construction industry is shifting its traditional way of operating, resulting mainly from increasing globalisation of construction products and activities and a demanding set of important clients who are becoming aware of the poor service provided (Latham, 1994). Major implications are the emerging business context of increased customer-orientation, which led to the importation from the manufacturing and service industries of new sets of production, logistical, and managerial philosophies and tools. There are two main aspects that are relevant to this work as they are often linked with IT: process-based perspective, and supply chain management.

1.1.3.1 - Process focus

A process is a set of inter-linked activities that take an input and transform it to an output to a specific customer. In generic terms, process focus means that when analysing a business, emphasis is placed on how things get done rather than what gets done. Associated with viewing companies through business processes are a set of new methodologies and tools which contribute to improvements in the performance of the processes. These are Just-In-Time production - elimination of waste and minimum inventory (Lubben, 1991); Total Quality Management - improving quality by continuous improvement of the processes that deliver product (Harrington, 1991); Business Process Re-engineering - challenging fundamental assumptions and redesign processes to achieve radical improvements (Hammer and Champy, 1993; Davenport, 1993); Lean Production - elimination of flow activities as they are non-value added (Womack *et al.*, 1990); and Agile Production - seeking flexibility and customer focus (ACI, 1998). The point to be made here is that IT has been used to enable some of these methodologies. There is evidence that the application of some of these concepts are starting to be applied by some construction firms (see e.g. Koskela, 1992; Alarcon, 1997; Betts and Wood-Harper, 1994; Bacon, 1997).

1.1.3.2 - Supply chain management

There has been an increasing awareness that competitive advantage relies partly on the internal processes and operations of firms but also partly on the larger network of firms with whom individual firms have interdependencies. Thus, supply chain management concerns with optimising the whole value chain through balancing, resource auditing and relationship monitoring (Macbeth and Ferguson, 1990). Information technology is a fundamental tool to the management of interdependencies by helping firms to better control and co-ordinate information (McHugh *et al.*, 1995; Scott Morton, 1991).

The application of supply chain management in the construction industry has been relatively limited, as demonstrated by recent studies (see e.g. Atkin *et al.*, 1995), despite this the concepts have been adopted by some big clients like British Airports Authority - BAA (see e.g. Bacon, 1997). Moreover, the wider dissemination of project partnering in recent years is likely to foster the application of more proactive supply chain management both by clients but also by other construction parties like architects, contractors, construction mangers, etc. (Bennett and Jayes, 1995).

1.2 - Area of concern: electronic trading in construction

1.2.1 - Electronic trading

Put it in simple words, electronic trading is a relationship between two firms where there is electronic exchange of information (Cunningham and Tynan, 1993). Electronic trading by improving information flows can contribute to enhancing considerably co-ordination and control mechanisms in business processes, and at the bottom line, increasing timeliness, accuracy, and accessibility of information (Cunningham and Tynan, 1993). According to Rockart and Short (1991), this new mode of co-ordination results from the recognition of the need for achieving a better management of inter-firm interdependencies, and therefore the acknowledgement that a firm's efficiency and efficacy derives considerably from its relationships with other firms. The deployment of electronic linkages has become a cornerstone of the new production and logistics philosophies like Just-In-Time, Lean Production and Business Process Re-engineering.

The importance of electronic exchange of information can be demonstrated by its widespread use by firms across disparate industries. The automotive, retailing, wholesaling and distribution industries are often cited as being highly successful in using electronic linkages both regarding the extent of use and in terms of the degree of sophistication of the systems deployed. There are different technologies that allow the electronic exchange of information, like EDI, e-mail, Internet, etc., but the most common type by far is EDI. Estimates suggest that there are about twenty five thousand EDI users in the UK (Ovum, 1993), which represent about 50% of the total number of users in the European Community (Commission of European Community, 1997a). These systems are used to exchange all sorts of information like orders, delivery schedules, and call-offs, invoices, CAD/CAM, etc., sometimes on stand-alone systems working like a fax machine, but also through fully integrated automated systems. While most electronic information exchange tends to automate previous paper-based systems, there are examples where their deployment has radically changed the whole structure of the supply chain (see e.g. Spinardi *et al.*, 1996).

1.2.2 - Electronic trading by construction firms

Electronic exchange of information between construction firms can, however, be considered insignificant, far from early forecasts which suggested that 15% of construction firms would be using EDI by 1995 (CICA and KPMG Peat Marwick, 1993). In a recent survey which attempted to assess the extent to which EDI has penetrated the construction industry, Akintoye and McKellar (1997) obtained details of only eighteen construction firms that were full EDI users, and ten firms in the implementation or pilot phase. Moreover, EDI systems were very basic, exchanging basically one or two types of information, and with little integration. This is supported by the few other existing studies, for example, studies by Baldwin *et al.* (1995a); Atkin *et al.* (1995) or O'Brien and Al-Soufi (1994) about the electronic information exchange by construction firms. Main conclusions of these studies are that EDI and other forms of electronic linkages are almost non-existent and that the largest users of EDI within the construction industry by far are builders' merchants, material suppliers, and manufacturers, which were essentially exchanging in an electronic format funds transfer and invoices, with systems with little sophistication. However, many of these firms were using EDI with firms from outside the construction industry, and had EDI links in construction with two or three firms only.

The conclusion to be drawn here is that, in spite of the clear justification for construction firms to deploy electronic linkages, there are very few construction firms who actually have electronic trading, especially when compared with the wide extent of use of the concept by firms from other industries. Moreover, existing electronic trading in construction seems to be based on systems with simple functionality and configurations, well behind current technological capabilities, and again existing systems in other industries.

1.3 - Research questions

There are some relevant questions that the previous analysis raises, which can be summarised as follows:

- Why is there scarce electronic exchange of information by construction firms, in spite of the clear justification for its deployment?
- Why do builders' merchants and manufacturers seem to have more electronic trading than other construction organisations?
- Why do existing systems for electronic exchange of information by construction firms have basic configurations and little sophistication ?
- Why have manufacturing and service firms much more electronic trading, both quantitatively and qualitatively, than construction firms ?
- What are the more adequate strategies to foster the adoption of sophisticated electronic trading by construction firms.

What these issues implicitly suggest is the importance of the need of understanding the process by which firms do or do not adopt a specific configuration of electronic exchange of information, in other words, understanding the electronic trading development process. This implies identifying **the factors determining the development of electronic trading** and also **how those factors influence the development process.**

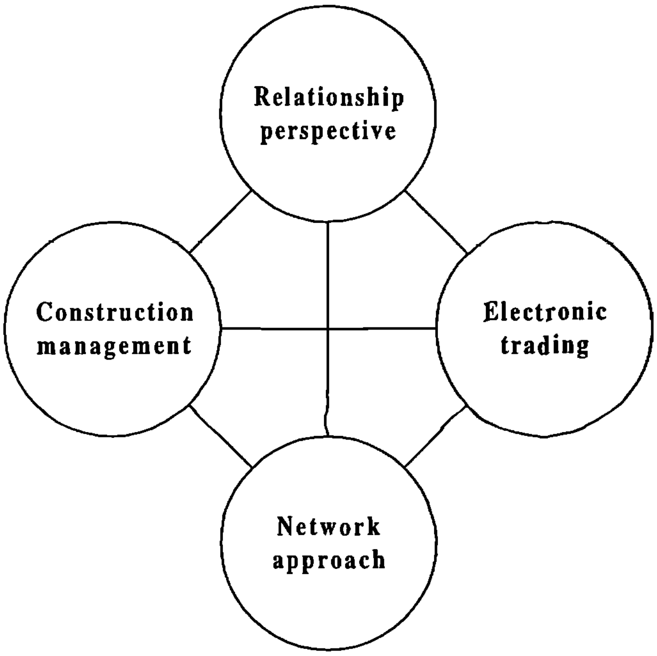
Most studies addressing electronic exchange of information have only a technological perspective, which is centred on the software, hardware, data transmission systems, protocols, standards, reliability, and security issues of electronic linkages. This is essentially the case of the new research field known as Computer Integrated Construction (see e.g. Brandon and Betts, 1995). Other studies have focused on the potential and real impact of the implementation of technologies like EDI and e-mail, at various levels: strategically, on internal operations, on the industry structure, and on inter-firm relationships (see e.g. O'Brien and Al-Soufi, 1994; Cunningham and Tynan, 1993; Bjorn-Andersen and Krcmar, 1995).

There is very little research work regarding the business factors that influence the adoption and development of electronic exchange of information. The low take-up of electronic trading by construction firms seems to be followed by scarce research studies addressing the subject. The review process will highlight several gaps in the knowledge regarding the development process of electronic trading by construction firms. Although the body of knowledge about the process by which non-construction firms adopt electronic trading systems is far more rich than that specific to construction, it will be argued here that is far from giving much insight to the construction case. Indeed, though several factors have been identified and analysed which are believed to influence the adoption process, there is no model or theory that addresses the inter-linkages and interdependencies between the disparate factors, and which provides a comprehensive way to describe and analyse the dynamics of the process.

1.4 - Framework of reference: the relationship perspective and network approach

The theoretical framework in which this work will be grounded is the relationship perspective and network approach along with current knowledge about construction management and electronic trading (Figure 1.1), from which will emerge the factors and variables that are anticipated to determine the adoption process of electronic trading and its configuration. It will also, partially, provide some of the potential interdependencies and influencing behaviour of the variables and therefore explain how they are expected to influence the development process.

Figure 1.1 - Framework of reference



1.4.1 - Relationship perspective

The relationship perspective stresses that the traditional economics perspective of free markets, pure competition, with unconnected and adversarial single transactions, basically co-ordinated by price mechanisms, is not considered adequate to explain inter-firm phenomena. Rather, the relationship perspective advocates that business relationships are mainly complex and rich social constructs between people in firms, which evolve over time (Håkansson, 1982). The implications of this perpective to the current work will be twofold. Firstly, the definition of the dyad (one-to-one inter-firm linkage) as the unit of analysis for electronic trading study, rather than the single firm. Secondly, that in order to understand the development of electronic trading, one needs to analyse the structure, and process dynamics of the business relationship in which it will be embedded.

1.4.2 - Network approach

The network approach assumes that firms are often interdependent of each other (in terms of technology, economic, social, legal, etc.), and these interdependencies lead to some relationships being connected to other relationships (see e.g. Håkansson and Snehota, 1995; Easton, 1992; Rockart and Short, 1991). The consequence of these connections is that dynamics in one relationship may effect or be affected by other relationships. Thus, firms and relationships are likely to be embedded in multiple, complex webs of interdependent relationships which, according to some authors, have distinct structural forms which constrain and enable firms' actions (see e.g. Powell, 1990; Harrison, 1994). The relevance of the network approach to this work is that in order to fully understand the development of electronic trading it is necessary not only to analyse the relationship between the firms and their internal characteristics, but also to explore the possibilities of the influence of the network of connected business relationships.

1.5 - Aims and objectives

1.5.1 - Aims of this work

From the literature review considerable gaps of knowledge were identified about the development process of electronic trading, which were 'reinforced' by framing the problem in a relationship perspective and network approach. This provided the rationale for this work. Thus, the aim of this work is to generate a more comprehensive picture of the electronic trading phenomena between construction firms. At the theoretical level, there was a desire to develop models and propositions that can be used to describe and explain the development of electronic trading and the factors influencing it, in general and between construction firms in particular. At the empirical level, the aim is to describe how some cases of electronic trading occur(ed) in different situations, to provide evidence of these variations, and give some explanations of these variations. The domain of application will be between different types of construction firms, and between construction firms and non-construction firms. It is important to stress here that this study's aim is not providing a solution to the low adoption of electronic trading by construction firms, rather it is about developing models and propositions that help to better understand the problem and therefore to contribute to the contribute to the definition of ways to overcome the problem.

1.5.2 - Objectives for the research

Hence, the objectives set in the beginning of this work were to:

1. Investigate current electronic trading between construction firms involved in the various phases of the construction process and compare this with existing systems in other industries.

2. Explore whether the business relationship perspective and network approach could be used for describing and explaining the process of electronic trading development, i.e. the process by which construction firms do or do not adopt a specific configuration of electronic exchange of information.

3. If positive, develop a generic model appropriate for describing and explaining the phenomenon, and provide normative strategies and guidelines for management.

4. Based on the theoretical model and empirical evidence, draw conclusions about the the factors that enable the development of electronic trading by construction firms.

1.5.3 - Scope of the work

This work has more of an exploratory nature than an explanatory one. Though it will explain how certain factors are likely to determine whether construction firms develop electronic trading, more importance will be given to the raising of a broad range of issues rather than delving too much on a specific topic. There are three main reasons behind this choice. Firstly, because this is a completely new approach for both construction and electronic trading body of knowledge it is of paramount importance to raise issues that can be further investigated by other works. Secondly, because individual knowledge on both electronic trading, and the relationship perspective and network approach are in such an embryonic stage, let alone combined, there is little literature supporting this study. Finally, there are very few empirical construction cases that may support theoretical research in this area.

The model will be generic enough to be able to deal with the phenomenon in both a construction context and in manufacturing and service contexts. The reason being twofold: there are not enough cases in construction to support theoretical propositions, and the necessity to make the comparison between construction and industries where there is a wide quantitative and qualitative electronic trading.

1.5.4 - Hypothesis

The research work conducted in this study will contribute to validate the following hypothesis, which emerged from the literature review, from the contextual understanding of the subject, and from the synthesis phase of the work.

> **The adoption of electronic trading between two construction firms and the configuration of the systems is determined, i.e. constrained and enabled, by the complex interplay of the three major factors: the relationship between the firms; the features of each individual firm; and the characteristics of the network within which firms are located.**

In Chapter 5 this generic hypothesis will be further developed, and it will be described and its assumptions and implications explained.

1.6 - Methodological approach

This study is divided in five main distinct phases: **problem definition**; **model development**; **data collection**; **analysis**; and **conclusions**. In the first phase, a high-level review of the literature is made in order to clearly identify the area of concern and the research questions of this work. This was a fundamental step in order to narrow down the scope and aims of the study. Having identified two main issues, in the second phase a more thorough literature review is conducted on the subjects of construction management, electronic trading, the relationship perspective and network approach. The objective is to devise a theoretically based model which identifies which factors and variables are likely to influence the development of electronic trading, as well as their behavioural aspects. This model is presented in the form of sets of propositions.

In order to validate the theoretical model, empirical research is conducted which collects data to match against propositions. This is the third phase of this study. In order to address the research questions, the control and temporal dimensions of the research, it was decided to adopt a case study strategy. A structured research project is designed, including choices regarding the unit of analysis, pilot cases, protocols, etc. Ten case studies, four non-construction and six in construction situations are conducted.

In the fourth phase, the analysis of each case study is made, along with a cross-case analysis of the ten cases. Conclusions are drawn about the matching between the theoretical propositions and the empirical results. Finally, in the last phase the model is modified according to the results, and final conclusions are obtained. In Chapter 6 a detailed description of the methodological aspects of this work is elaborated.

1.7 - Outline of this work

This work is organised in ten chapters, as follows. In **Chapter 2 - Conceptualising electronic trading development**, the existing body of knowledge is reviewed regarding electronic trading. Definitions about the main aspects of electronic trading are stated, some of the more important technology configurations are described. Finally, the actual knowledge about the development process and which factors are perceived as important are described and discussed. It follows **Chapter 3 - Business relationships**, introduces the main concepts of business relationships. It also refers to the suitability of the relationship perspective to construction situations, as well as the connection between electronic trading development and relationships. **Chapter 4 - Networks**, explains the network concept and the assumptions behind it. The interconnection with the relationship perspective is described. How construction situations can be described in network terms are analysed, as well as the connection between electronic trading development and networks.

Having reviewed the main theoretical bodies of knowledge relevant to this work, in **Chapter 5 - Electronic trading development between construction firms**, the CONNET model is presented in the form of propositions which identify the main factors and variables that are anticipated to determine whether construction firms do or do not adopt electronic trading systems and the configuration. **Chapter 6 - Research approach, strategy, and design**, explains in more detail the main elements and process of this research work, from both the theoretical and practical aspects. The major emphasis in on the empirical part of the work and its connection with the theory.

The description of the data collected for each of the ten case studies along with their individual analysis and pattern matching to theoretical variables is documented in **Chapter 7 - Intra-case analysis**. Following is **Chapter 8 - Cross-case analysis**, where the results of the previous chapter are grounded and comparisons and contrasts are made between the individual cases. This permits the drawing of conclusions about the factors found empirically to determine the development process. In **Chapter 9 - Results**, matching between the findings of the previous two chapters and the propositions put forward by the CONNET model in Chapter 5 is analysed. This allows validation of the model, and the making of necessary corrections.

Finally, in **Chapter 10 - Conclusions**, are presented about the objectives and hypotheses of this work, through highlighting the major contributions of this study. It also discusses the future work that can emerge from this research.

CHAPTER 2

CONCEPTUALISING ELECTRONIC TRADING DEVELOPMENT

2.1 - Introduction

Having outlined the research problem, its origins and defined the objectives, scope and strategy of this work, this chapter provides the background knowledge about electronic trading and its development process. The clarification of the main concepts around the term 'electronic trading' is one of the main aims of this chapter, as the term has often different meanings to different people. The chapter also reviews current knowledge on the factors influencing the development process of electronic trading, and concludes by uncovering gaps of existing research and knowledge.

2.2 - Defining electronic trading development

In order to avoid misinterpretations of what is meant by electronic trading and associated expressions, this chapter starts by making a full and extensive definition of some of those concepts.

2.2.1 - Working definition of electronic trading

A definition to be useful shall reflect the reality that it is supposed to describe, and at the same time define the domain of interest. A concern in this work was to make a definition of electronic trading in a way that would include the elements of relationships, information, technology, and change, but would not restrict their domain in order to allow the exploration of the various possible situations. The approach adopted was adapted from the definition made by Cunningham and Tynan (1993:5), and is as follows:

> **Electronic trading (ET) is a business relationship which relies upon the use of computer and telecommunication technology for inter-firm communications and exchange of information. Electronic trading systems exploit information and communication technology in order to improve the efficiencies of business communications and/or alter the nature of inter-firm relationships.**

According to this definition, the description, and explanation of electronic exchange of information can not be disassociated from the characteristics of the relationship between the two firms. There is no restriction regarding the type of relationship, they can be pre-determined long-term customer-supplier relationship, or have any other form. They can be between clients and architects, between consultants, clients and contractors, builders merchants and manufacturers, between consultants and contractors, or between any other dyadic interaction. Also, it is explicit from the definition that the development of electronic trading implies a degree of change in the relationship between the two firms but does not constrain its scope.

The definition is open regarding the type of information that may be electronically exchanged. Information can be commercial, e.g. BoQ, quotations, purchase orders, invoices, payments, etc.; technical like CAD, CAD/CAM, engineering calculations, valuations, site instructions, etc.; or managerial like delivery schedules, minutes of meetings, etc. There is no specific differentiation between project information and transactional information, as some authors like to make in construction (Thorpe *et al.*, 1994). Similarly, the definition does not restrict the type of technology which can be used for electronic exchange of information. Any technology that uses computer and telecommunication technologies, like EDI, e-mail, interactive and on-line systems, etc., either proprietary or open, is considered.

2.2.1.1 - Electronic trading systems

Electronic trading systems (often designated in the literature by Inter-Organisational Systems - IOS), are computer-based information systems shared by separate business entities, crossing company boundaries and therefore are not under the control of a single organisation (Cash and Konsynski, 1985). **Electronic trading systems configuration** is defined in this work as the set of characteristics of the systems responsible for exchanging information in an electronic format. Based on O'Callaghan and Turner (1995) dimensions of configuration include not only the technological issues (e.g. EDI, e-mail, Internet, interactive and on-line systems; related standards; communication networks), etc., but also:

- The level integration of the electronic exchange of information systems with internal systems;
- The range of information exchanged;
- Frequency of exchanges;
- Direction of flow.

Obviously, the characteristics of the systems involved in the electronic exchange of information may vary greatly, which consequently leads to different configurations of electronic trading systems. For example, a proprietary EDI system may be used to send invoices on a monthly basis from a supplier to a buyer, but the supplier system works on a stand alone basis and the accounting system of the buyer allows the automatic reception of the invoice but not the automatic reconciliation (Bradley, 1993). Comparatively, a buyer may have a fully automated purchasing system, which integrates its Material Resources Planning system with an EDIFACT-based EDI system, and sends requests for quotations, purchase orders and payments directly to a supplier on a weekly basis, and the supplier receives and processes automatically the quotations, purchase orders, and invoices (O'Callaghan and Turner, 1995). Section 2.3 makes an in-depth description of the potential characteristics of electronic trading systems.

2.2.1.2 - Sophistication of electronic trading systems

Sophistication is seen here as the degree of complexity, refinement and elaboration of electronic trading systems configurations. It is assumed in this work, that sophistication raises with: *i*) the higher the level of integration with internal systems; *ii*) the wider the range of information exchanged; *iii*) the higher the frequency of exchange; and *iv*) two-way systems. Thus, for each electronic trading system (e.g. EDI, e-mail, Internet, etc.) there is range of configurations in a continuum of sophistication. For example, an e-mail system exchanging only unstructured informal information is much less sophisticated than an e-mail based concurrent design and engineering system which integrates two CAD systems in distinct firms. Similarly, an EDI system which is fully integrated is much more sophisticated than an EDI system which works on a stand alone basis; or an EDI system which exchanges only purchase orders is much less sophisticated than a system that exchange purchase orders, invoices, delivery schedules, etc.

2.2.2 - The development of electronic trading

This work is concerned with the development of electronic trading between construction firms, and not with the technological aspects of electronic information exchange. According to several authors, the development process of electronic trading usually follows a recurrent pattern: a firm aims at electronic exchange of information with its suppliers or customers and "invites" them to establish electronic links. The initiating firm is often called **hub**, **initiator** or **source** and the invited firms **spokes**, **followers** or **targets** (MacDonald, 1991; Riggins *et al.*, 1994; O'Callaghan *et al.*, 1992). In this work the designations to be adopted are of **leading firm** for the former situation, and **target firm** for the later.

The decision process in electronic trading development involves not only a decision of whether the two firms develop electronic linkages but also a decision regarding the configuration of the electronic trading system. This means that within the adoption process, firms decide on the technology to be implemented, the information to be exchanged, the integration with internal systems, the frequency and direction of flow. The configuration may be carefully planned and/or emerge during the development process itself (Bjorn-Andersen and Krcmar, 1995).

This work focuses on the factors that determine the decision process regarding the adoption and the configuration of the systems, rather than the development process itself. The current body of knowledge concerning the development of electronic trading refers to several factors as potentially influencing the process. This shall be reviewed and criticised in section 2.4 of this chapter. The following section will review some of the current state-of-the-art of electronic trading systems configurations, and in Chapters 3, 4 and 5 of this work, a new perspective and approach for describing and analysing the development process of electronic trading between construction firms will be put forward, in the form of a model.

2.3 - Configurations of electronic trading systems

This section characterises the most important features of electronic trading systems, and the function of its main elements. It also highlights how some of the technical aspects of the technology may influence the development of electronic trading. An important remark to be made here is that some terms like EDI, e-mail, Internet, etc. are used loosely in the literature and it is quite difficult to make some technical distinctions between them. Cunningham and Tynan (1993) stress that the main reason for this definition problem is the rapid convergence and evolution of telecommunication and computer technology. In this work definitions have been adopted which seem to be more adequate for explanation purposes.

2.3.1 - Multitude of proprietary IT systems

In technical terms, information can not be directly transferred between disparate computer applications because proprietary differences in technologies result in incompatibilities of hardware, software and telecommunications equipment (Jayachandra, 1994). Incompatibilities can be found primarily at the operating system level, both at PC (UNIX, OS/2, Macintosh OS, MS DOS, Windows) and mainframe products (MVS/VM, VMS, and UNIX). Secondly, at the application level, programs vary in the range of operating systems under which they can run, how they represent information at machine register and storage level, and in presentation form. Finally, telecommunication hardware and software are a source of incompatibilities as there are many physical and logical protocols for Local Area Networks (LANs) and Wide-Area-Networks (WANs). The use of IT in construction reflects the large portfolio of systems available (CICA and KPMG Peat Marwick, 1993; O'Brien and Al-Soufi, 1994). In addition to the technical incompatibilities there is little standardisation of the information related to construction processes and products which means that each firm has its own way of organising, structuring and managing information and data, increasing the integration problem. To summarise the problem, in order to transfer information between two independent companies there are many conversions, protocols, and logistics to be overcome.

2.3.2 - Diskette exchange

The simplest way to exchange information in a digital format is through storing a file on a diskette from a sender's application and physically deliver it to the receiver, which will retrieve and open the file in its application. The file can be in its binary form or in a neutral format (ASCII). This method is often used in construction to exchange CAD files amongst designers (in binary or DXF formats), CAD and spreadsheets with BoQ between designers and contractors (Baldwin *et al.*, 1995b). The CITE group has developed a neutral file standard for the transfer of Bill of Quantities data, but using floppy disks rather than telecommunication media.

Because there is still the need for a physical transportation of the diskette and it does not use telecommunication media, diskette exchange can not be considered a real electronic linkage. Therefore the information transfer through diskette will not be considered in this work as electronic exchange of information.

2.3.3 - Electronic Data Interchange

2.3.3.1 - Definition of Electronic Data Interchange

Electronic Data Interchange (EDI) is by and large the most used technology for electronic exchange of information. There are many definitions for EDI, some of which restrict the domain of EDI more than others. In this work, such considerations are irrelevant, as our focus is on electronic trading systems in general and not on EDI specifications. McLoughlin (1994:146) defines EDI as "*The transfer of structured data, from computer to computer, using agreed communication standards*". McLoughlin stresses that two key aspects differentiate EDI from other technologies. Firstly, the information transmitted should be directly usable by the receiving computer system, without the need for human processing, e.g. re-keying data to the recipient application or analysing it. This is of major importance as far as benefits of electronic exchange are concerned. Secondly, EDI involves a group of organisations communicating with each other in a common agreed standard format. Standards define the documents to be electronically exchanged, which data are included in each document, the exact meaning of each individual data, the sequence of the data, and the form of the data (O'Callaghan and Turner, 1995).

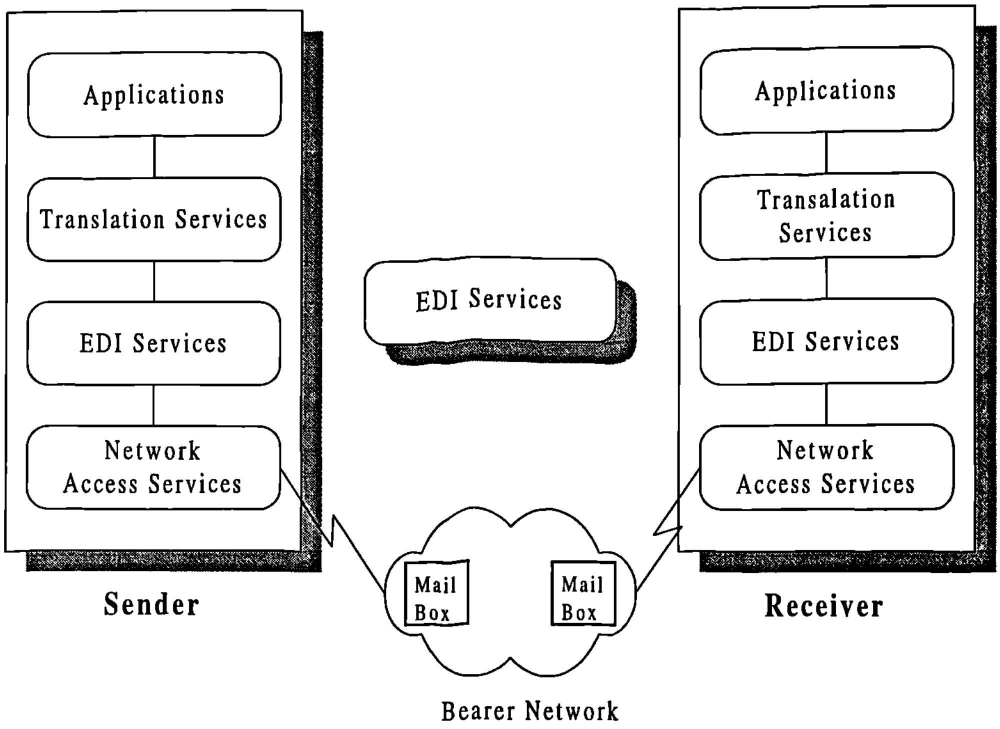
2.3.3.2 - Standards

In EDI terminology, standards refer to both the syntax and messages (Emmelhainz, 1990). Currently, UN/EDIFACT (United Nations/EDI for Administration, Commerce and Transport) is the main body setting pan industrial and internationally accepted EDI standards for commercial applications (O'Callaghan and Turner, 1995; McLoughlin, 1995). EDIFACT is a way to overcome the disparate standards developed by groups of companies, some proprietary and others specific to industrial sectors like e.g. SWIFT, ODETTE, ANSI X.12, UN TDI, which emerged both in Europe and in the US (Reekers, 1994; McLoughlin, 1994). The trend is for old proprietary, idiosyncratic EDI systems to migrate towards EDIFACT standards which enable firms with EDI systems to exchange information electronically with a wider range of firms. EDIFACT has developed twelve messages for the construction process (Molad and Back, 1995; EDIBUILD, 1997). In the UK, the EDICON, a group for setting standards for the British construction industry (essentially based on EDIFACT recommendations), has defined about fifty four message standards for the whole spectrum of the construction process (Baldwin *et al.*, 1995b). More recently CITE - Construction Industry Trading Electronically has emerged. This is a group of seventeen large construction firms including contractors, builders merchants, material suppliers, etc., whose aim is to develop EDIFACT-based standards for the construction industry, provide technical assistance to its members, and foster its dissemination in general. Similarly, the Builders Merchant Federation has also created MERNET, that also develops EDIFACT-based standards for the builders merchants sector.

2.3.3.3 - Ways of working

The way EDI works is fairly simple. A sender's application generates the document data to the transaction, but instead of printing it on paper, it passes it to a translation software which converts the data into the common agreed structure. This message is sent to an EDI service software (usually the EDI translation and service software are a unique application) which triggers the commands to send the message, track it, and ensures that it reaches the destination across a network. Usually, EDI networks work on a store and forward basis. The sender puts the message on its mail box, and the system forwards the message to the destination mail box. The receiver then retrieves the message from its respective mail box using its network and EDI services, and the message is passed to the receiver's translator and converted to the format required by the receiver's computer system (McLoughlin, 1994; O'Callaghan and Turner, 1995). Figure 2.1 depicts a simplified representation of the way EDI works.

Figure 2.1 - EDI way of working



Source: adapted from McLoughlin (1994)

2.3.3.4 - Communication networks

The communication network in which messages are exchanged can be of two types. It can be a direct link between the two firms, where a leased or dial up link is established. This is worthy if only two firms are connected. As the number of firms connected raises, the cost and complexity of multiple direct links makes it a prohibitive option (Thorpe, 1995; Gibson and Bell, 1990). The most common option is, however, the use of Value Added Networks (VAN), which are third-party network service providers (McLoughlin, 1994). EDI VANs give mailboxing and other telecommunication tasks like security, reliability, auditing, translation and EDI software, and consultancy, charging a fee in relation to the services provided (Graham *et al.*, 1994; Jayachandra, 1994). A major issue regarding VANs is that there is very low interconnectivity between the various providers, therefore if a firm wants to join a group of firms trading electronically it has to join the VAN which they are in (Graham *et al.*, 1994). Sometimes, firms have to join more than one VAN in order to exchange information electronically with different firms.

2.3.3.5 - EDI configurations

EDI is a technology to exchange commercial and managerial information. The most common documents exchanged are invoices and purchase orders (Bjorn-Andersen and Krcmar, 1995; Reekers, 1994). Other commercial documents like requests for quotation, quotations, purchase order acknowledgements, shipping notices, and managerial information like delivery scheduling, point-of-sale information, stocks, call-offs are also exchanged but more rarely (Bjorn-Andersen and Krcmar, 1995; Reekers and Smithson, 1996; Bradley, 1993). Though there are some standards available for the exchange of structured design and engineering information (often designated as Product Data Interchange - PDI), especially outside of the construction industry, current commercial applications seem to have considerable implementation problems (Spinardi *et al.*, 1995). However, research is being conducted to develop technology and standards for construction which include the exchange of graphical and technical information along with existing commercial standards (see e.g. Dubois *et al.*, 1995; Debras *et al.*, 1997; or Rezgui *et al.*, 1997). Akintoye and McKellar (1997) concluded from a survey of the use of EDI by construction firms that the information exchanged varies according to the type of firm though it is basically commercial. Contractors mainly exchange invoices and BoQ data. Other uses are sending purchase orders, sending enquiries to subcontractors and receiving quotations. Subcontractors use EDI for purchase orders, invoices and pricing information. Manufacturers and builders' merchants exchange purchase orders and invoices.

EDI systems do not have to exchange information in both directions. Sometimes, the information flow is one-way only, for example an EDI system which only sends invoices from supplier to buyer. Most of the EDI systems though, seem to have a two-way direction of flow (Bjorn-Andersen and Krcmar, 1995). According to Reekers and Smithson (1996), in the automotive industry, the frequency of EDI use ranges from 20 - 90 minutes, to daily, weekly, or monthly intervals, depending on the type of supply.

The degree of integration of the EDI system with firms' internal information systems is also an important configuration characteristic. In principle, EDI systems are integrated with internal applications, which automatically process the transferred information. However, many firms, especially small ones, use EDI systems on a stand alone basis, which means that information requires manual transfer to internal systems (Reekers and Smithson, 1996; Iacovou *et al.*, 1995; Reekers, 1994).

Some authors have advocated that EDI could lead to radical changes in business processes and operational procedures between firms (see e.g. Benjamin *et al.*, 1990; Venkatraman, 1991; Davenport, 1993). Though there are some examples of substantial changes in the business process and systems due to the development of EDI systems (see e.g. O'Callaghan, 1995; Hammond, 1993; Bridley, 1993), changes associated with most EDI systems seem to be conservative, basically the automation of existing paper-based systems (Graham *et al.*, 1996; Bjorn-Andersen and Krcmar, 1995).

2.3.3.6 - Extent of EDI use

EDI is by and large the most applied technology for electronic exchange of information between independent companies (Commission of European Community, 1997b). EDI has become a common way of working in several industries, like automotive, retailing, distribution, banking, insurance, etc. Indeed, Bensaou and Venkatraman (1995) concluded that US and Japanese automakers exchanged information through EDI with 50% and 47% respectively of their suppliers. Mukhopadhyay *et al.* (1995) reported that at Chrysler, EDI had a 90% penetration with its one thousand and seven hundred suppliers. In the retailing industry, Marks &a Spencer has EDI links with 60% of its total suppliers, the proportion being almost 100% for their clothing suppliers (Cunningham and Tynan, 1993).

In the construction industry, the levels of EDI use are lower, and are centred essentially around builders' merchants, manufacturers, and material suppliers. Table 2.1 depicts the results of a recent survey. It is important to note here that the authors of the study acknowledged to have used a very biased sample population (CITE and EDICON members) in order to obtain a more clear idea of the characteristics of existing EDI, rather than its extent of use.

Table 2.1 EDI usage in construction

	Type of construction firm				
	Contractor (26)	Subcontract. (9)	Manufacturer (21)	Merchant (5)	All firms (61)
Using EDI (nr)	2	1	13	2	18
Piloting EDI (nr)	5	1	2	2	10
Considering EDI (nr)	8	1	4	1	14

Source: Akintoye and McKellar (1997)

The results show clearly that EDI is almost absent amongst some crucial firms in the construction process such as contractors and subcontractors. This is in accordance to another study by Baldwin *et al.* (1995a) which refers to an a internal survey amongst the Construction Industry Trading Electronically (CITE) group, where from eighteen firms of the major UK construction organisations committed to electronic trading, only seven firms were using EDI, and these were builders' merchants and manufacturers. Also, on a supplier management benchmarking study amongst the ten largest UK contractors, it was concluded that none of the companies were using EDI or any other form of electronic communications with their subcontractors and suppliers in general (Atkin *et al.*, 1995). Though there are few empirical studies describing the configuration of existing EDI systems in construction, empirical evidence points towards very low sophistication (Akintoye and McKellar, 1997).

This study will contribute to enhance current qualitative knowledge regarding the configurations of EDI systems by construction firms, their level of sophistication, and analyse why EDI systems are not being deployed in crucial relationships within the construction process, like e.g. between consultants and contractors, or between contractors and subcontractors and suppliers.

2.3.4 – Internet

EDI has been established as a firm-to-firm technology for over twenty years. However, in the last four years, the widespread utilisation of the Internet to applications in fields other than in the universities and research institutions, has led to the emergence of a set of new technologies that can be applicable for electronic trading. The Internet is a Wide Area Network, linking hundreds of thousands of computers around the world, based on the communication protocol TCP/IP (Ellsworth and Barrow, 1997). It is a constantly metamorphosing collection of many different kinds of networks. Although the Internet is not really a technology for the exchange of information, several technologies were created for the Internet and provide much of its functionality for the electronic exchange of information.

2.3.4.1 – Electronic commerce

The application of the Internet to the business environment has led to what some authors designate as **electronic commerce**. In generic terms, electronic commerce can be defined as the carrying out of business activities that lead to an exchange of value across telecommunications networks, being these networks usually perceived as the Internet (EC DGXIII.A3, 1997). However, the label includes a wide range of activities and applications, whose boundaries are still unclear and at the time of writing, are in very rapid evolution. Electronic commerce addresses not only the business-business situation but also the business-consumer, business-administration, and consumer-administration (Commission of European Community, 1997a).

The general interest in the opportunity for economic transactions through the Internet derives mainly from the outstanding growth in the number of its users. It was estimated that in 1996 there were world wide about thirty two million users of the Internet (Tapscott, 1996), while in the beginning of 1998 there were about one hundred million (CommerceNet, 1998), nearly a 300% growth. Forecasts shows that expected total value of electronic commerce in Europe will reach twenty seven billion ECUs by the year 2001 (CommerceNet, 1998). Internet business potential derives from the fact that the Internet provides firms, both large-size and SMEs, with a nearly free access channel to global commerce.

As far as electronic commerce is concerned, there are five main types of interactions (EC DGXIII.A3, 1997):

- Advertising. Action performed by inserting firm presentations and multimedia product catalogues into WWW pages. It generally consists of the creation of web pages and usually does not imply any form of interactive communication over the Internet.
- Interactive communication and information. Usually means adding to the advertising integrated electronic facilities (electronic mail) for communication and information, e.g. to respond to customers' enquiries.
- On-line orders. Allow users to place or receive orders or reservations for goods/services on the WWW, either through electronic forms or simple e-mail messages. Does not include payment.
- On-line sales and purchases. Both orders and sales/purchase transactions are finalised on the Internet, through the performance of electronic payment (usually by credit card).
- On-line sales/purchase and delivery. The transaction is completely performed on the Internet, including order, payment and delivery (must be a digital good).

For some authors, electronic trading is seen as a particular case of electronic commerce, when there are only business-business interactions, and the telecommunication network is the Internet (Commission of European Community, 1997a).

2.3.4.2 – Configurations of Internet technologies

There are two main types of Internet technologies that support electronic commerce: the **World Wide Web** (WWW), and **electronic mail** (e-mail).

Word Wide Web (WWW) – This is a hypertext information and communication system operating on a client/server mode, which can access multiprotocol and hypermedia information. WWW is a navigation tool which appears to the user as a graphical front-end viewer, allowing them to consult, and retrieve multimedia documents stored in servers around the world (Ellsworth and Barrow, 1997). There are many Web application programs that can access many other Internet services, like Gopher, Usenets news, file transfer, remote connectivity, relay chats, and even special access to data stored in local databases. The number, type and functionality of these applications are changing at an incredible pace. With the increase in available bandwidth, the new Web applications have been focusing on new communication technologies that allow the exchange of video and sound on-line, as well interactivity over whiteboards. The WWW has been the driving force behind the amazing growth of Internet use in the last few years (Tapscott, 1996).

Electronic mail (e-mail) – Electronic mail is a communication system that allows applications/users to send messages to other applications/users located anywhere else in the world through the Internet (McLaren, 1996; Ellsworth and Barrow, 1997). E-mail is based on store-and-forward technology. Thus, in e-mail systems a sender transmits messages, from the sender's computer to a central storage or mail server. The system then sends the message to the receiver's mailbox, and notifies that a message is pending in its mailbox. The receiver then downloads the message and read/processes it on its computer.

Initial e-mail systems were used by firms for internal use only, and were built on local area networks – LANs or mainframe based (Jayachandra, 1994). In the late 1980's and early 1990's, public e-mail systems emerged, built on wide area networks (WANs). These were provided by firms like CompuServe, British Telecom, etc., and were used to transfer information between geographically distant computer applications, either within the boundaries of a firm (e.g. regional offices and head office) or between applications across firms' boundaries (Jayachandra, 1994). In the last four years, the Internet is replacing these telecommunication services. Internet-based e-mail systems have become the preferred communication infrastructure (Commission of European Community, 1997a).

E-mail systems may exchange several types of messages. Most e-mail systems are used to exchange unstructured, personal and ambiguously formated text messages. Many e-mail systems also support electronic exchange of information stored in binary files of word processing, spreadsheets, databases, presentation graphics, CAD/CAM design, DXF, etc., as attachments to the free-text format messages (Collin, 1995; Lewis, 1994). This assumes that both sender and receiver have the same or compatible application to process the binary file. McKenney *et al.* (1992) advocate that managerial information which monitors status, sends alerts, broadcasts information, and invoke action are the main types of information exchanged on basic e-mail systems.

Simple e-mail systems are essentially person-to-person systems (Collin, 1995; Lewis, 1994). It is a person who writes and sends the message, and it is a person that receives and processes the information of the message. Whenever attachments are made, it is a person that makes the attachment, eventually encoding it, and it is a person that retrieves the attached file and inputs it into the respective application and processes the information. Sophisticated e-mail based systems may also be a support for applications that use a messaging system as an information transport mechanism (McLaren, 1996; Jayachandra, 1994; Collin, 1995; Lewis, 1994). These applications range from word processors, spreadsheets, scheduling, project management, workflow, document imaging systems, decision support systems, groupware, CAD, etc. These type of e-mail systems were initially used within Local Area Networks aimed at automation of internal business processes (Jayachandra, 1994), but have recently been evolving towards applications geographically separated, linked through the Internet (Ellsworth and Barrow, 1997). Obviously, the sending and receiving applications have to be the same or highly compatible. One of the most well know systems is Lotus Notes™ and its new version Domino™, a groupware tool that uses e-mail systems as a support to exchange managerial information between users. Other systems like Decision Support Systems, distributed project planning, or concurrent engineering tools that use e-mail functionality are now emerging.

In the last two years, many firms have started to deploy **Intranets** - corporate computer-based information systems based on Internet technologies (Crumlish, 1998; Sinclair, 1997). The deployment of Intranets and their connection with the Internet, may lead, in the foreseeable future, to a truly interworking and interconnecting business environment (Ellsworth and Barrow, 1997; Jayachandra, 1994).

2.3.4.3 - Extent of Internet use

The Internet has been provoking great excitement amongst IT professionals, consultants, businessmen, and user in general. It is generally perceived that the Internet and electronic commerce is likely to radically change the way things are done and the organisation of markets and businesses (Commission of European Community, 1997b). For example, the Internet is often seen as a powerful enabler for virtual organisations – a set of co-operating legally independent organisations, which to the outside world provide a set of services and a functionality as if they were one organisation (Tapscott, 1996).

There are many well established examples of electronic commerce in a wide range of industry sectors and a wide range of application areas, that are seen as paradigmatic examples of the future potential of the Internet (Commission of European Community, 1997b):

- Retailing. The Internet Bookshop (iBS) exists only as a site on the WWW, with no physical outlets. Similarly, Virtual Vineyards offers wines and gourmet foods, and delivers them around the world, without a physical outlet.
- Finance. Many banks now offer on-line querying of accounts, and more recently some banks, like Barclays Bank, are offering customers full banking services from their home computers.

- Distribution. Potential customers can browse products like high quality photographic pictures (DIPA GmbH), or software (Oracle), and make a transaction and download them to their local computers.
- Pre/post sales support. Web sites of firms like Hewlett Packard or GE Plastics provide thousands of pages of information with details of their products and services, guidance, recommendations, etc.
- Engineering design. Ford engineering teams world wide collaborate in the design of new car engines. The Global Engineering Network is an example of a marketplace for engineering knowledge where customers and suppliers exchange technical data.
- Publishing. Many newspapers and magazines are now on-line on the WWW.
- Professional services. A lawyer from Amesterdam provides a legal question answering service that is available 24 hours a day through the Internet.

However, results of a recent survey in the European Community have shown that for the large majority of the users, the Internet is used and seen as only suitable for advertising, and information exchange and communication (EC DGXII.A3, 1998). Only a small minority considered it suitable as an economic transaction engine. The few empirical studies on electronic commerce in the construction industry also reflect this conclusion. Indeed, the most used technology in construction seems to be e-mail. Murray and Thorpe (1996) found in their study that some construction firms are using e-mail to exchange not only plain text messages but also attachments of word-processing, spreadsheets and CAD files. Although most of its use was internal, between site and head-offices, there were some examples of consultants and contractors exchanging information in this way. Baldwin *et al.*, (1996) describe an e-mail based system that electronically links the CAD tool of a design and engineering management firm to the manufacturing database of a fabricator, exchanging 3D CAD drawings on a construction project of an offshore oil installation. Boughton *et al.* (1997) describe a Project Information Management System (PIMS), based on e-mail and document imaging and processing systems, which allows a client to exchange information electronically with its main contractors. Hannus *et al.* (1996) describe the use of Internet technology (e-mail, FTP, WWW, etc.) on a real construction project to link electronically the client, architect, construction engineer, HVAC engineer, electric engineers, and contractor, exchanging CAD, design documents, site instructions and other management information.

Thus, before the full potential given by Internet technologies for electronic commerce can be realised, particularly due to the non-proprietary nature of the technology, its easy implementation and user-friendliness, and low-cost, there are some issues that need to be addressed (Commission of European Community, 1997b; Crumlish, 1998; Terry, 1997; McLaren 1996). Firstly, financial issues like, customs and taxation, and forms of electronic payments must be internationally agreed. Secondly, legal issues that clarify the uniform commercial codes for electronic commerce, intellectual property rights, privacy laws and security systems must be designed. Thirdly, technology needs development in the telecommunication infrastructure and computer applications, and international technical standards must be agreed.

2.3.5 - Concluding remarks

The technical aspects of electronic trading systems are an important issue to bear in mind in considering the adoption process of electronic trading development, and this work will put forward some conclusions regarding how some of the characteristics of electronic trading systems may hinder or facilitate the adoption process. However, it can be argued that the adoption process of electronic trading can hardly be considered a technological problem since there is a large portfolio of technologies available and wide extent of use within some industries.

Despite all the Internet hype, EDI is still by and large the most used technology for electronic exchange of information between firms, and most literature addressing electronic trading focuses on EDI. This is reflected also in this work, where most examples given relate to EDI, and the case studies are mostly referring to EDI-based systems. However, in this work it was decided not to restrict the study of the adoption process of electronic trading systems solely to EDI, as there seems to be evidence that the use of technologies like electronic mail and Internet is emerging, especially in the construction industry. An important issue that must be clarified here is that the focus of this work is not on analysing which type of electronic trading system is more appropriate for construction firms. It is rather about the development process of electronic trading, whether firms do or do not adopt electronic trading and how the configuration of the systems is determined.

2.4 - Current understanding of the factors influencing the development of electronic trading

This section reviews current knowledge regarding the development of electronic trading. The review is presented on individual themes (benefit and costs, legal and control issues, and context) because no consistent models or theories have been successfully developed which clearly explain the process of electronic trading development. Moreover, most conclusions are drawn from outside the construction industry as there are very few theoretical or empirical studies which address the situation of construction firms.

2.4.1 - Benefits and costs

According to several authors, the adoption process of electronic trading systems is determined by the potential benefits and costs of the system as perceived by the firms involved. This section describes generically the potential benefits and costs, and analyses how they may influence electronic trading development.

2.4.1.1 - Potential benefits

The benefits of electronic trading may be divided in two main categories: operational and strategic benefits. Table 2.2 summarises both categories of benefits of electronic trading according to several authors (see e.g. O'Callaghan and Turner, 1995; Iacovou *et al.*, 1995; Emmelhainz, 1990).

Leading firms tend to obtain immediate and measurable benefits like reduction in processing and communication costs, reduction in inventory costs, better information quality, sometimes better operational procedures, and improved business relationships (Reekers and Smithson, 1996; Iacovou *et al.*, 1995; Benjamin *et al.*, 1990). Target firms tend essentially to have strategic benefits like better customer service and improved business relationships, increased business share, and very little benefits regarding cost reductions. The reasons that benefits for leading and target firms tend to be different are twofold.

Table 2.2 Electronic trading potential benefits

Type of Benefit	*Reasons*
Operational	
Reduced processing costs	Elimination or reduction of paperwork like re-keying, correcting errors, manual reconciliation; labour savings by re-deployment, etc.
Reduced communication costs	Reduction of mail, fax and telephone communications
Improved cash flow	Faster processing and exchange of information, reduction of float
Reduced inventory costs	Reduction of order cycle; reduced uncertainty; reduction of safety stocks; reduction of obsolete stocks; reduction of transportation and premium freight costs
Higher information quality	Increased timeliness, accuracy, adequacy and accessibility of information
Strategic	
Improved business processes	Re-assessment of business operations leading eventually to improvements in business operations and/or re-engineering of business processes
Better customer service	Shorter lead times; higher responsiveness; supports complex manufacturing and logistics approaches like JIT or Efficient Consumer Response
Improved business relationships	Increased co-operation and collaboration; more information sharing and wider and stronger communication channels; reduction of nuisance factors (e.g. errors, lost information, etc.); increased partnerships and alliances
Competitive advantage	Increased ability to reach new markets; faster and cheaper production and delivery; potential to lock-in customers and/or suppliers; increased market share; redesign of business networks

Source: O'Callaghan and Turner (1995); Iacovou *et al.* (1995); Emmelhainz (1990)

Firstly, leading firms tend to have electronic trading with several targets which allows them to obtain more operational benefits by addition, where target firms are usually linked with very few firms (Benjamin *et al.*, 1990). Secondly, targets have much less integration with internal systems, which, as shall be discussed below, reduces potential benefits (Iacovou *et al.*, 1995; Reekers, 1994).

There are few empirical and theoretical studies about electronic trading benefits achieved by construction firms. Back and Bell (1995) through simulation techniques suggest that the full information integration with EDI and bar coding (internal and external) of the construction materials management process could result in improvements of 68% of total process cycle time, and cost saving per cycle of 52%. With re-engineered processes the improvements could go as far as 85% and 75% respectively. Despite restricted data, Akintoye and McKellar (1997) concluded that manufacturers claim that enhanced relationships with trading partners and competitive advantage are the most achieved benefits, whilst contractors emphasise operational cost savings. Baldwin *et al.* (1996), Boughton *et al.* (1997) and Archer *et al.* (1997) argue that electronic trading can also enhance and extend partnering agreements by improving ways of working, avoiding disputes and providing new services.

Benefits are interlinked with the configuration of the electronic trading system. Empirical evidence has been presented which suggests that, in general, the more sophisticated the electronic trading system the higher the potential benefits both strategic and operational. For example, the more integrated EDI systems are with internal applications the higher the operational benefits (Bergeron and Raymond, 1992; O'Callaghan *et al.*, 1992; Benjamin *et al.*, 1990). Thus, an EDI system that is not integrated with internal systems, working on a stand alone basis, though it will eventually obtain reduced communication costs and higher information quality, it will not reduce paperwork through re-keying, correcting errors, manual reconciliation, and labour savings as much as if the system was fully integrated (O'Callaghan and Turner, 1995). Moreover, in integrated systems, the more types of information that are exchanged, i.e. the more EDI is integrated with different applications, the higher the operational benefits (O'Callaghan, 1995). Similarly, it may be expected that e-mail systems exchanging free-text messages are likely to achieve fewer operational benefits than advanced e-mail systems which e.g. integrate project management applications, especially benefits related with the processing costs. It is difficult to make benefit comparisons between different electronic trading systems, e.g. between EDI and e-mail systems. Though it is reasonable to expect that sophisticated EDI systems may bring more benefits than e-mail systems which exchange basically free-text messages, it would be difficult to assert the same if the comparison was made with integrated e-mail based systems.

Although EDI systems that automate existing manual or paper-based operations may achieve reasonable operational benefits, many authors advocate that for the greatest potential to be realised, EDI must do more than just be integrated with internal systems. Applications and business processes must be re-engineered and improved seamlessly with EDI to accommodate the potential capabilities of the electronic exchange of information. Therefore configuration of electronic trading systems should not just emulate paper-based systems but rather develop new functionality altogether (see e.g. Swantan *et al.* 1994; Davenport, 1993; Benjamin *et al.*, 1990). However, there has been little evidence of these types of benefits occurring in real cases. The underlying trend in electronic trading is to obtain operational efficiency and a process of automation rather than radical improvements or changes (Spinardi *et al.*, 1996; Bjorn-Andersen and Krcmar, 1995). This work will contribute to a better understanding of the benefits that different construction firms (consultants, contractors, etc.) are obtaining from deploying different configurations of electronic trading systems, and make comparisons possible with benefits obtained in other industries.

2.4.1.2 - Potential costs

The development and running costs of electronic trading systems vary greatly with the function of the technology and its configuration. Thus, developing and running an electronic trading system based on the Internet is quite inexpensive in absolute terms, and much cheaper when compared with e.g. EDI or e-mail systems. Within each technology, costs vary accordingly to the configurations, like if it is mainframe or PC based or the level of integration with internal applications (Jayachandra, 1994). To exemplify the contrast regarding the costs, examples of development costs of Internet-based systems and EDI-based systems are presented.

According to Hannus *et al.* (1996), if firms already have a PC and use the services of an Internet Service Provider (ISP), the main costs of using Internet to exchange, e.g. project information, will consist of Internet connection and server charges: connection hardware (modem, ISDN card or network adapter); telephone line use (dial-up, ISDN, or leased); and Internet service (time used, entry fee, monthly charge of disk space). The required software (WWW browser, FTP client, e-mail) are freeware. Expenditure with technical development and training of users should be very low as the technology is very simple. Hannus *et al.* (1996) suggest that the Internet implementation and running costs are smaller than traditional paper-based systems, and even lower than transferring diskette copy with a courier. However, if firms were to install an Internet server than the costs would rise considerably.

The costs of EDI-based systems vary considerably with the function of the system and its configuration. In principle the more sophisticated the EDI system (higher levels of integration, more messages exchanged, bigger process and system changes, and high frequency of exchange), the larger the cost of development and running. The main costs of EDI development and use are depicted in Table 2.3 (see e.g. Riggins *et al.*, 1994; Reekers, 1994; Jayachandra, 1994; Graham *et al.*, 1994).

There are other less tangible but significant costs associated with the development of electronic trading systems. An important cost relates to the management time and effort of establishing the methodologies, procedures and the terms of establishing electronic trading (Cunningham and Tynan, 1993). Other important cost is associated with the disruptions due to implementation and learning curves of the systems (O'Callaghan *et al.*, 1992). Finally, the development of electronic trading systems may imply changes in firms' internal systems and changes in operating procedures which have less obvious costs (Bjorn-Andersen and Krcmar, 1995).

Table 2.3 EDI potential costs

Costs	*Description*
Communication hardware and software	The system that connects the EDI translation software with the communication networks. Not very expensive.
EDI translation software	The software that converts messages from standard format to the format required by the application. It can be purchased or developed in house. The cost varies considerably whether the software is for mainframes or PC. Moreover, the more standards support and integration facilities the more expensive. Off-shelf software ranges between £500 and £5000.
Integration	The integration of EDI translation software with internal applications is probably the most expensive element of an EDI system. The costs relate essentially with programming interfaces with internal applications. Moreover, the more applications are integrated with EDI translation software (i.e. more messages exchanged) the more expensive it is. Integration costs could run over £10,000.
Communication network	Charges on Value Added Network services or direct links. Regarding the use of VANs, cost vary according to the services supplied and the chosen firm. Costs vary also with the volume and frequency of information exchanged.
Training	Costs associated with providing training to EDI system's users. Not expensive and often not done.
Expertise	Costs of technical experts. The development process of EDI often requires a range of technical personnel as it involves dealing with disparate expertise such as standards, telecommunications, programming, etc. Technical experts may be internal or hired as consultants.

Source: Riggins *et al.*, 1994; Reekers, 1994; Jayachandra, 1994; Graham *et al.*, 1994

The overall real cost for firms developing a specific electronic trading system may not be constant across firms that are developing similar configurations. Thus, for example, if a firm has implemented an EDI system, the cost of developing an electronic link with another firm is much lower than if it had not any linkage, as part of the necessary hardware, software and expertise is already deployed (Riggins *et al.*, 1994).

2.4.1.3 - Perceptions of benefits and costs

As described before, there is empirical evidence suggesting that benefits and costs vary with the function of the electronic trading systems and its configuration. Sophistication of electronic trading systems seems to positively influence benefits, but it also raises costs. Though some firms claim to make rigorous economic cost-benefit analysis regarding the development of electronic trading systems, Bjorn-Andersen and Krcmar (1995) found that most firms do not make any formal economic evaluation of benefits and costs.

There is a general acceptance, based on empirical evidence, that perceptions over the balance between benefits and costs of electronic trading systems is one of the most critical inputs in the decision over whether to adopt electronic trading (O'Callaghan *et al.*, 1992; Iacovou *et al.*, 1995). Empirical findings also suggest that the perception of benefits influence the sophistication level of electronic trading systems (Iacovou *et al.*, 1995). These findings are echoed by research into construction firms, where the lack of perceived tangible benefits and the potential costs are advocated as two of the main hinders to the development of electronic trading systems by construction firms (Akintoye and McKellar, 1997; Coomber and Chevin, 1990).

2.4.2 - Legal and control aspects

2.4.2.1 - Legal issues

Because electronic trading is still a relatively new phenomenon and the pace of computing and telecommunication change is so great, the legal establishment regarding its use are not, in generic terms, able to cope with it. The most relevant legal issues are depicted in Table 2.4 (see e.g. Baldwin *et al.* 1993; and Parfett, 1992).

In order to cope partly with the legal issues, firms involved in electronic trading often rely on written contractual agreements or interchange agreements, which detail rights, duties and actions in the case of any problems that occur. These may be based on the Uniform Rules of Conduct Interchange of Trade Data (UNCID) which specify some aspects to be covered in those agreements (Parfett, 1992). In the UK, the Standard Electronic Data Interchange Agreement has been published to guide the implementation of EDI (National Economic Development Council, 1992). However, the agreements are rules of conduct not laws. The settling of these agreements which aim to deal with the legal aspects may be a time consuming and demanding, requiring much co-operation between the parties involved.

Table 2.4 Relevant legal aspects

Legal issue	*Description*
Authentication	Display of proof that electronic information is authentic (not corrupted);
Authorisation	Absence of form stating the condition of the document (e.g. conditions of an order);
Digital records	Low acceptance of computer records as legal evidence;
Written and signed	Law requires that some documents (e.g. contracts, invoices, etc.) be written and signed;
Liability	Difficulty of apportioning of risk and errors amongst parties involved;
Privacy	Threats to privacy regarding information exchanged
Conflicting laws	Current complex and conflicting national and international laws
Audit trail	Difficulty of checking of information flows.

Source: Baldwin *et al.* (1993); and Parfett (1992)

2.4.2.2 - Control issues

The existence of control elements in electronic trading systems aims to deal with either deliberate or accidental: access and use, damage, corruption of data, re-direction of electronic exchange of information (Baldwin *et al.*, 1993). Control factors may be audit trails, acknowledgement messages, error detection mechanisms, backups, password protection, digital signature, and encrypting systems (Jayachandra, 1994). The application of these control elements may however be quite cumbersome and time consuming, which hinders its use.

2.4.2.3 - Perceptions of legal and control issues

Not all information requires the same concerns regarding legal issues or control (Parfett, 1992). In general, the exchange of commercial information like tenders, purchase orders, invoices, etc., requires systems more demanding in terms of legal and control issues, due to the sensitivity of its content. The exchange of managerial and technical information tends to be less formal. Some electronic trading systems, like advanced EDI or e-mail based systems using third-party services are more likely to handle the authentication, authorisation, liability, privacy, audits issues and provide more advanced control factors (McLoughlin, 1994) than e.g. Internet systems, which have little control or transmission reliability (Terry, 1997; McLaren, 1996).

Legal issues can be perceived as a hindrance to the development of electronic trading. In short-term and adversarial relationships, like those in the construction industry, the uncertainty regarding the legal aspect of electronic trading may become a serious obstacle for developing electronic trading by some firms (Baldwin *et al.*, 1993). Similarly, control issues are also of prime importance in electronic trading development. Though some electronic trading systems may potentially offer a higher level of control than paper-based systems, until the security issues have been clearly guaranteed there will be a reluctance to adopt electronic trading systems (Baldwin *et al.*, 1993).

2.4.3 - Contextual factors

Several authors stress that while perceptions of benefits, costs, and implementation issues are major inputs on the adoption process, the decision over the development of electronic trading is responsive to a social and business context (see e.g. Bjorn-Andersen and Krcmar, 1995; O'Callaghan *et al.*, 1992). These factors are now reviewed.

2.4.3.1 - Intra-firm context

This section reviews the most important internal aspects of firms which are referred to in the literature as specifically influencing the development of electronic trading.

Based on the application by Rogers (1983) of the innovation adoption theory to EDI adoption, O'Callaghan *et al.* (1992) suggest that systems and organisational incompatibility may be major obstacles to the deployment of electronic linkages between firms. The former relates to the ease with which electronic trading systems can be integrated with IT systems within the company, whether changes to present systems are necessary, and the later refers to organisational implementation issues like required disruptions, development and learning time, and changes in internal procedures. However, empirical evidence only supports the proposition that systems incompatibility has an influence on the adoption process of electronic trading systems.

From another perspective, Iacovou *et al.* (1995) suggest that financial IT resources and IT capability are two important factors which may influence the development of electronic trading. The availability of financial resources for the implementation of electronic trading systems would be expected to contribute positively to its adoption and level of sophistication. IT capability refers to the level of firms' internal IT usage and management commitment to IT. Highly integrated and computerised business processes, and a management staff highly committed would also be expected to raise adoption of electronic trading systems and increase sophistication. However, empirical evidence by the same authors found that that there is no clear relationship between the adoption of EDI and firms' availability of financial resources for IT, and IT capabilities (Iacovou *et al.*, 1995). Their conclusions stress also that though financial IT resources and IT capability may be needed for the adoption of electronic trading and use of sophisticated systems, they do not necessarily lead to adoption and an increase in sophistication of electronic trading systems.

Some authors attempt to measure the importance of firms' internal financial and technological issues for the development of electronic trading by analysing the relation between firm size in terms of turnover and number of employees and adoption rate. Indeed, studies have shown that the rate of electronic trading adoption seems to raise with the size of the firms (Reekers, 1994). Leading firms seem to have larger turnovers and number of employees than target firms, though target firms are also often large-size (O'Callaghan and Turner, 1995; Riggins *et al.*, 1994; Reekers, 1994). There is recent evidence that small-size firms are also playing the role of leading firms (Commission of European Community, 1997b). The pattern is similar within the construction industry, where surveys demonstrated that the few firms with electronic trading tend to be large-size firms, with high turnover and a large number of employees (Akintoye and McKellar, 1997; O'Brien and Al-Soufi, 1994). The point to be made here is that the direct relationship between firm size and high financial IT resources and high IT capability is dubious, as there are many large firms which are not willing to expend on IT or are far from having sophisticated internal IT systems.

Emmelhainz (1990) argues that the technical issues of electronic trading are not very demanding in comparison with the complex organisational and cultural factors brought about by their implementation. The problems of managing the internal change process is compounded by the fact that electronic trading systems development superimposes the requirement of involving people from at least two different organisations, which are likely to have distinct values, capabilities, interests, and commitments (Bjorn-Andersen and Krcmar, 1995; Rao *et al.*, 1995). This is corroborated by studies that clearly demonstrated that full management commitment towards electronic trading is a crucial aspect towards the adoption of electronic trading, its successful implementation, and the development of sophisticated systems (Rao *et al.*, 1995; Bjorn-Andersen and Krcmar, 1995; Reekers, 1994; Emmelhainz, 1990).

2.4.3.2 - Inter-firm context

Empirical evidence has been produced which point out that inter-firm context seems to be one of the major factors influencing the development process of electronic trading between firms.

The duration and volume of transactions seems to be a major factor contributing to the development of electronic trading. Indeed, firms which have a long-term relationship and have a high volume of transactions are more likely to adopt and develop electronic trading, though there is little evidence regarding its effect on the configuration of electronic trading systems (Graham *et al.*, 1996; O'Callaghan, 1995; Benjamin *et al.*, 1990). However, some authors suggest that it is not just the nature of the relationship that is important but also the way the process is conducted. Whilst some leading firms encourage potential target firms to develop electronic trading voluntarily, others exert pressure or eventually coerce them, especially if the former are buyers and the later are suppliers (Riggins *et al.*, 1994; Cunningham and Tynan, 1993). According to Reekers and Smithson (1996) and Iacovou *et al.* (1995), the pressuring/coercion is the most important factor influencing the development of electronic trading, especially for small firms. This seems to be applicable to the construction industry, as Akintoye and McKellar (1997) stress that one of the major reasons regarding the low use of EDI by construction firms, especially contractors and subcontractors, is the lack of pressure on the part of customers and suppliers. During this work this subject shall be further discussed.

There seems to be, however, several methods and degrees of pressuring firms. The lowest level of pressuring firms is by trying to convince potential spokes of how their organisations might benefit through electronic exchange of information, aiming to raise their awareness and therefore the likelihood of adoption of electronic trading (Iacovou *et al.*, 1995; Riggins *et al.*, 1994). On the other extreme of pressuring, there is coercion, where leading firms explicitly or implicitly suggest the discontinuance of the relationship if the potential targets do not adopt electronic trading (Reekers and Smithson, 1996; Iacovou *et al.*, 1995; Riggins *et al.*, 1994). Coercion is often used within the automotive and retailing industries (Reekers and Smithson, 1996; Cunningham and Tynan, 1993). However, according to some authors, coerced firms tend to be electronic trading compliant instead of committed to it (Haughton, 1992). This means that coerced firms develop only the minimum requirement for exchanging information electronically with the leading firm. For example, in EDI-based systems, target firms tend to implement EDI on stand alone PCs, without concerning integration or sophistication (Riggins *et al.*, 1994; Haughton, 1992). According to Iacovou *et al.* (1995), the ability to pressurise firms is a function of a firm's channel power over the other firms. Thus, if a buyer has a large proportion of supplier's sales, it is more likely to be able to exert pressure on the development of electronic trading, including part of the system's configuration, especially if suppliers are small firms.

Cunningham and Tynan (1993) stress that some leading firms seem to have found a more enriched way of pressuring, through providing incentives to the firms which comply with electronic trading. Riggins *et al.* (1994) suggest several examples of those incentives: long-term trading commitment; substantial risk sharing; technical support and expertise; free or subsidised software/systems and training. Incentives seem to contribute positively to the adoption of electronic trading, and to the likelihood of firms developing more sophisticated systems. Riggins *et al.* (1994) advocate that the integration of EDI with firms' internal systems is more likely to happen where leading firms provide incentives to targets, and Iacovou *et al.* (1995) concluded empirically that this situation is particularly adequate when the later have very low internal capabilities to develop electronic trading, which is the case with most small firms.

2.4.3.3 - Industrial context

The structure and organisation of the construction industry is considered by many authors as one of the main factors restricting the adoption of electronic trading. According to Baldwin *et al.* (1993), the structure and organisation of the UK construction industry is not suited to the adoption of EDI. The special construction characteristics which are believed to hinder the development of electronic trading are: the number of small firms within the industry; the cyclic nature of the construction business and short-term horizons; the one-off project oriented process. O'Brien and Al-Soufi (1993) also advocate that the industry's large fragmentation are serious hinders to the wide dissemination of EDI in the construction industry. Because of the fragmented nature of the industry, construction firms do not have a clear incentive to invest in innovation, as the separation of the costs and benefits inhibits investments to achieve inter-firm efficiency (Centre of Strategic Studies in Construction, 1989). The problem of construction fragmentation is partly reinforced by Graham *et al.* (1994), who stress that the higher the industrial concentration, i.e. domination by a small number of large firms, the more likely the development of EDI. Firstly, because high concentration decreases the complexity of agreeing the configuration EDI in the sector, including standards. Secondly, because high concentration means that large firms are more able to coerce firms to develop electronic trading. However, there is little empirical evidence that supports the effect of industry fragmentation upon the development of electronic trading.

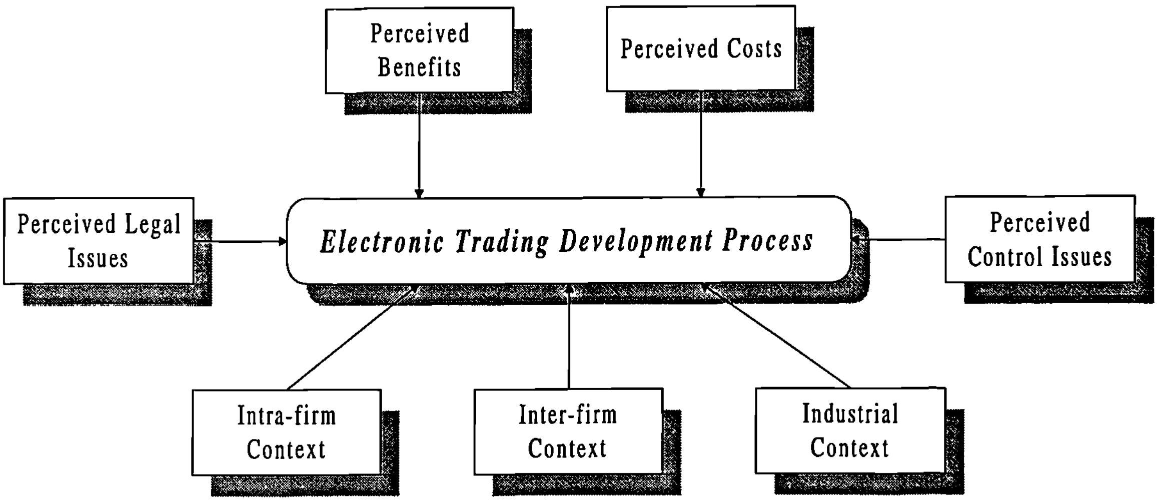
Several authors suggest that in industries where electronic trading has almost became a way of doing business, a requisite to be in the industry, like e.g. the automotive, retailing, or pharmaceutical industries, etc. firms are more likely to develop electronic trading, as most of its competitors and customers have developed them and thus put higher competitive pressure (Iacovou *et al.*, 1995; Bjorn-Andersen and Krcmar, 1995). Moreover, O'Callaghan *et al.* (1992) suggest that when similar firms have developed electronic trading, that adoption may encourage imitation, regarding the development itself and its configuration. However, several empirical studies found no reasonable correlation between the adoption of electronic trading and the influence of imitation or competitive pressures (O'Callaghan *et al.*, 1992; Reekers, 1994; Iacovou *et al.*, 1995).

The industrial context may have other potential influences on the development of electronic trading. Benjamin *et al.* (1990) and O'Callaghan *et al.* (1992) suggest that industries with strong trade associations, or other industry-wide organisations may also contribute to shape the development of electronic trading, especially in relation to the definition of standards and awareness of potential benefits (Benjamin *et al.*, 1990). This is the case in the automotive industry, where the European automotive industry association successfully implemented an EDI project, designated by ODETTE, amongst most of the automakers and their suppliers (Graham *et al.*, 1996). According to Akintoye and McKellar (1997) and Baldwin *et al.* (1996), in the UK this role is being addressed by the two construction firm-led bodies EDICON and CITE, responsible for developing standards and promoting EDI within the UK construction industry.

2.4.4 - Critique of the current approach

Based on the literature review, current knowledge regarding the process of adoption of electronic trading by firms in general, and by construction firms specifically, has been described. It was referred that, in general, managerial perceptions of the benefits, costs, legal and control issues are believed to influence not only whether firms adopt electronic trading but also its potential configuration and degree of sophistication. It was also stressed that some authors argue that though perceptions are major inputs into the decision process, the adoption decision should be responsive to a social and business context. Thus, current knowledge about how intra-firm, inter-firm and industrial contexts may influence the development of electronic trading was also reviewed. The full review is depicted in Figure 2.2.

Figure 2.2 - Summary of the reviewed factors influencing electronic trading



The literature review has highlighted several gaps in knowledge regarding the development process of electronic trading by construction firms. The most important issue is the fact that there is very little empirical and theoretical knowledge regarding the adoption process. The low take-up of electronic trading by construction firms has been followed by scarce research studies addressing the subject. Thus, there is little understanding of how benefits, cost, legal issues, and contextual factors influence whether construction firms adopt electronic trading and their impact on configurations. Moreover, the existence of disparate types of organisations within the construction industry, like clients, architects, consultants, contractors, subcontractors, builders' merchants, manufacturers, etc. suggests that each type may have specific needs and problems regarding the adoption process which should be better understood, though little has been done addressing that.

Thus, current knowledge is not able to fully explain why construction firms have so little electronic exchange of information, and existing electronic trading systems have such low sophistication; why some types of construction firms like builders' merchants and manufacturers seem to have more electronic trading than others; and why manufacturing and service firms have much more electronic trading and more sophisticated systems. Moreover, current understanding of the development process is quite insufficient in order to devise effective strategies to foster the wider adoption of sophisticated electronic trading systems.

Although the body of knowledge about the process by which non-construction firms adopt electronic trading systems is far more rich than that specific to construction, it is argued here that it is still considerably poor. In other words, the current understanding of the generic development process is far from giving much insight to the construction case. Indeed, though several factors have been identified and analysed which are believed to influence the adoption process, there is no model or theory which addresses the interlinkages and interdependencies between the disparate factors. Current models tend to be static and pinpoint only the factors which are believed to influence the adoption process in a restricted domain. Moreover, there is no conceptual framework or model which provides a comprehensive way to describe and analyse the dynamics of the process by which firms in a relationship decide whether to develop electronic trading, and the decision over the configuration of the electronic trading systems. The stance in this work is that it is necessary to have a strong understanding of the development process in order to be able to devise effective strategies for the development of electronic trading.

The remainder of this work will focus on enhancing the understanding of the development process of electronic trading, in general, but referring especially to the construction industry. The conceptual framework for describing and analysing the development process will be based on the business perspective and network approach (Håkansson and Snehota, 1995). A model shall be produced, based on the insights from the conceptual framework and the aspects reviewed in this chapter, which will contribute to the theoretical knowledge regarding the development of electronic trading by construction firms. Cases studies will be undertaken to sustain and test the theoretical propositions.

2.5 - Summary

This chapter defines electronic trading as a relationship between two firms where there is electronic exchange of information through computer and telecommunication technologies. Configurations of electronic trading systems were seen as varying on a continuum of sophistication and using disparate technologies like EDI, electronic mail, interactive and on-line systems, or the Internet. It was stressed that current knowledge advocates that perceptions over the balance between benefits and costs; legal and control; intra-firm, inter-firm and industrial contextual aspects are the main factors influencing the development of electronic trading. However, studies were sometimes inconclusive, and most importantly lacked a strong theoretical background that provide a comprehensive way to describe and analyse the dynamics of the process of electronic trading development.

CHAPTER 3

BUSINESS RELATIONSHIPS

3.1 - Introduction

The definition of electronic trading as a business relationship with specific characteristics, draws attention to the business aspects of the electronic exchange of information. This chapter reviews the current knowledge about the relationship perspective advocated by a stream of researchers. A description of the main relationship issues is elaborated, along with an analysis of the application of the relationship perspective in the construction context. The chapter concludes by analysing the implications of framing electronic trading development in a relationship perspective.

3.2 - Conceptualising business relationships

3.2.1 - Relationship perspective

The previous chapter defined electronic trading as a business relationship between two firms where there is electronic exchange of information. The main consequence of this definition is the fact that in this work the basic unit of analysis is the electronic trading dyad (i.e. one-to-one electronic trading linkage) rather than the focal organisation. Most previous studies (partly reviewed in the previous chapter) addressed the problem of understanding the development of electronic trading by analysing the internal and external factors which influenced the focal organisation to develop electronic trading. In other words, electronic trading development is seen through the "eyes" of an individual organisation, e.g. a contractor, or a builders' merchant. In this work it is considered that electronic trading is embedded in a business relationship, and therefore in order to understand the development of electronic trading, one needs to analyse the structure, and process dynamics of business relationships. This is also supported by authors like Cunningham and Tynan (1993) and Reekers and Smithson (1996) who stress that research into the business perspective can provide important insights into how electronic trading systems may be initiated and developed.

Relationship perspective in this work implies that relationships between firms are considered to be as complex and rich social constructs between people in firms, which evolve over time, rather than single exchange episodes and transactions (Håkansson, 1982). This means that the traditional economics perspective (and related models and theories) of pure competition with unconnected and adversarial relationships is not considered adequate to explain inter-firm phenomena like electronic trading (Easton, 1992).

3.2.2 - Traditional view of relationships

Classic economic models have seen firms in industrial markets, especially firms in buyer-supplier interactions, as homogeneous, atomistic, unrelated entities mainly controlled by price mechanisms. This implies that buyers buy where the market offers better conditions, there are no transaction costs, change is the norm rather than the exception, and therefore firms act in little or no historical context (for an extensive review on this subject see e.g. Biggart and Hamilton, 1992). These assumptions have been implicitly used by the traditional marketing-oriented management literature, which also tends to use themes from consumer marketing and apply them to industrial situations. The consequence is the assumption of supplier dominated industrial markets, where the supplier sets the mix parameters and the faceless buyers respond (Kotler, 1976; McCarthy, 1978; Corey, 1976). On the other hand, traditional purchasing literature assumes a totally contrary position, by stating that negotiation is the means by which 'active' buyers gain control over the 'passive' sales representative (England, 1970; Webster and Wind, 1972). Some of the early literature about electronic trading development, partly reviewed in Chapter 2, grounded its research frameworks on these economic, marketing, and purchasing assumptions.

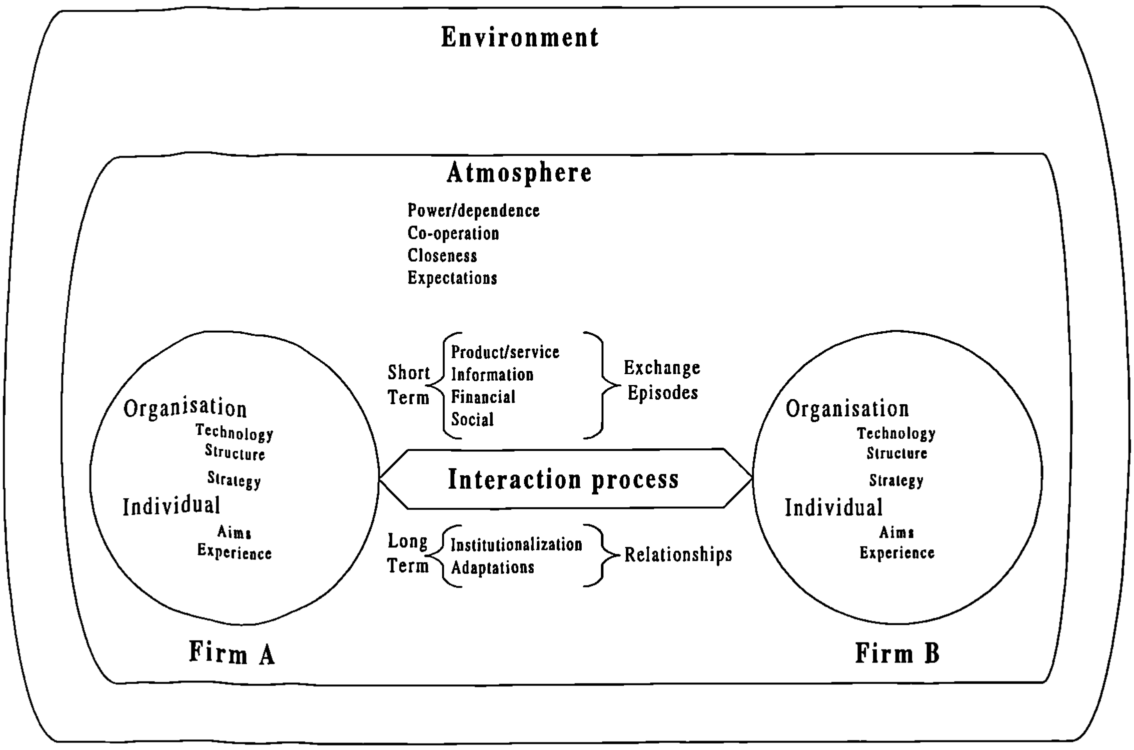
Empirical research on industrial interaction processes is, however, at odds with traditional approaches, which has led to new theoretical developments. Empirical evidence shows that both buyers and sellers are active participants in the transaction process - which means that in order to understand inter-firm relations it is necessary to study both buyer and seller, and that stable, long-term, complex relationships between firms are the norm rather than the exception (Håkansson, 1982). Thus, new economic theories like transaction costs analysis (see new institutionalists as e.g. Williamson, 1985), new marketing theories and models, like distribution channels (see e.g. Benson 1975), and the application of sociological concepts to industrial relations (Levine and White, 1972; Van de Ven *et al.*, 1975; or Arndt, 1979), have given new insights to the interaction process between firms which are much more in accordance with empirical results. These approaches became the basis of much of the current relationship models and theories.

3.2.3 - The IMP interaction approach

In the last two decades or so, business relationships have received, a growing attention, and have been the object of a number of distinct studies in Europe, US, and Japan: e.g. Johanson (1994); Håkansson (1982, 1989); Gadde and Mattson (1987); Ford (1990); Dwyer, Schurr and Oh (1987); Van de Ven *et al.*, (1989); Powell (1990); Miles and Snow (1992); Nohria and Eccles (1992); Axelsson and Easton (1992); Takeuchi and Nonaka (1986); Teramoto (1990). Though these studies have often used different frameworks and varying perspectives, there are some interesting common traits. In this work it was considered that the model devised by the Industrial Marketing and Purchasing (IMP) group (see e.g. Håkansson, 1982), is very useful to identify and explain the structural and dynamic issues of business relationships, providing a framework to the concepts found in the literature, especially because a lot of research into relationships has sprung from the IMP model. Therefore, the IMP model will be one of the core theoretical frameworks in this work regarding the development of electronic trading. Where appropriate, an enrichment of the concepts by other authors is presented.

The IMP Group produced the 'interaction approach', closely related to the theoretical ideas of 'inter-organisational theory' (Van de Ven *et al.*, 1975) and the 'new institutionalists' (Williamson, 1975), and built also from empirical evidence. The main focus of the interaction approach is the two-firm manufacturing relationship, but it can also be applied to a several party relationship or network (Håkansson, 1982, 1989). By explicitly focusing on the situation of buyer-supplier relationships, the model considerably improves and enhances knowledge regarding business-to-business relationships. The model is summarised in Figure 3.1.

Figure 3.1 - The IMP interaction approach



Source: Håkansson (1982)

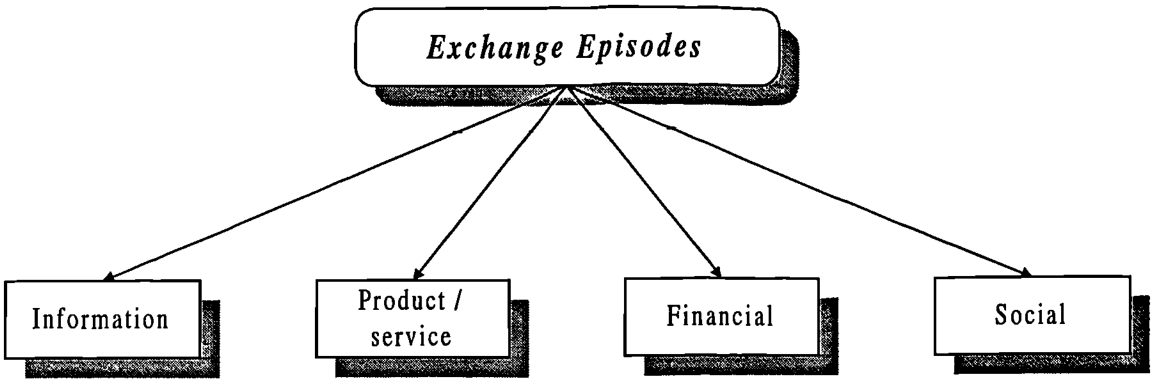
The main elements of the IMP model are (Håkansson, 1982):

- The **elements** and **process** of interaction
- The **participants** involved in the interaction
- The **environment** in which the interaction takes places
- The **atmosphere** affecting and affected by the interaction

3.2.3.1 - Exchange episodes

The model considers that it is important to distinguish between the individual **episodes** or **interactions** in a relationship, i.e. the day-to-day exchanges, and the longer-term aspects of that relationship. Firms are likely to exchange four elements: **products and service**; **information**; **financial**; and **social** (Figure 3.2).

Figure 3.2 - Exchange episodes in relationships



Products and services are the core of the exchange, though what is exchanged may vary greatly, from simple commodities to highly customised products. Financial exchange is an indicator of the economic importance of the relationship between the firms. Social exchange is perceived by the IMP model as playing an important part in the development of relationships. It is important as a way to overcome short-term difficulties and maintain the relationship between transactions. Moreover, individuals in business relationships tend to create personal relationships which seem to be an important factor in the development of inter-organisational ties. Building mutual trust is a social process which requires time and it is critical to relationship development. Finally, information exchange is an important element in relationships. Its content (technical, commercial, or managerial), its depth and width, the communication channels and formality are all characteristics of the exchange which may contribute to the relationship. Relationships can exist even without product/service exchanges only, e.g. with social or informational exchanges.

3.2.3.2 - The process of interaction

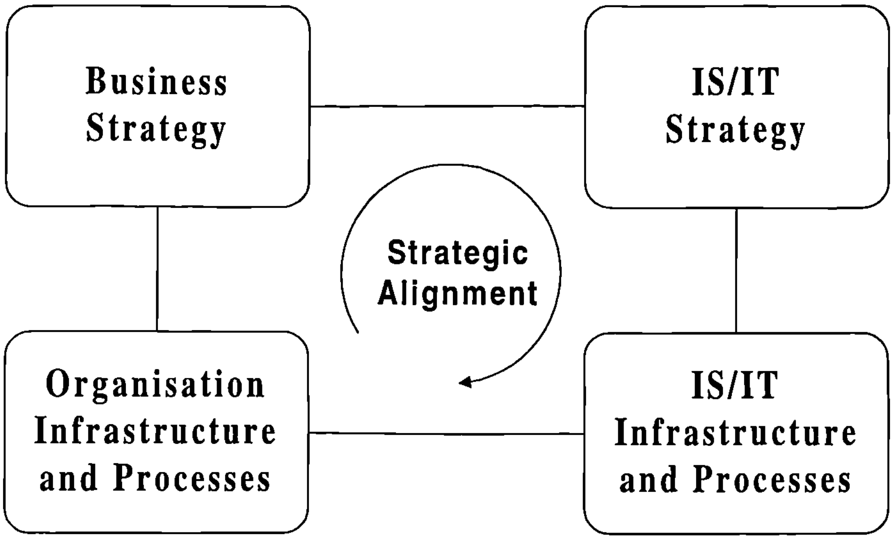
The IMP model stresses that product, finance, information, or social exchanges may become routine over a period of time, leading to the **institutionalisation** of expectations and contact patterns between firms (Håkansson, 1982), where certain implicit and explicit norms and procedures are taken for granted. As the relationship builds up, firms become more aware of what the other firm can do and have to offer, and seek more efficient and effective inter-firm co-ordination (Easton, 1992). Hence, two companies in a relationship tend to modify and make adaptations in either the elements exchanged, the process of exchange, or other internal activities (Håkansson, 1982). Technical adaptations in product features or in the production process are common, but so are adaptations in administrative and logistic activities of both firms (Håkansson and Snehota, 1995). Adaptations can occur during the process of a major interaction, or in a continuous way, over the time of a relationship (Håkansson, 1982). The mutual adaptations create interdependencies and bonds between the firms, which strengthens and conditions the relationship (Håkansson and Snehota, 1995; Johanson and Mattsson, 1987).

Relationships between two firms develop over time as a chain of interaction episodes, and how it develops depends on how each firm act and react in the relationship (Håkansson and Snehota, 1995). The development of a relationship can not happen unilaterally, it requires mutual orientation, commitment and interdependency (Johanson and Mattsson, 1987). Social aspects down play the importance of the contribution of price mechanisms in determining the behaviour of the two firms (Powell, 1990; Easton, 1992; Sako, 1992). Relationships usually show continuity, i.e. extend over a long time period, and have a considerable stability. Continuity is believed to be a pre-condition for change and development in the relationship (Håkansson, 1982; Håkansson, 1989; Easton, 1992, Håkansson and Snehota, 1995). Thus, perceptions about the history, present and future of the interaction are crucial elements in the development of a relationship.

3.2.3.3 - Participants

Another important element of the interaction approach are the characteristics of both firms involved in the relationship. Håkansson (1982) stresses that the mutual knowledge and structural fit of the characteristics of the two technological systems, and their organisational size, strategy and structure (e.g. extent of centralisation, specialisation, etc.) affect the nature of the relationship. Also the personalities, experience, and motivations of individuals involved in the relationship affect its development. Following Venkatraman (1991), it is argued here that for relationship development, each firm should seek (implicitly or explicitly) a dynamic alignment between four various domains (see Figure 3.3 and Table 3.1), which means that these are internal factors of each firm that are likely to affect and be affected by the interaction process between firms.

Figure 3.3 - The alignment of the four domains



Sourcc: Adapted from Venkatraman (1991)

Table 3.1 Internal domains

Domain	*Description*
Business strategy	Defined in terms of business scope; distinctive competencies; and mostly important to this work, business governance.
Organisation infrastructure and processes	Defined according to the administrative structure - organisation structure, roles and responsibilities, reporting relationships; processes - management processes and activities; and skills.
IS/IT strategy	Defines the choices regarding the IT marketplace.
IS infrastructure and processes	Defined in terms of choices regarding the data, applications, and technology infrastructure to deliver the required IT products and services.

Source: Venkatraman (1991)

3.2.3.4 - Atmosphere

The IMP model states that exchange episodes, and norms and procedures are affected and affect the atmosphere of the relationship. The variables characterising the atmosphere in relationships are depicted in Figure 3.4, and described on Table 3.2.

Figure 3.4 - Atmosphere variables in relationships

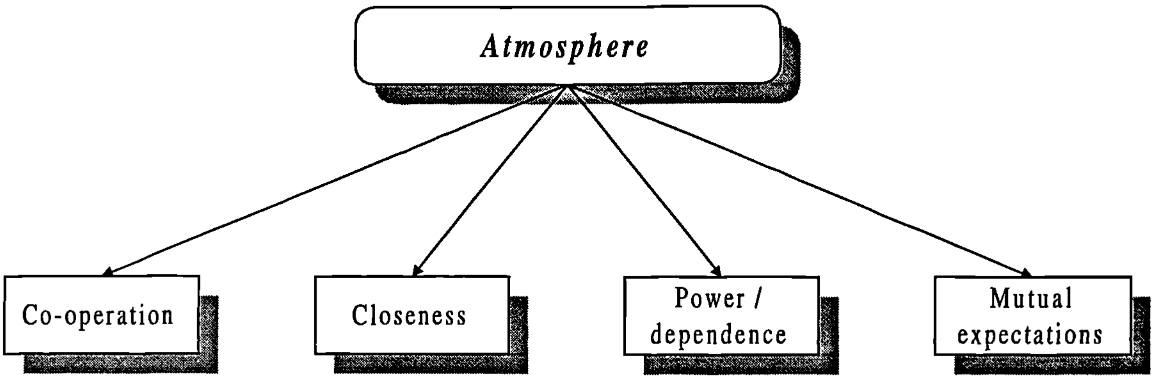


Table 3.2 Atmosphere variables of relationships

Atmosphere	*Description*
Power-dependence relation	Inter-organisational power depends on the ability of firms to pressurise, coerce or reward the other party. The power of a firm over the other is partly related with its transactional dependence and its network position. Power may be symmetrical or highly asymmetrical.
State of conflict or co-operation	A relationship can be characterised by co-operation and collaboration on their transactions or firms may co-operate little in making the transaction, and eventually have a situation of latent or open conflict.
Closeness or distance	Close relationships are characterised by large mutual adaptations, and the development of technological (e.g. joint product development), knowledge (e.g. R&D), social (e.g. meetings), administrative and logistic interdependencies (e.g. electronic trading), and therefore the creation of strong ties between the firms. Distant relationships are those where both firms have simply exchange episodes without adaptations and ties.
Mutual expectations	The routinization of exchanges leads to the expectations by the firms regarding both behaviour, norms, procedures, and future transactions. Firms expect a certain behaviour from the other party.

Source: Håkansson (1982); Håkansson and Snehota (1995)

The atmosphere is a product of the relationship, which results from the combination of the other elements of the interaction process, i.e. the exchange episodes, the characteristics of the firms, the adaptations and institutionalisation, and the context in which it is involved. In certain situations, one specific variable e.g. a strong social exchange or a firm's structure may dominate the atmosphere of the other elements. Atmosphere provides the way to understand the development of relationships, though its full understanding also requires the analysis of individual episodes and the interaction process. Thus, there is a very high degree of interdependency between the individual variables, meaning that sometimes it is difficult to discern individual effect. Still, it is generally accepted that it is important to distinguish between the various factors and variables in order to obtain a more clear picture of the structure and dynamics of business relationships.

3.2.3.5 - Environment

Although the original interaction model advocates that interactions take place in a wider context, and define a set of environmental factors like market structure, dynamism, internationalisation, etc., in recent studies the IMP model is embedded in a network context (see e.g. Hallen and Johanson, 1989; Easton, 1992; Håkansson and Snehota, 1987). This will be discussed in Chapter 4.

3.2.4 - Patterns of relationship development

Relationships are also characterised by complexity, both in their development process and in their structure. The development of relationships is a complex process for the various elements involved, i.e. the various elements of exchange, the characteristics of the parties, the process itself, the environment and the atmosphere, all interplay with each other affecting its outcome (Johanson and Mattsson, 1987; Sako, 1992; Håkansson and Snehota, 1995). The result is that no two relationships are alike, and this heterogeneity of relationships pose managing problems for firms (Håkansson and Snehota, 1995). In order to capture this heterogeneity, Sako (1992) defined a continuous spectrum of relationships, from Arm's-length Contract Relations to Obligational Contract Relations (ACR - OCR). Addressing some of the issues brought up by the IMP model, Sako discerns remoteness at one extreme (ACR), where relationships are mainly based on price-mechanisms, with no interdependencies, short-term, adversarial, and interacting on a free market basis. At the other extreme with OCR she sees closeness, where mutual trust and indebtedness are the main co-ordination mechanism, firms being highly interdependent, relations having a long time span. Sako stresses that real relationships are rarely at these extremes, they tend to have a mix of ACR and OCR characteristics.

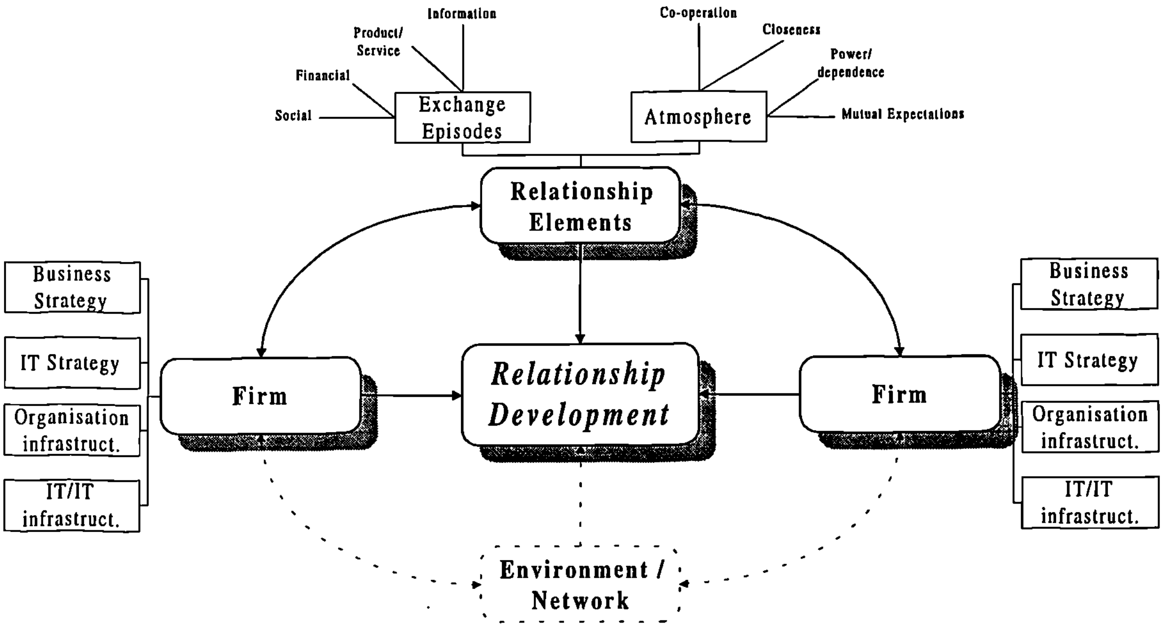
In spite of relationship diversity, they are rarely random, they tend to form patterns. Though some authors stress that strong, close relationships, tend to be found mainly in Japanese industrial relationships (see e.g. Dore, 1983; Sako, 1992), there is evidence that those type of relationships can also be found between Western firms. Empirical research has demonstrated that in manufacturing and service industries like e.g. automotive, electronics, distribution, most firms have few main customers and suppliers that account for a major part of their total sales and purchases, and that the relationships with these firms tend to be close, long-term and co-operative, opposite to the remaining relationships which tend to be weak and short-term (see e.g. Håkansson, 1982; Gadde and Mattsson, 1987; Bensaou and Venkatraman, 1995). Moreover, there seems to be a current trend towards fewer but closer relationships between firms (see e.g. Helper and Sako, 1995; Lamming, 1993).

Though some authors stress that close relationships can be highly inefficient and less competitive (e.g. Williamson, 1985), other authors like Håkansson (1982), Sako (1992), Hagg and Johanson (1983) advocate that firms implicitly or explicitly choose to develop close relationships for economical reasons. Thus, continuity and stability of close relationships means that uncertainty associated with the transactions is partially eliminated, and that adaptations by both firms can be made on production, logistic, administrative, negotiation, etc. processes, which can both reduce costs and increase efficiency and effectiveness. There can also be increased revenues (especially for a supplier) which can be gained by a closer relationship.

3.2.5 - Concluding remarks

By reviewing the main aspects of the existing body of knowledge regarding relationships, with special focus on the IMP approach it has been possible to identify the fundamental assumptions about relationships, as well as a set of variables and inter-linkages which are believed to contribute to explaining their development process (Figure 3.5). These factors shall be particularly relevant to this work because electronic trading is seen here as a business relationship between two firms where the information exchanges use some form of telecommunications and computer technology, and thus they are expected to influence the adoption process of whether firms develop electronic trading and its configuration.

Figure 3.5 - Summary of the relationship variables



The factors reviewed here are the nature of the present exchange episodes; the perception regarding the power-dependence, co-operation, closeness and expectations between the firms; and the structural and technological characteristics of firms. The environment influence will be described in the next chapter when the main aspects of networks will be reviewed. The characterisation of the factors in the construction industry context, and the way these factors are anticipated to influence the development of electronic trading between construction firms will be briefly addressed in the remainder of this chapter, and discussed in-depth in Chapter 5.

3.3 - Business relationships in the construction industry

The fragmentation of construction organisation, both horizontal and vertical, with the traditional separation between design and construction, and the extensive use of subcontracting imply that in construction projects there is a multitude of inter-firm interactions (Bresnen, 1990; Centre of Strategic Studies in Construction, 1988; Cherns and Bryant, 1984). Indeed, the number of firms involved in the whole construction process, from the inception phase to commissioning, may range from a dozen to hundreds, depending on the type, size and procurement system of the construction project (Bresnen, 1990; Bennett, 1985). Most of these firms have different functions - client, designers, main contractors, subcontractors, suppliers, and therefore directly or indirectly interact with each other. Hence, there is a multitude of interactions between firms, and correspondent exchange episodes and relationships.

3.3.1 - Evidence of relationships in construction

The general perception of the construction industry's atomistic, adversarial, short-term, and price-based co-ordination mechanism characteristics leads to the fact that often research and practitioners focus their attention on the heterogeneity of the exchange episodes between construction firms on individual construction projects. Indeed, product/service episodes have been studied by e.g. Crichton (1966), Hillebrandt and Cannon (1990); information episodes by e.g. Higgin and Jessop (1965); Ndekugri and McCaffer (1988), Atkin (1990); social exchange by Bresnen (1990), McDermott (1992); and financial (Hillebrandt and Cannon, 1990; Betts and Gunner, 1993). Little attention has been given, however, to the resulting chain of episodes over time, i.e. the relationship between the firms, with their adaptations and institutionalisation, and atmosphere, which is fundamental to understand behaviour.

Following some of the considerations put forward regarding business relationships, the challenge is to look to construction interactions through a relationship perspective, which means analysing beyond simple project-specific exchange episodes. The assumption here is that a relationship between two construction firms emerges from the set of interactions across multiple projects involving those firms, including projects separated by a time dimension (past, present and future). In spite of the scarce applications of the relationship perspective in construction, this point is hardly new in construction studies. Indeed, addressing the importance of the interdependence between relationships and the management of construction projects, Bresnen (1990:69) stresses that "*one needs to take account of both the breadth of activity that constitutes the wider relationships, and the length of the relationship in a historical sense. Only by taking account of these factors is it possible to gain a full understanding of both the importance of the relationship to the parties concerned, and of the project relative to that relationship*". Recent research regarding relational contracting and partnering has also brought some concern to the relationship dimension of the interaction phenomenon between construction firms.

There are many actions between construction firms, some more evident than others, that are evidences of the relationship phenomenon. For example, on a negotiated process between a contractor and a major client from which the former is dependent on present and future projects, it is likely that the adjustment of the contractual price bears that relationships dependence (Bennett and Jayes, 1995; Bresnen, 1990; Chern and Bryant, 1994). A similar situation may happen between a contractor and small subcontractors and suppliers (Gadde, 1996; Eccles, 1981). Also, there are many large projects where the long duration (often years) and high intensity of exchange episodes lead to mutual adaptations and to the development of strong relationships amongst some of the members, for example between client, project manager, architect, and main contractors (Bennett and Jayes, 1995). A less obvious evidence of relationships is given by contractors and subcontractors/suppliers through traditional enquiries. Thus, the fact of a contractor sending enquiries based on a pre-defined database of subcontractors and suppliers with data about the performance on previous projects, is an evidence of the existence of a relationship. A relationship between two firms does not require product/service exchanges, the mere existence of informational and social episodes may be enough to maintain a relationship (Håkansson, 1982; Easton and Araujo, 1986). Moreover, relationships between construction firms do not necessarily mean continuous exchange of products/services, long-term transactions, and strong bonding (Easton and Araujo, 1986). As a result of the large heterogeneity of construction exchange episodes, there are, of course, a multitude of possibilities of construction business relationships: client-designer; client-project manager; client-contractor; contractor-designer; contractor-subcontractor; contractor-supplier; to mention the most common. The aim here is not to examine or describe the full range, rather highlight that distinct construction relationships may have different characteristics, which it is expected will influence the development of electronic trading.

3.3.2 - Characteristics of construction relationships

A common perception within some construction studies is that the atmosphere of relationships amongst clients, architects, designers, contractors, subcontractors are in general confrontational, adversarial, short-term, self-centred and with no mutual expectations (see e.g. Latham, 1994; Atkin and Pothecary, 1995; O'Brien, 1994; Fenn and Gameson, 1992; Gray and Flanagan, 1989; Centre of Strategic Studies in Construction, 1988). These characteristics are believed to be one of the main reasons for low construction productivity, cost and time overrun, poor product quality, and a hindrance to the construction product and process technology development, like e.g. electronic trading (Latham, 1994; Atkin and Pothecary, 1994; Centre of Strategic Studies in Construction,1989).

In recent years, emerging from looking towards practices in manufacturing and services practices, and initiatives like the Latham Report (Latham, 1994), research has been focusing on fostering and developing long-term, collaborative relationships between construction firms, often designated by 'partnering'. According to Bennett and Jayes (1995:2) partnering is defined as a "*management approach used by two or more* *organisations to achieve specific business objectives by maximising the effectiveness of each participant's resources. The approach is based on mutual objectives, an agreed method of problem resolution and an active search for continuous measurable improvements*". The authors distinguish between project partnering - single project, and strategic partnering - long-term commitment between firms to achieve better goals in the long run. The application of partnering methodology seems to improve the quality, and reduce time and costs of construction products (Cooper *et al.*, 1997; Baden-Hellard, 1995). However, O'Brien *et al.* (1996) stresses that the way it has been implemented, and despite its apparent success, construction partnering is only a method to resolve conflict, and that it does not fundamentally change the co-ordination mechanisms between firms.

In spite of the partnering hype, and according to some authors, non-adversarial and long-term relationships are not new in the construction industry (see e.g. Barlow and Cohen, 1996; Green and McDermott, 1996). Indeed, some empirical studies demonstrate there are many exceptions to the common general perception. For example, in the UK construction industry long-term relationships between clients and designers and contractors do exist, some for more than twenty years (Cooper *et al.*, 1997; Bennett and Jayes, 1995; McDermott and Alsagoff, 1994). Similarly, Haksever *et al.* (1996) found that most contractor-subcontractor relationships in the UK are longer than five years, findings also supported by McDermott and Alsagoff (1994). In the US, Eccles (1981), found that in the house building sector, clients, contractors and subcontractors maintain on-going relationships, with high degrees of co-operation and trust, forming what he designated as 'quasi-firms'. Also, Birrell (1981) stresses that some relationships between contractors and subcontractors are highly informal and showing signs of mutual trust and strong collaboration.

The degree of adversary, trust and duration of current construction relationships remains mainly an empirical question, which triggers many authors to advocate the need to better investigate its current patterns (Green and McDermott, 1996; Allen and Carminchael, 1996; Haksever, *et al.*, 1995). However, an indisputable fact is that relationships between clients, designers, contractors, subcontractors, etc. seem to have very little or no bonding (e.g. electronic trading), and therefore a low level of closeness. Thus, even in the best practice partnering cases, the level of adaptations on the administrative, production, logistics, etc. on internal processes and exchanges is very limited and usually restricted to project-level operations and duration. In a study of best practice in construction partnering (client-project manager-contractor-designer relationships), Cooper *et al.* (1997) found that though that there were some adaptations on the exchange episodes regarding initial meetings, lines of communication, trust building, physical integration of design activities, those occurred only through the duration of the project, and thus there were no sustainable adaptations and routinization e.g. between project manager and contractors or designers, and therefore few bonds established. The same authors suggest that construction partnering is rather less sophisticated than in the automotive and retailing industries, especially regarding long-term interdependencies. Stronger bonding between construction firms is possible as demonstrated by relationships between Japanese construction organisations (see e.g. Townsend, 1996; Bennett, 1993; Centre of Strategic Studies in Construction, 1989; Hasegawa, 1988).

3.3.3 - Development of construction relationships

Finally, it is important to stress that the development and nature of construction business relationships result from its exchange episodes like for example contractual agreements, close and non-transparent information exchange, payment methods, high staff turnover, etc.; from the internal characteristics of firms like the existence of few large-size firms and many small-size firms and their structural and technological misfit; the atmosphere itself with little adaptations, routines, and co-operation; and on the network of firms in which they are embedded. It is vital to this work to understand the dynamics of construction business relationships to explain the development of electronic trading, though the analysis of its characteristics is outside the scope of the study. Still, it is important to remember here that relationships evolve, and that industrial patterns of relationships, like those of the automotive and retailing/distribution, have shifted from adversarial, short-term, confrontational in the past (like construction today) to what today is considered the best practice of close, trust-based, co-operative, and long-term relationships (Lamming, 1993; Buzzell and Ortmeyer, 1995).

3.4 - Business relationships and the development of electronic trading

The second chapter stressed that this work is concerned with understanding the factors which influence the development of electronic trading, i.e. the process by which firms do or do not adopt electronic trading and its potential configuration. Electronic trading was also defined as a relationship where there is electronic exchange of information through disparate computer and telecommunication technologies. The point here is that by identifying the most important structural and process characteristics of relationships it is possible now to draw some interesting conclusions about electronic trading development in general. Thus, as referred to previously, the development of relationships affects and is affected by the atmosphere of the relationship, the characteristics of the firms, the exchange episodes, and the environment. Other authors have investigated how electronic trading effects business relationships (see e.g. Cunningham and Tynan, 1993; Webster, 1995; Holland, 1995). This research work puts electronic trading in a relationship perspective and is concerned with how the business relationship affects the development of electronic trading. In this section the former is addressed while in Chapter 5 the later will be discussed in detail.

3.4.1 - Electronic trading from a relationship perspective

The fundamental assumption which emerges by taking a relationship perspective is that the development of electronic trading implies mutual orientation and commitment by the two firms. In other words, a firm can not decide whether to deploy electronic trading systems (and its configuration) with another firm by itself, it emerges from the perceptions of both firms. Another basic assumption is that underlying the development of electronic trading are changes for both firms in internal operations and exchange episodes. At a minimum an adaptation in the information exchange episodes by the two firms is required, from a paper-based process to an electronic one. Sophisticated systems, like e.g. fully integrated EDI systems, may require a wider range and degree of adaptations than others, and changes may occur not only in the information exchange processes but also in e.g. processes related with logistics like like Just-In-Time deliveries (reduction of inventories, theoretically at both firms but in practice often re-allocation of the stocks from the buyer to the supplier), or internal administrative or production processes (e.g. re-distribution of production processes amongst firms).

Electronic trading means that these adaptations become institutionalised in the relationship between the two firms, and therefore they constrain the behaviour of the firms but also provide new opportunities (O'Callaghan and Turner, 1995; Emmelhainz, 1990). The institutionalisation of adaptations ties the two firms together. These bonds result not only from the electronic trading system itself but also emerge from the correlated adaptations, e.g. with JIT, or production processes (Reekers and Smithson, 1996). From the implementation process itself may also emerge social and knowledge bonds (Cunningham and Tynan, 1993). The social bonds emerge from the social contact between managers and technical personnel from both firms while developing the system. Knowledge bonds are likely to appear as the managers exchange more 'soft' information about firms' internal processes in order to enhance electronic trading efficiency and effectiveness. Sophisticated configurations of electronic trading systems are likely to create stronger bonds and therefore closer relationships.

Having previously discussed that there is an economic rationale behind the development of closer relationships, the same conclusion can be drawn here for the development of electronic trading. Indeed, adaptations related with the implementation of electronic trading systems have costs for both firms, like communication hardware and software, translation software, integration, management time and effort, etc. (see Chapter 2 for further detail). The more sophisticated the system the higher the adaptations, and therefore the larger the costs. But those adaptations also bring benefits, like reduced processing costs, reduced communication costs, reduced inventory cost, shorter lead times, JIT, competitive advantage, etc. (see chapter two for further detail). There is, though, a time gap between the incurred costs of developing electronic trading systems and the potential benefits, which means that two firms developing electronic trading are both making an investment in each other. Thus, firms' managers deciding whether to adopt electronic trading and the configuration of the systems are essentially making an investment decision.

However, the risk of the investment may be quite different for each of the firms. The power dynamics of the relationship may have allowed one of the firms (usually the leading firm) to dictate the main configuration elements, like the technology (e.g. EDI or e-mail), the information (technical, commercial, etc.), or the functionality of the system (frequency, direction, etc.), which may better suit the dominant firm over the other (Iacovou *et al.*, 1995; Webster, 1995; Kumar and Dissel, 1996). Thus, the level of costs and benefits may be asymmetrical in relation to each of the firms. This is supported by the empirical evidence about the difference for benefits by leading firms and target firms. Indeed, as described in Chapter 2, while leading firms tend to have operational benefits like e.g. reduction of processing and communication costs, target firms tend to achieve strategic benefits like better customer service, and improved business relationships (O'Callaghan and Turner, 1995).

These investments can only be considered if seen as investments in the future of the relationship (Easton, 1992). Firms will hardly make investments, and therefore develop electronic trading, if there is no perceived future in the relationship, or if that future is not perceived as interesting, for example if the atmosphere between the firms is of conflict, high dependence or distance. However, rarely is the future of the relationship explicitly or formally defined by the two firms, often it is implicit and based on the historical and present situation. The perception about the future of the relationship derives mainly from the continuity, stability and the atmosphere of the relationship so far. Continuity and stability in a business relationship should not only be a facilitator in the adoption process of electronic trading but also an important element for the evolution towards more sophisticated configurations of electronic trading systems. This is supported by empirical evidence which suggest that electronic trading and sophisticated configurations emerge mainly in long-term relationships (see e.g. Benjamin *et al.*, 1990; Graham *et al.*, 1996). This is not to say that electronic trading can not emerge in short-term relationships or relationships that had a recent start. Nor does it mean that the future of the relationships can only be assured by the past. Long-term relationships do not necessarily lead to the development of electronic trading. The point to be made here is that the development of electronic trading has to be seen in a time dimension.

3.5 - Summary

This chapter started by arguing that relationships between firms are more than single, atomistic, free market exchanges. Based on the IMP interaction approach, it was shown that relationships emerge from the routinization of products/services, information, social, and financial exchanges. It was stressed that a fundamental aspect of relationships are the adaptations that firms make that lead to the emergence of production, administrative, logistic bonds, like e.g. electronic trading. It was also defined that the power-dependence, the state of conflict or co-operation, closeness or distance, and mutual expectations are the set of variables that describe the atmosphere of the relationship, and that these are fundamental for the understanding of the development process of electronic trading. It was concluded that there is scarce research which allows an in-depth characterisation of construction business relationships as there are different perceptions about its features.

The relationships perspective suggested that the rationale for electronic trading, like any other inter-bond, is mainly economic and that the implementation of electronic trading should be seen as an investment that each firm makes in the other. Regarding the relationship perspective the final conclusion drawn was that electronic trading development should therefore be constrained and enabled by the managerial perceptions about the historical precedents, and current and future interactions between firms.

CHAPTER 4

NETWORKS

4.1 - Introduction

The relationship perspective described in the previous chapter stressed that business relationships should not be seen in isolation. Network approach authors argue that individual relationships are embedded in complex webs of relationships. This chapter sets out to review the main concepts of networks, how the network approach is connected to the relationship perspective, but especially to relationship development issues. An analysis of the application of the network approach in the construction context is elaborated. The chapter concludes by analysing the implications of framing electronic trading development on a network approach.

4.2 - Conceptualising networks

4.2.1 - The network approach

In analysing business relationships, it is often assumed that relationships can be studied in isolation, and therefore we search for answers by focusing on either the internal characteristics of the two firms, or on the nature and characteristics of the interactions and development process between the firms. However, according to some authors, in order to understand the dynamics of business relationships fully (and therefore electronic trading development), relationships must be seen in a broader context, which the network approach stresses shall be defined by the network of interrelated firms (Håkansson and Snehota, 1995; Nohria, 1992; Easton, 1992). This has also been acknowledged by the IMP group, who have modified the initial IMP model, considering that dyadic relationship should be embedded in its complex network of interconnections (see e.g. Håkansson, 1989).

Thus, the network approach pushes beyond abstract notions of environmental uncertainty, resource dependencies, institutional pressures, etc., presented by traditional organisational and economic theories (Nohria, 1992). The most important elements of firms' context are the other firms with which they must interact, the environment consisting of a field of relationships that bind organisations like suppliers, customers, regulatory bodies, competitors, etc. together (DiMaggio and Powell, 1983). The network approach differs from industrial organisational theory (see Porter, 1980) essentially in the sense that the later sees customer-supplier relationships as adversarial and atomistic, and very marginal to the central issue of rivalry between firms (Easton, 1992; Nohria, 1992).

Underlying the network approach is the assumption that firms are often interdependent with each other (in terms of technology, economic, social, legal, etc.), and that these interdependencies lead to some business relationships being connected with other relationships (Håkansson and Snehota, 1995; Easton, 1992; Rockart and Short, 1991). Business relationships are connected when the dynamics in one relationship affects or is affected by other relationships, though not all relationships are connected (Håkansson and Snehota, 1995; Easton, 1992). Thus, firms and relationships are likely to be embedded in multiple, complex webs of interdependent relationships which, according to some authors, have distinct structural forms which constrain and enable firms' actions (see e.g. Powell, 1990; Harrison, 1994). The embedding of the firms in these complex webs may be reasonably static, like e.g. in traditional manufacturing systems, or more dynamic, with webs being dynamically formed and dissolved according to market needs, like e.g. in the construction industry.

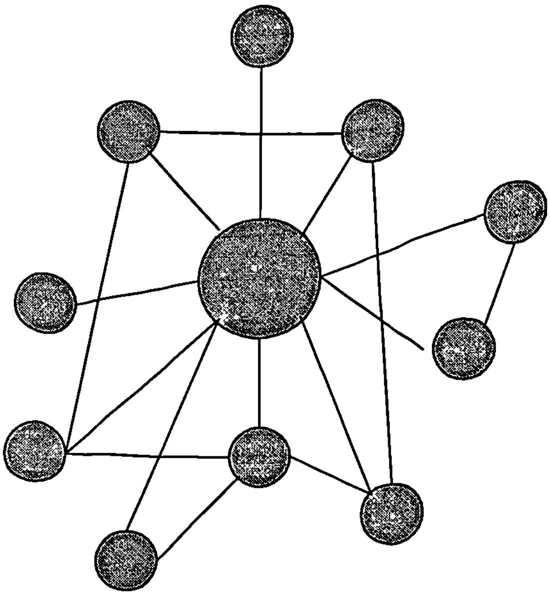
The relevance of the network approach to this work is that in order to understand the development of electronic trading it is necessary not only to analyse the relationship between the firms and their internal characteristics, but also explore the possibilities of the influence by the network of connected business relationships. The adequacy of the network approach to the description and explanation of electronic trading development has been stressed by superficial theoretical and empirical evidence, where some authors have started to, more explicitly or implicitly, use the network approach to describe and analyse situations where hubs develop electronic trading with several spokes (see e.g. Reekers and Smithson, 1996; Riggins *et al.*, 1994; or Cunningham and Tynan, 1993). Also, in the MIT's Management in the 1990s Research Program, Rockart and Short (1991) through asserting that the major role for IT in the 1990s is the management of interdependencies between firms, implicitly recognised the importance of the network approach for the understanding of electronic trading development.

4.2.2 - Different network approaches

There is some confusion concerning the concept of networks, i.e. what does the term mean and what are the main elements of networks. Two apparently distinct major approaches are identified in the literature (Axelsson, 1992; Nohria, 1992). In the first approach, some authors consider that networks are a new form of organisation, which has emerged from the necessity to cope with the current dynamics of the economic, technological, and social environment (see e.g. Piore and Sabel, 1984; Miles and Snow, 1986; Powell, 1990). This approach makes the assumption that networks are groups of firms with well defined boundaries, linked through relationships, that act in order to achieve a common goal (See Figure 4.1). There is also the assumption that networks as structures, are sometimes the most efficient way to organise (Miles and Snow, 1986; Powell, 1990; Axelsson, 1992). Examples of these organisations are presented by the Japanese keiretsu, Italian small-firm industrial districts or large networked based production systems like those of Toyota, Benetton, etc. (Piore and Sabel, 1984; Miles and Snow, 1992; Harrison, 1994). Networks are posed as a distinct form for co-ordinating economic activities (Powell, 1990), distinct from the decentralised, atomistic organised markets and the vertically integrated hierarchies that have become the dominant model for comparative analysis (Williamson, 1985).

In the second approach, networks are defined as a set of loosely connected organisations linked through social and other bonds (Aldrich, 1979; Axelsson, 1992). Thus, the general connectedness of firms and relationships implies the existence of an aggregate structure, the network form, which has distinct proprieties that originate in the nature of the relationships between the organisations (Axelsson, 1992; Nohria, 1992; Håkansson and Snehota, 1995). This approach also advocates that all organisations can be characterised through networks and that the structure and relationships are not determined or imposed *a priori* but result from enactment and evolution over time (Håkansson and Snehota, 1995). It makes the assumption that each individual organisation is purposefully goal-seeking, and that the network does not have clear

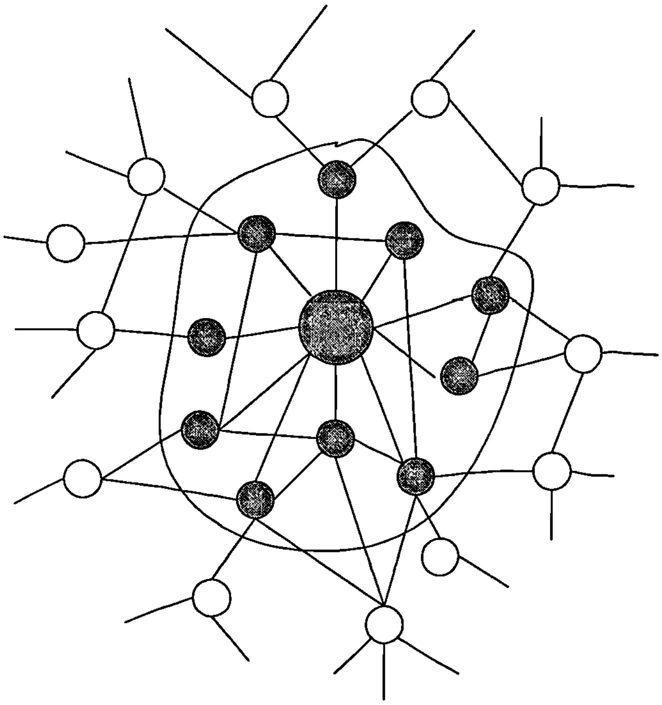
Figure 4.1 - Bounded network approach



boundaries or are arbitrary, instead, the whole environment can be regarded in terms of a network (Mattsson, 1988; Axelsson, 1992; Nohria, 1992). The approach is that, for analytical reasons, the whole network is often subdivided according to criteria of interdependencies, like product, geography, process, technology, etc. (Hagg and Johanson, 1983; Mattsson, 1988). In that sense authors like Harrison (1994) use the term production networks to define network organisations in terms of the strength of complementarity regarding the production of a certain product, where natural boundaries emerge as relationships between member firms within the network are stronger than relationships between members and non-members (Hagg and Johanson, 1983). These production networks can be seen as local concentrations of the whole industrial network system (Easton, 1992), like depicted in Figure 4.2.

Nohria (1992) advocates that the first approach can be considered as a simplification of the second, by focusing only on certain aggregations of firms and relationships with distinct proprieties rather than on the whole system. This is also defended in this work, and therefore the reference to production network implies bearing in consideration the second approach.

Figure 4.2 - Production networks as local concentrations of relationships.



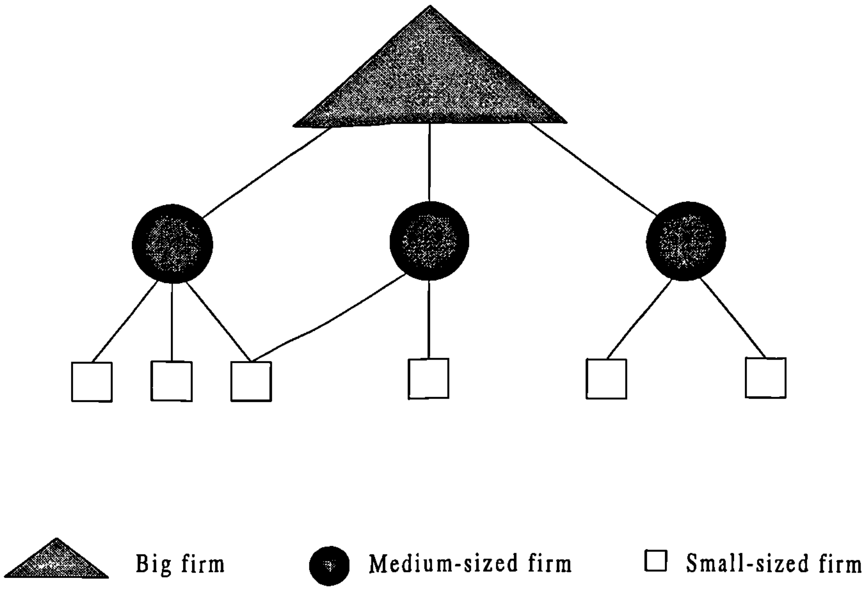
4.2.3 - Typologies of production networks

There is not a clear identification of the development pattern and characteristics of production networks. There is the perception that the development of production networks is complex and that there is no simple explanation to tie all the various cases of networks (Powell, 1990). Theoretical research has not yet been able to give an indisputable and comprehensive model or theory to explain the variety of cases identified by empirical studies. Still, some authors have recognised that a typology of classes of production networks is emerging, which according to Harrison (1994) are as follows.

- **Craft-form** networks. "*Independent firms are linked together for the one-time or short-term production of a particular product or service*" (Miles and Snow, 1992:66), and work tends to be organised around specific projects rather than around well-defined and bounded firms (Harrison, 1994; Powell, 1990). These networks are common in architecture, engineering, construction, publishing, computer programming, and record and film industries (Harrison, 1994).

- **Big firm-led** networks. Rather than vertically integrated structures, the network replaces a large customer's internal functions for specialised subcontractors and suppliers, usually small and medium firms (Figure 4.3), which are linked to the customer by contractual arrangements and other informal strong ties, and work together on a long-term basis (Miles and Snow, 1992; Harrison, 1994). Examples can be found on the cases of Toyota in Japan, Benetton in Italy, or in the US the General Electric.

Figure 4.3 - Big firm-led production network



Source: adapted from Harrison (1994)

- **Industrial districts.** This type of production networks are geographically clustered (around a 'district') and in its ideal form are an integrated network of highly specialised small firms, which focus on a particular phase of the production process (Harrison, 1994). On each project, firms "*will often co-operate with one another, sharing tools, information, and even skilled personnel, only to compete fiercely for a share of the next new contract or market opportunity*" (Harrison, 1994:79). Examples are the northern and central Italian industrial districts of Emilia-Romana, Veneto and Tuscany (see e.g. Piore and Sabel, 1984).

- **Strategic alliances.** Are less formal links than other forms like e.g. joint-venturing, licensing, equity-partnering, or R&D consorting and are "*crafted among big firms striving to span a manageable but diverse range of related activities and markets without having to undertake the full expense involved in actually building new plants or acquiring existing ones*" (Harrison, 1994:135).

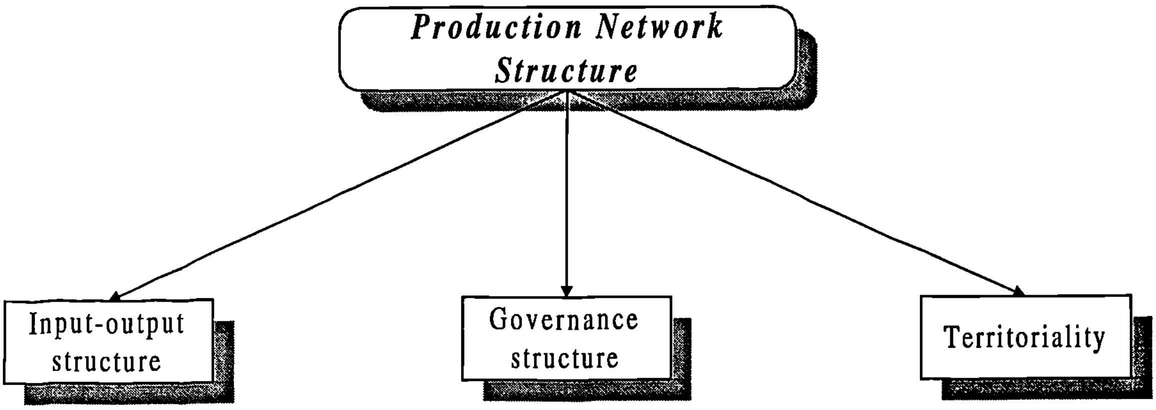
In order to understand how the characteristics of the production networks influence the process by which firms adopt electronic trading and its configuration it is important to go beyond the identification of the typology and analyse the structural and process characteristics of production networks. As some authors acknowledge, the body of knowledge regarding theory and models which provide comprehensive frameworks to understand the structural and process characteristics of production networks is still very immature (see e.g. Axelsson, 1992; Nohria, 1992; Harrison, 1994). Recent research has shown, however, that in spite the immaturity of concepts, the network approach has brought interesting conclusions when applied to electronic trading (see e.g. Reekers and Smithson, 1996; or Riggins *et al.*, 1994; Cunningham and Tynan, 1993). Thus, it was considered important in this work that the most important structure and process elements of production networks which may contribute to describe and analyse the development process of electronic trading be reviewed, though bearing in mind existing current theoretical limitations.

4.2.4 - Production network structure

4.2.4.1 - Interconnections

Business relationships between firms are the *sine qua non* of production networks. The technological, knowledge, social, legal, etc. interdependencies between firms and the fact that these interdependencies are connected, directly or indirectly to other firms and relationships is the core of the network concept (Easton, 1992). Interconnection implies that what happens between two firms in one relationship is affected and effects directly or indirectly the structure and process of the relationships with which it is connected (Håkansson and Snehota, 1995). From the aggregation of these complex webs of interdependencies and interconnections will, however, emerge a systemic structure with proprieties that are more than the simple addition of dyads (Powell, 1990; Easton, 1992). The point here is that the development of a focal relationship, and therefore of electronic trading, will be influenced by the structural and dynamic characteristics of the network in which the relationship is embedded (Easton, 1992; Håkansson and Snehota, 1995). The development of a business relationship will also effect the overall structure. According to Harrison (1994:142), a full production network has three main structural elements: the **input-output structure**; the **governance structure**; and the **territoriality**.

Figure 4.4 - Elements of the production network structure



4.2.4.2 - Input-output structure

The input-output (I-O) structure is a set of transacting production units of various firms (e.g. in the automotive industry the assembler plant and the units of production of each supplier) which in aggregation lead to the production of a specific marketable product (e.g. a car, an aeroplane, a building). Thus, firms may own many production units (plants, sites) and be involved in many I-O systems. In this work and for simplifying purposes, the distinction between production units and firms is only made where it is important, thus the I-O system will refer to the collection of firms involved in the production of a specific product. Input-output systems may have a small number of production units and firms, or conversely may have several thousands.

4.2.4.3 - Territoriality

The territoriality expresses the geographical location of the production units. An I-O system may be geographically agglomerated or dispersed (Harrison, 1994). Agglomerated production networks are those in which I-O systems are localised in a limited region, e.g. in a district or county. Dispersed networks are those where the production units are long-distance localised from each other, e.g. in the North and South of England or in different countries. Many production networks are partly dispersed and partly agglomerated.

4.2.4.4 - Governance structure

The governance structure of production networks emerge from the aggregation of the pattern of the atmosphere (power, co-operation, and closeness) of business relationships between the firms within the production network, though it acquires systemic proprieties. Thus, Harrison (1994) stresses that the structure of governance specifies the degree of hierarchy, leadership, collaboration and co-operation in co-ordinating the I-O system. Harrison (1994) distinguishes the forms of governance within the **core** of a production system - where power is asymmetrically distributed and some core firms are able to influence and control the development and configuration of the system, and the **ring** of that system - where power is likely to be symmetrically distributed and firms are not able to influence or control the production system. The typology of structure of governance is defined through a continuum from production networks where there is only ring, to systems where there is a very strong core amidst a weak ring. Thus, in the case in which the production network is essentially all ring and no core there is no enduring lead firm or there is a rotating leader. Examples can be found on the systems that link firms together in a project-by project basis, like some industrial districts and most cases in the construction industry (Harrison, 1994).

A degree of hierarchy and asymmetric power in the production network is found in core-ring systems where at least a well-placed co-ordinating firm can influence the configuration and direction of the system, and eventually the internal operations of some member firms. Examples can be found in the some lead car companies such as BMW and Porsche over their ring of suppliers (Harrison, 1994), and in some construction production networks, like those found in some large projects. Finally, in strong core-ring systems, a lead firm emerges within the core of the production system, and becomes dominant and controls the configuration of the system and the other firms within the system (Harrison, 1994). Power within the core-ring system is highly asymmetrical and there may be a considerable hierarchy governing relationships among firms. Typical examples are the production networks around firms like General Electric, Sony, Thomson, Philips, Toyota, General Motors, Marks & Spencer, Benetton, Fiat, etc. (Harrison, 1994). The various types of governance structures in a way reflect the level of homogeneity in terms of power balance of the business relationships within the network. The highest level of heterogeneity can be found in core-ring systems with a weak leader.

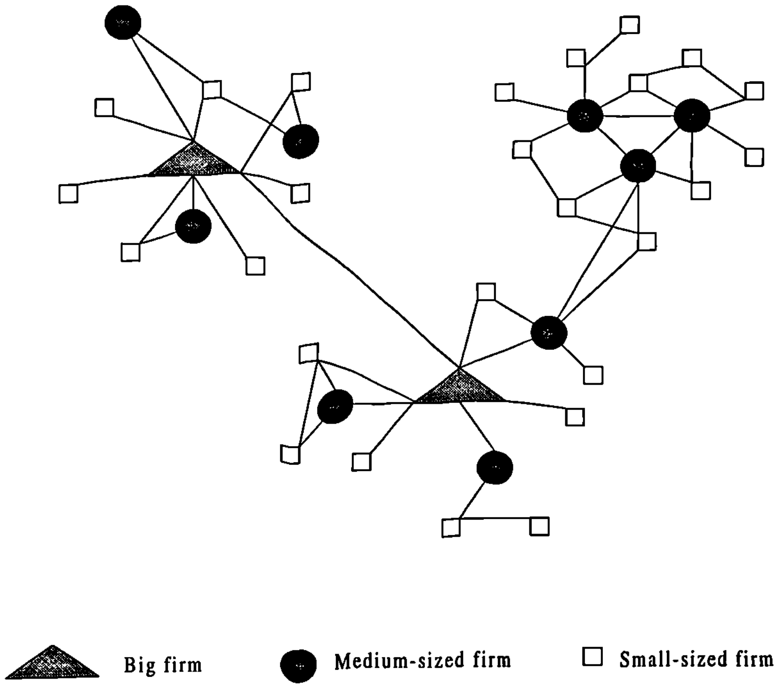
Though Harrison's (1994) structure of governance typology presented above captures essentially the ability of firms to influence, control and co-ordinate a network - i.e. the network's division of work, production technology and processes, logistics, quality, etc., the author also acknowledges that the other relationship dimensions like the degree of closeness, co-operation and expectations are also important in characterising governance structures. For example, governance structures may have highly asymmetrical power, and distant and non co-operative relationships between core and ring firms, e.g. General Motors (Harrison, 1994); or hierarchical ruling, and high degree of closeness, co-operation, and mutual expectations, e.g. Toyota and its ring of suppliers or other Japanese keiretsu-type production networks (Harrison, 1994); or Marks & Spencer and its ring of suppliers (Tse, 1985). Similarly, ring-based governance structure may have co-operative and close relationships, e.g. in Italian industrial districts (Piore and Sabel, 1984) or have little co-operation and essentially be adversarial, like e.g. those found in many construction projects (O'Brien, 1994).

4.2.4.5 - Networked production systems

As referred to previously, production networks are hardly isolated from other networks, they are interconnected and form networked production systems like the one depicted in Figure 4.5 (Harrison, 1994; Miles and Snow, 1992). The degree of exclusiveness of production systems varies greatly though, from highly networked to systems basically insulated from other networks (Mattsson, 1986).

Thus, individual firms are usually involved in several distinct production networks simultaneously, often of different classes and geographical dimensions. For example, a large firm like General Motors is the co-ordinating firm of a big firm-led production network and has a strategic alliance with Toyota which is the leader in another production network, interconnecting the two production systems; or a firm like Robert Bosch which acts as a co-ordinator in a core-ring system, and is the main supplier (and therefore belonging to the ring) of other production systems, e.g. Porsche, Volkswagen (Harrison, 1994). Finally, firms sometimes have linkages outside the Input-Output

Figure 4.5 - Networked production systems



nexus, e.g. with groups or associations of firms which define standards, government bodies, research institutes, etc. which complete the list of members interconnected but raises the structural complexity of production networks.

4.2.5 - Production network development

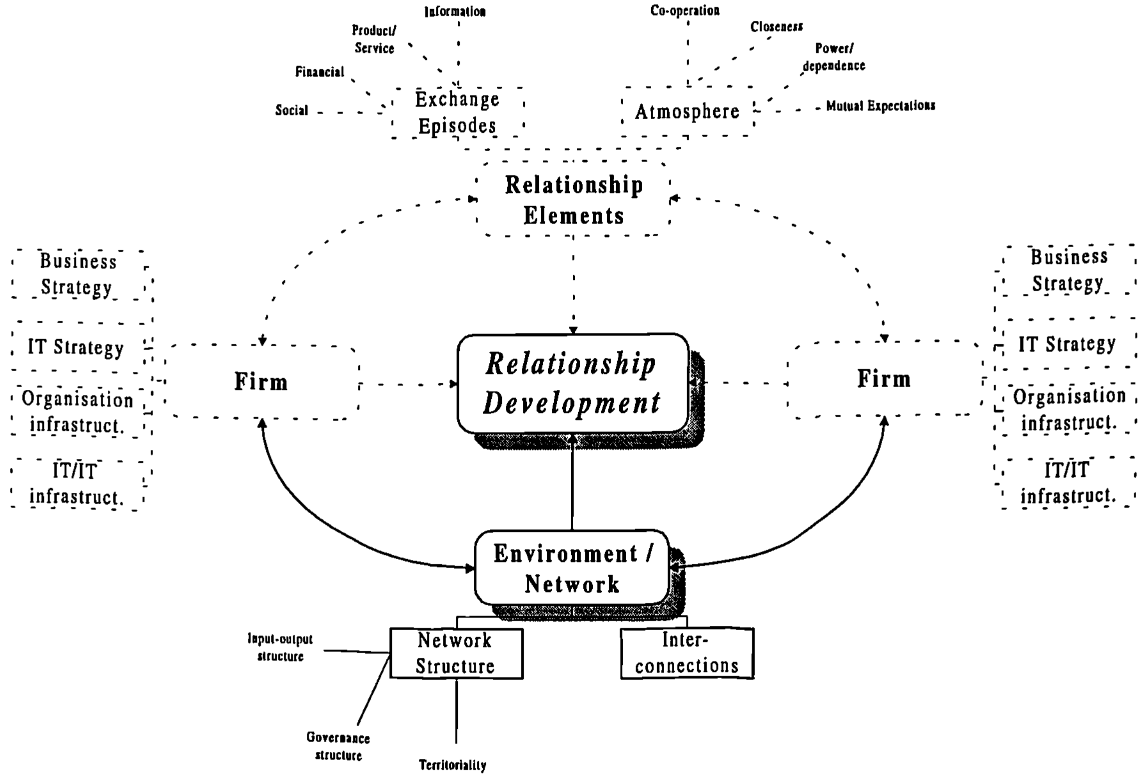
Changes in the nature of any relationship in the production network affects the overall structure but also the whole set of interconnected relationships has consequences for the development of a relationship (Håkansson and Snehota, 1995). While network structures tend to be relatively stable they are not static. Due to changes occurring in individual relationships, some are altered, others disappear and others are newly formed, such that the structure of the production network evolves over time and eventually may achieve radical changes in production, location, and governance structures (Harrison, 1994; Nohria, 1992; Easton, 1992). The existing structure of a production network has in any given moment a limiting effect (constraint) on the firms and relationships, and at the same time provides the basis (enabler) for the development of firms and relationships (Håkansson and Snehota, 1995; Nohria, 1992; Easton, 1992). In other words, changes in the structure of the network and in the individual relationships are dependent on the existing I-O, territoriality and governance structure of the production network.

Network dynamics are essentially a wrestling between firms for gaining and maintaining control of advantageous structural positions, e.g. emerging as a core firm (Nohria, 1992). However, underneath current change in networks is the trend of shifting away "*from agglomerated, fragmented, symmetrically powerful, mainly small firm production systems to core-ring systems - some agglomerated and some dispersed, but commonly organised around powerful lead firms*" (Harrison, 1994:147). There is evidence that core-ring systems around powerful firms seem to be more efficient, and technologically more advanced in terms of production, logistics, and administrative systems, as the core firm is able to redesign the co-ordination and production processes across the whole network, and thus deploy more efficient mechanisms like JIT, Lean Production, Total Quality Management and, as shall be discussed in this work, electronic trading. Distinct research seems to confirm these arguments, at least in the automotive industry (see e.g. Lamming, 1993). The applicability of these arguments to the construction industry remains an empirically unproved issue.

4.2.6 - Concluding remarks

By reviewing the main aspects of the existing body of knowledge regarding networks, it has been possible to identify the fundamental assumptions about networks, as well as the connection with the relationship body of knowledge. This allows the definition of a set of variables and inter-linkages which contribute and complement the explanation of the development process of business relationships (Figure 4.6). These factors are particularly relevant to this work because, as argued before, electronic trading is seen here as a business relationship between two firms using telecommunications and computer technology for information exchanges, and thus they are expected to influence the adoption process of whether firms develop electronic trading and its configuration.

Figure 4.6 - Summary of the network variables



The factors reviewed here are the relationship interconnections with firms and other relationships; the input-output structure; the governance structure; and the territoriality. The characterisation of the network factors on the construction industry context, and the way these factors are anticipated to influence the development of electronic trading between construction firms will be briefly addressed in the remainder of this chapter, and discussed in-depth in Chapter 5.

4.3- Construction networks

The literature review reveals that in spite of the scarce application of the network approach to actual situations in the construction industry, the network literature does sometimes refer to the construction industry as an example where there are distinct production networks. Indeed, the work of authors like Powell (1990), Miles and Snow (1992), O'Brien (1994), or Harrison (1994) suggest the application of the network approach to analyse the construction industry, and examples can be found regarding the linkages between contractors and subcontractors, which are identified as a craft or dynamic type of production network. The stance of this work is that other aggregations of firms can be considered as production networks. For example, the whole construction project, big firm-led production systems around large clients like BAA - British Airports Authority (Bacon, 1997), or strategic alliances between big construction firms to build large and complex projects (Badger and Mulligan, 1995).

Similarly to what happens in relation to construction business relationships, the body of knowledge regarding the description and analysis of production networks is poor. The theoretical and empirical description and analysis of construction production networks and their structural characteristics is non-existent in the reviewed literature. Because this work considers that these concepts are fundamental to a better understanding of the electronic trading development phenomenon, a basic theoretical analysis will be done. However, the status of the input-output structure, territoriality, and governance structure in construction production networks will remain an empirical question.

4.3.1 - Interconnections

Within construction projects there is a high level of product, information, and financial interdependencies between relationships (Crichton, 1966). Actions in one relationship are very likely to affect the operations of other firms (O'Brien, 1994). The choice of different construction products and methods by firms is likely to influence both the overall project and each relationship and firm involved. For example: the design choice of an architect will influence the actions of the structural, mechanical and electrical engineer and therefore the main contractors and subcontractors; the delay in the action of one subcontractor may have shared ramifications for the schedule and cost of other subcontractors; the information that subcontractors receive is dependent on the information received by the main contractor from the designers; the contractors' payment to subcontractors is often dependent upon the client's payment to the main contractor; an alternative given to a client of a new construction method by the main contractor is often dependent on the information given by a specialist subcontractor (Crichton, 1966; O'Brien, 1996). A multitude of exchange interdependency possibilities exist, both sequential and horizontal (parallel). However, these interdependencies do not usually provoke durable major changes, and eventual adaptations (mostly small-scale) tend to last the duration of the interaction on the project. Thus, interconnections between relationships and firms exist and are complex but are not durable, they tend to finish when the project ends.

4.3.2 - Input-output structure

The input-output structure of construction projects can be described as the collection of activities that lead to the production of a specific construction product like e.g. a building. It includes the activities of the client, architect, designers, quantity surveyor, project manager, contractor, subcontractors, material suppliers, and the manufacturers. Production units involved on each project vary considerably, from the office of the client, to the office of the architect and designers, the site, and to the plants of the manufacturers. Obviously, both the number and type of activities and production units involved in each I-O system vary considerably and are essentially a function of the type, and size of the project (Newcombe *et al.*, 1990). The number of activities and firms involved for building a house is considerably smaller than for building a large shopping centre. Also, the type and size of the firms involved in the I-O system of any construction network are usually very different: from the large and sophisticated client organisations like BAA, private investors, public or recently privatised organisations like the Railways, to small clients like local authorities or the individual who needs a shed in the garden; from the large architect practices and designers to the home-based designers; from the large contractor and management service providers, to the small but technologically sophisticated specialist subcontractor, or the small and simple craft brick layer or plumber (Macomber, 1989; Hillebrandt, 1985; Ward, 1979).

4.3.3 - Territoriality

The territoriality of construction I-O systems tends to be a mix between geographically agglomerated and dispersed production units. Small projects rely usually on local firms for their execution. Large and sophisticated projects use local firms to produce certain activities (e.g. local aggregates suppliers, or brick layer, plumbers subcontractors), and geographically dispersed units and firms like project managers, main contractors, designers, specialist subcontractors, manufacturers, etc. Compared with automotive, apparel or electronics production networks (Miles and Snow, 1992; Harrison, 1994), construction projects are much more agglomerated in the sense that production units tend to be localised within national boundaries, whether regionally agglomerated or dispersed (Atkin and Pothecary, 1994; Bennett, 1985). However, the tendency, especially for large projects, is to have geographically dispersed I-O systems but on global dimension, like the case of the project of the new river Tagus bridge - in Portugal, where a consortium of British, French, and Portuguese firms are involved, with some production units localised in the different countries.

4.3.4 - Governance structure

The governance structure of construction production networks can be considered as essentially all ring, or eventually ring with a very weak core, especially those of craft-form (Harrison, 1994). In principle, there is no enduring leader, no firm has the ability to permeate boundaries of the other firms or influence the direction of the production system over the time because in construction projects the linkage between firms usually lasts only the small duration of each project, and it is likely that for each project a different construction team is assembled (Centre of Strategic Studies in Construction, 1989; Bennett, 1985). Thus, construction firms tend to follow the general practice and standard procedures of the construction industry, and each firm does not usually make more than what is contractually expected (O'Brien, 1994; Bresnen, 1990). The natural leader for each project, the client or the client's representative, apart from some basic, though important, decisions like the decision of whether to build, the configuration of the product, and the choice of the participant firms, has little lasting influence on the production system as a whole or on the internal operations of construction firms. However, on each individual project, characteristics like the procurement method and size may give some variations on the degree of hierarchy, leadership and co-operation in co-ordinating the I-O system (Bresnen, 1990; Franks, 1990; Masterman, 1992).

Though this work does not focus on the analysis of construction production networks structures, due to its importance to the subject of this work this matter is now discussed a little further. It is important to note here that there are other forms of construction production networks, like those similar to big-firm led production systems (around powerful contractors, consultant, clients). Clear examples are provided by Japanese construction industrial organisation, where the biggest five contractors are powerful core firms within their rings of subcontractors and suppliers (Bennett, 1993; Levy, 1990; Hasegawa, 1988). The effects of these, however, are expected to be similar to what was said before regarding this type of networks, and thus will not be reviewed.

4.3.4.1 - Traditional method of procurement

In the traditional method, the authority and decision making of the production network is fragmented between client, architect/designer, and main contractor (Franks, 1990; Masterman, 1992). Thus, the client decides upon the selection of the architect and its project proposal, the quantity surveyor, and the main contractor. The architect is the leader of the design process and co-ordinates in a partly hierarchical and partly co-operative way the specialist designers, and the nomination of specialist subcontractors. The client, QS and architect co-operate with each other though the last two are hierarchically subordinated to the former. The main contractor is the leader of the construction process and the hierarchical co-ordinator of the subcontractors, material suppliers, and the nominated subcontractors. However, the design team is responsible for construction management and supervision, to ensure that the contractor and its network of subcontractors are building the product in accordance to the specifications. The main contractor is supposed to co-operate with the design team in the construction process but is only contractually linked to the client. The conclusion to be drawn here is that, in spite of the apparent hierarchy form of client-architect-contractor-subcontractors, the governance structure of the I-O system derived from the traditional method is far from having a clearly defined global hierarchical authority and decision-making (Bresnen, 1990). Indeed, there is neither much co-operative decision-making nor one clear hierarchical authority. The emergence of three distinct nodes of hierarchy (client, architect and main contractor) with different and often conflicting goals (Atkin and Pothecary 1994; Bresnen, 1990) means that, as a whole, the structure of governance of traditional method I-O system is of ring-type, at best a weak core-ring system with three distinct leaders.

4.3.4.2 - Management-orientated method of procurement

The governance structure of construction production networks based on management-orientated procurement systems like management contracting and construction management have, in principle, a more defined hierarchical nature than the traditional method, in spite of its traditional reputation of being a flatter organisation. Thus, the fact that the contractor is elevated to the status of a consultant like the architect and eventually quantity surveyor, and that both work in a close and co-operative way amongst themselves and with the client's project manager (Masterman, 1992) avoids the emergence of three different and conflicting hierarchical nodes. The governance structure between the firms is based on co-operation and collaboration regarding the whole production process, and they together form a core organisation (with the client's project manager as the ultimate leader) that has a reasonable degree of hierarchy and leadership over the ring of specialist designers, specialist contractors, and suppliers. Still, the strength of the core is much dependent on the attitude of the client and core consultants regarding leadership and co-operation (Gordon, 1994). On large, complex and long duration construction projects, it is possible that the core firms are able to have a significant influence on the configuration of the I-O system and eventually on the internal operations of some firms, and therefore can be considered as a core-ring system with a co-ordinating leader.

4.3.4.3 - Integrative method of procurement

On integrated procurement systems like design and build, a single organisation, usually a contractor, is responsible for the design and construction of the project, and depending on the variants like package deal, turnkey, or DBFO responsible also to obtain funding, fitting out, installing process equipment, etc. (Masterman, 1992; Franks, 1990). By receiving the full responsibility from the client for the whole construction process, the contractor becomes the sole co-ordinator of the core-ring system. The strength of the contractor as a core firm is, however, dependent on many factors, though especially on its strategy towards the co-ordination of the system (Masterman, 1992). Contractors who rarely undertake anything other than design and build contracts may develop long-term relationships within the ring of specialist designers, specialist subcontractors, and material suppliers, and therefore there is the possibility of the emergence of a lasting degree of hierarchy and asymmetric power with the contractor in the core of the system. The most remarkable example of this situation is given by the Japanese big-five contractors, which act essentially on design and build systems and that have emerged as durable strong leaders in the core-ring systems of designers, contractors and suppliers (Levy, 1990; Hasegawa, 1998; Bennett, 1993; Centre of Strategic Studies in Construction, 1989). In those systems, the contractor has the capability to determine the configuration of the core-system but also the internal operations of most member firms, especially regarding cost structures, quality, planning, technology, and logistic issues.

4.3.5 - Development tendency and networked production systems

The tendency found by Harrison (1994) in other industries of network development towards core-ring systems around powerful firms seems to be reflected in the growing market share of the integrated procurement system in the UK (Masterman, 1992; Franks, 1990). Moreover, the necessity of strong leadership in construction networks by clients, both private and public, has been identified by the Latham Report (Latham, 1994) as one of the fundamental points in order to considerably improve construction processes. This stance has been taken by British Airport Authority (BAA), which through assuming a leading position and long-term partnering programmes with suppliers of component parts, construction managers and design consultants, is now able to control and co-ordinate projects in order to develop improvement initiatives towards implementing lean construction (Bacon, 1997).

To finalise, it is important to stress that there is very low exclusiveness on construction production networks. Construction firms, designers, contractors, subcontractors, suppliers, are often involved in many distinct concurrent projects, with different structural characteristics. This makes each project link to other projects, thus producing a rich and complex construction networked production system.

4.4 - Networks and the development of electronic trading

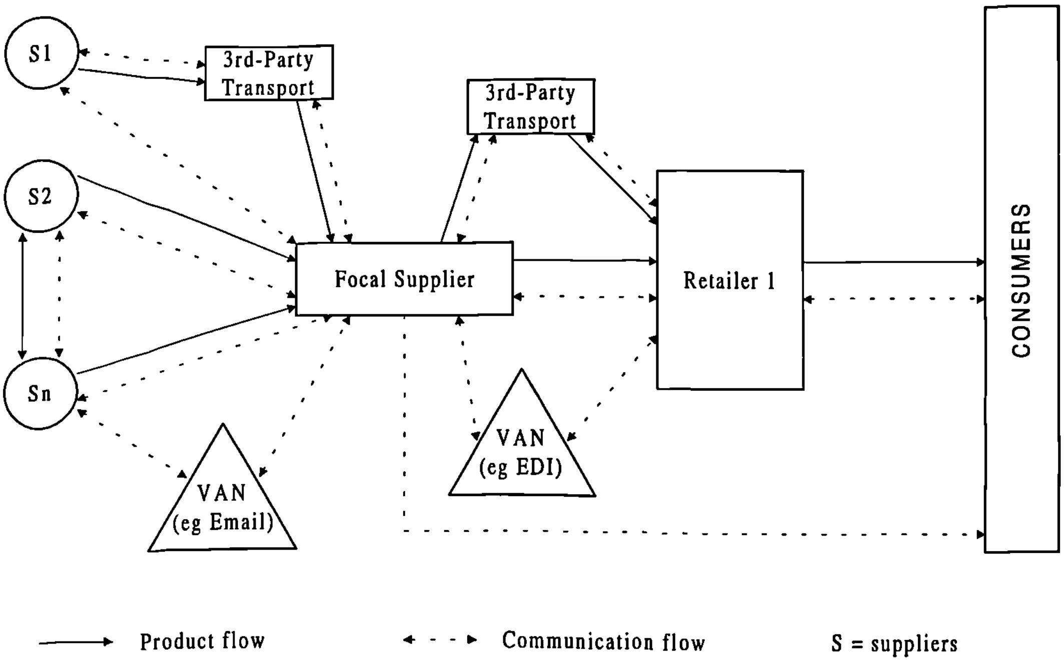
The fundamental aspect of the network approach regarding this work is the consideration that in order to understand the process of adoption of electronic trading between two construction firms it is important to consider the interconnections that those firms have with other organisations. These can be due to individual interconnections or due to the constraints and opportunities of the overall network structure and development process.

4.4.1 - Electronic trading and individual interconnections

Some individual relationships can have a direct influence on the development of electronic trading between two firms. An obvious example of the effect of the interconnection on the adoption process is the influence of the pilot system. Thus, the decision regarding the development of electronic trading between e.g. a buyer and a supplier is often conditioned on whether a previous pilot system had success between that buyer and another firm (Bjorn and Krcmar, 1995; Emmelhainz, 1990). An example of the influence of individual interconnections may also be the case where the development of an EDI system between a buyer and a specific supplier was triggered mainly by the previous development of a similar system between that buyer and a direct competitor of that supplier. Another situation may be the case of a supplier that had to develop electronic trading with a buyer on a certain production network and due to its successful implementation decided to develop electronic trading with some of its own suppliers in another production network (Cunnigham and Tynan, 1993).

Individual connections do not only influence whether firms adopt electronic trading but also the configuration of the system to be implemented, essentially the technology to be used. A basic example is when two firms develop EDI and use the services of a VAN. The configuration of the EDI systems is partially determined by the two firms (e.g. the basic technology, the information to be exchanged, intensity, etc.) and partly determined by the VAN, since standards, translation software, integration facilities, and other technical issues are often the responsibility of the VAN (Jayachandra, 1994; McLoughlin, 1995). Another typical example is when a supplier has to develop an electronic trading system with two distinct buyers. Thus, a supplier in that situation would rather adopt an electronic trading system configuration with one of the buyers that would be compatible with the other buyer, e.g. similar standards, translation software, integration mechanism, same VAN, etc. (Reekers, 1994). Also, when two firms belong to an industrial association which promotes the implementation of specific technology and standards, e.g. ODETTE in the European automotive industry, or EDICON and CITE in the British construction industry, it is likely that firms adopt electronic trading systems configurations in accordance to the recommendations (Benjamin *et al.*, 1990; Baldwin *et al.*, 1996).

Figure 4.7 - Effect of interconnections



Source: adapted form Cunningham and Tynan (1993)

There are infinite possibilities regarding the influence of individual interconnection on the development of electronic trading development (Figure 4.7 depicts a simplified example in the retailing industry). The point here is to stress the importance that some individual interconnections may have on the process of adoption and configuration of electronic trading between two firms.

4.4.2 - Electronic trading and network structures

The adoption process of electronic trading between two firms is likely to have a stronger influence from some interconnected individual relationships than from others, though all the other dyadic relationships may somehow affect the decision process. Moreover, while in some cases the development of electronic trading between two firms is quite independent of the overall interconnections, in many other cases the overall interconnections are stronger and will influence the development process. This influence can be captured through the emergent input-output structure, territoriality, and especially the governance structure which is the dimension describing the influence, control and co-ordinating aspects of the network structure.

Hence, whenever two firms decide to adopt a specific electronic trading system they will usually have to consider the existing and potential systems with other firms, e.g. with other suppliers and customers. A classical example of this situation is the case when the development of electronic trading between a leading firm and a particular target firm is included in the former's strategy to develop electronic trading with other firms so that a critical mass of users is reached in order to obtain substantial operational benefits (see e.g. Reekers, 1994; Riggins *et al.*, 1994). The decision of whether to adopt electronic trading and the configuration of the system is thus much dependent on the structure of the network. Firstly, the input-output structure and territoriality influence the configuration of the system as the technology (EDI, e-mail, etc.), the standards used (proprietary or universal), the information exchanged, the choice and service of the VAN, the security and legal issues, etc. should be different whether the system is to cope with a one-to-one or with one-to-many linkages; and whether the firms are locally agglomerated in one region or dispersed over two or three countries and eventually across distinct continents. Secondly, the structure of governance position of the leading firm and of the target firms determine the capacity of the former to convince the other firms to adopt a specific electronic trading system configuration. Thus, a leading firm's capacity to influence target firms is higher if it has a position of leader or co-ordinating firm in a core-ring system (targets being on the ring) rather than if its position is in the ring.

4.5 - Summary

This chapter begun by stating that the network approach stresses that business relationships are not isolated dyads, they are interconnected with other organisations and relationships. Therefore, it was advocated that in order to fully understand the development of electronic trading it is necessary also to study the influence of the interconnections. According to the network approach, the complex aggregation of relationships and interconnections - defined here as production networks, has an emerging structure with systemic proprieties: the input-output structure; a territoriality; and a governance structure. The absence of empirical and theoretical studies led to the need for a theoretical analysis regarding the construction situation. It was argued that the structural characteristics of the construction production networks may vary considerably function of the characteristics of the project, particularly, regarding the procurement system and the governance structure. Finally, it was concluded that the development of electronic trading between two firms can be considerably influenced not only by individual interconnections with those firms but also by the structure of the network in which they are embedded.

CHAPTER 5

ELECTRONIC TRADING DEVELOPMENT BETWEEN CONSTRUCTION FIRMS

5.1 - Introduction

Having reviewed the current body of knowledge regarding electronic trading development, and the relationship perspective and network approach theoretical background, this chapter describes the theoretical model developed in this study that aims to contribute to enhance the understanding of electronic trading development. The model becomes the framework for the remainder of this research. The chapter describes the assumptions of the model, and through four sets of propositions the variables influencing the adoption and sophistication of electronic trading systems and their behaviour. The chapter concludes by presenting the two hypotheses that are tested in this study.

5.2 - The CONNET model: a conceptual framework of electronic trading development

5.2.1 - Presenting the model

Based on the generic framework presented before, on the contextual understanding of the subject and on the arguments discussed in the second, third and fourth chapters of this work, the **CON**struction **N**etwork **E**lectronic **T**rading - **CONNET** model has been developed. This allows a systematic description and analysis of the factors and variables that influence the process by which two construction firms decide to adopt electronic trading, and the configuration of the systems. Thus, the model considers that there are three sets of factors that are believed to determine the development process: the relationship between the two firms; the internal features of each of the firms involved; and the characteristics of the network where both firms are embedded. Grounded in the theories and models of the relationship perspective and network approach, the CONNET model for each of the three factors defines a set of variables which allow a more detailed and richer understanding of the phenomenon of adoption and configuration of electronic trading systems. These factors and variables are depicted in Figure 5.1.

5.2.2 - Assumptions of the model

As referred above, the CONNET model was grounded on assumptions deriving from the relationship perspective and network approach. These assumptions, discussed in the previous chapters, are now re-stated.

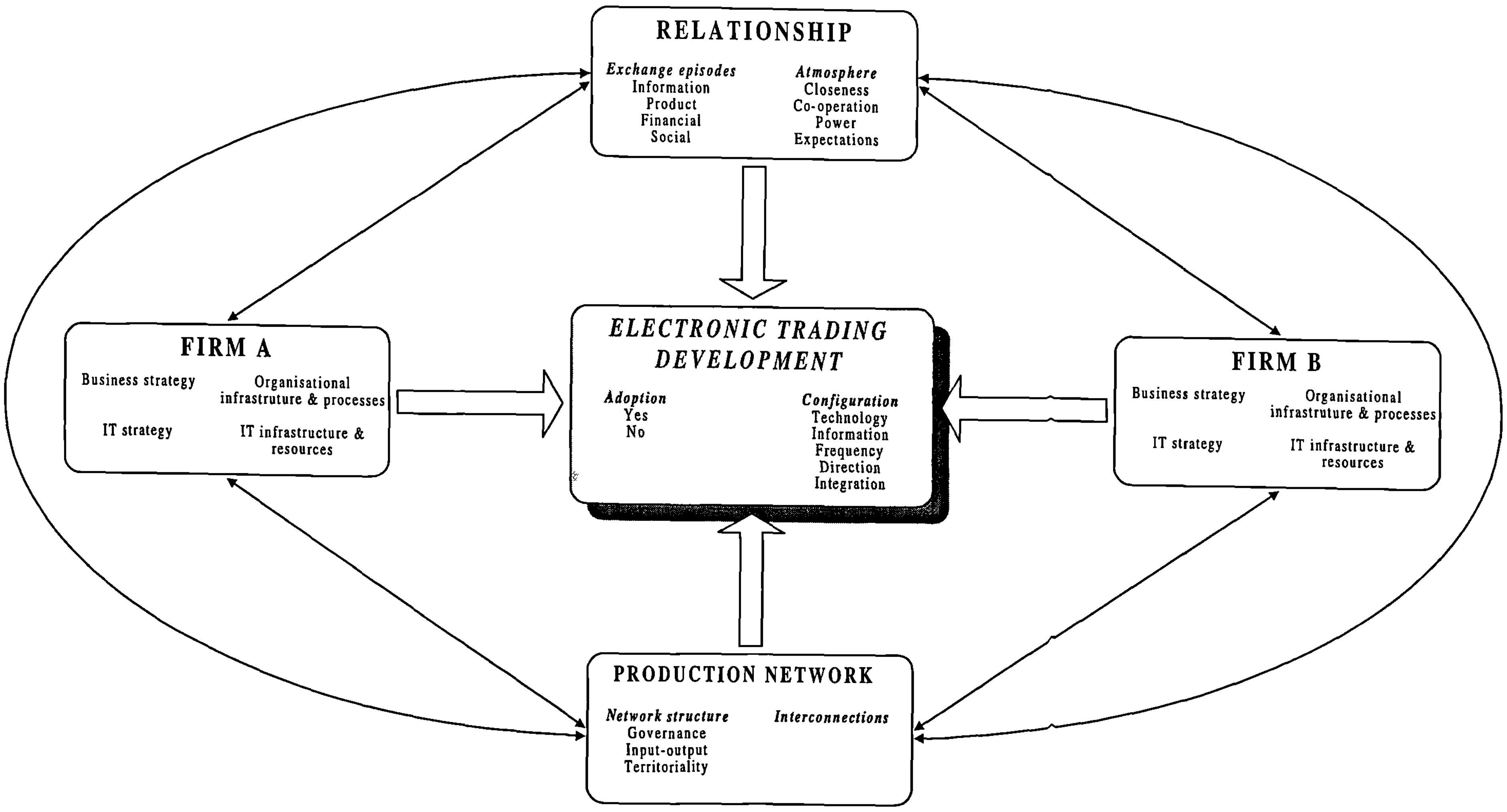
1. The development of electronic trading is more than a simple technological problem. It is a complex and rich process, involving essentially social and information interactions between two firms, and internal changes at the individual, organisational and technological levels.

2. Electronic trading cannot emerge without the establishment of a business relationship between two firms. Electronic trading is a business relationship between two firms where some of the information exchange episodes use computer and telecommunication technology - electronic trading systems.

3. The development of electronic trading between two firms implies mutual orientation and commitment. Therefore, both firms participate in the decision regarding whether to adopt the technology, the level of integration, information exchanged, internal changes, and functionality of the electronic trading system.

4. There is essentially an economic rationale behind the development of electronic trading. Thus, whether firms adopt electronic trading systems and its configuration is an investment decision. Factors and variables presented in the CONNET model are expected to determine implicitly or explicitly managers' perceptions about potential costs and benefits, which will determine whether their firms adopt electronic trading and its configuration.

Figure 5.1 - CONNET model factors and variables

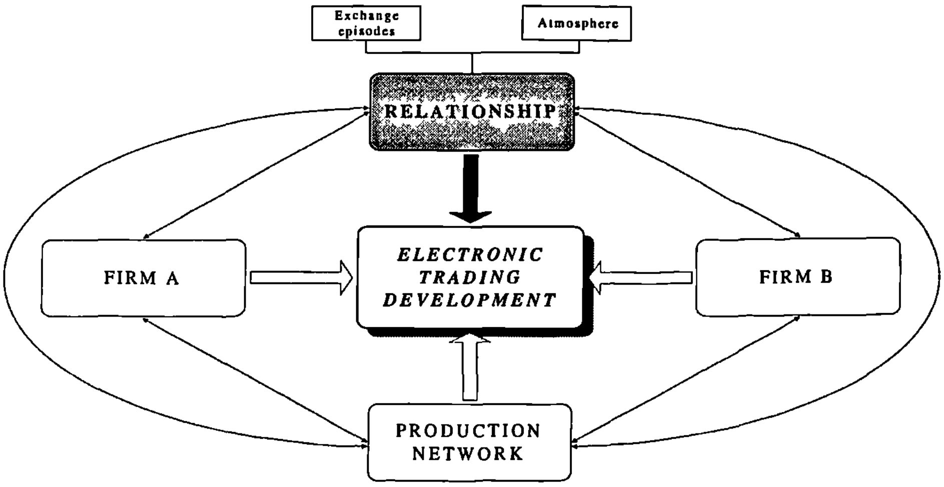


5.3 - Propositions

Having identified the main factors and variables that compound and support the CONNET model its theoretical description is represented through theoretical propositions of how these factors are expected to influence the adoption and configuration of electronic trading systems between two firms. These propositions are the theoretical core of this work, and will be the basis for the hypotheses that will be tested through empirical data. The propositions are grouped around each determinant factor.

The propositions put forward here are all high-level, and therefore some of them may seem common sense about this subject. However, it is in the nature of this research to test that they indeed reflect the reality of the electronic trading development, and also through the empirical analysis to be able to refine and detail them in accordance to the real-world situations.

5.3.1 - Determinant: relationship



The factor that is expected to have a major contribution to the development of electronic trading systems, like in the development on any inter-firm bond (Håkansson and Snehota, 1995; Sako, 1992), is the relationship between the two firms - the exchange episodes and the atmosphere of the interaction. According to Johanson and Mattsson (1987), the more intensive the exchange episodes the stronger are the reasons to make adaptations. The same authors advocate that the type of adaptations are also related with the frequency, complexity, and regularity of product/service, information, social, and financial exchanges. Hence, the first set of propositions can now be presented.

Proposition 1

Intense, complex, frequent and regular information exchange episodes enable adoption.

Firms are likely to be more willing to make adaptations in order to improve their internal systems and exchange episodes if they have considerable volume and frequent information exchanges, on a regular and continuing basis. Also, the more complex and formal is the information exchange, e.g. very demanding in terms of accuracy, timeliness, and adequacy, the more important the role of electronic exchange of information becomes and therefore the likelihood of adoption.

Regarding the construction situation and the likelihood of adoption of electronic trading, the most frequent and intensive information exchanges are expected to be found between clients, architects, contractors and contract managers; between architects and specialist designers; between contractors, subcontractors and material suppliers; between project/contract managers, designers and contractors; and between builders' merchants, manufacturers and material suppliers (Higgins and Jessop, 1965; Murray and Thorpe, 1996; Thorpe, 1994). However, because in most of these interactions information exchange is restricted to the duration of the participation in a specific project, there is little regularity and frequency in the information exchange episodes and therefore this is expected to become a serious hindrance to the development of electronic trading. The likelihood of adoption increases when construction firms have multi-project information exchanges or when the duration of the project is very long and so is their interaction.

Proposition 2

Intense, complex, frequent and regular information exchange episodes enables sophisticated configurations. The type of information determines the technology.

It is expected that the configuration of the system is directly related with the characteristics of the information exchange episodes. Thus, for example, if there are intensive, frequent and regular commercial paper-based information exchange episodes it is expected that this should be the type of information to be electronically exchanged, and therefore the implementation of EDI which is the appropriate technology for this type of information. For technical, and managerial information exchanges the implementation of e-mail based systems is more likely. In generic terms, highly complex and frequent information exchange episodes are likely to foster the development of sophisticated systems in order to achieve better economic benefits. Sophisticated systems entail higher levels of integration and changes in internal systems and processes, a wider range, and more frequent and two-way direction of electronic exchange of information.

In some interactions between construction firms - especially between architects and specialist designers; designers and contractors; contractors and subcontractors; project/contract manager and designers and contractors, the larger volume and most frequent information exchange episodes are of a technical or managerial format (Higgins and Jessop, 1965; Murray and Thorpe, 1996). Thus, it is expected that it is this type of information (drawings, specifications, programmes, etc.) which is more likely to be electronically exchanged, and therefore the use of e-mail based technology is more likely. In other interactions, like between clients and contractors; contractors and builders' merchants, material suppliers, subcontractors; builders merchants and manufacturers, material suppliers, there is essentially commercial information exchange (BoQ, enquiries, quotations, purchase orders, invoices) and therefore it is this type of information that is anticipated to be electronically exchanged, using EDI technology. Finally, because currently most information exchange episodes between construction firms are neither very frequent (or regular) nor very demanding in terms of timeliness, accuracy and adequacy it is expected that the development of unsophisticated electronic trading systems will prevail.

Proposition 3

Intensive product/service and financial exchanges facilitate the adoption and sophistication of systems.

It is anticipated that information exchanges are associated with reasonably intensive product/service and therefore financial exchanges between the two firms, in order to economically justify the adoption of electronic trading. It is unlikely that the existence of enabling conditions regarding information exchange will by themselves be enough to lead firms to the development of electronic trading. Economical benefit can only occur if there is product/service-financial exchanges. In principle, the more intensive the product and financial exchanges the more likely firms will be willing to make major adaptations, and therefore develop sophisticated configurations (e.g. fully integrated EDI, a wider range of information, etc.).

There are sometimes intensive information exchange episodes between construction firms without any product/service and financial exchanges, like between e.g. clients and contractors regarding tenders; contractors and subcontractors, builders' merchants, material suppliers for enquiries and quotations; designers and contractors for site instruction. In these situations, the non-existence or low level of continuing product and financial exchanges constrains the opportunity given by the information exchange episodes.

The characteristics of the exchange episodes are not the only relationship variables to influence the development of electronic trading. The atmosphere of the relationship between the two firms also has a major role in determining the development process. There are two generic points that should be stressed regarding the atmosphere of relationships that are important to this work. Firstly, the notion that is often rather less important to a relationship development what is being exchanged than how it is being exchanged. Secondly, that atmosphere is something that is much dependent on the time dimension. Historic events in the relationship are as important as present and future interactions. This shall now be further discussed.

In the relationship literature there seems to be a generalised consensus that the existence of strong bonds, co-operation, and mutual expectations are crucial relationship aspects to the development of adaptations which are likely to improve exchange episodes efficiency and efficacy (see e.g. Håkansson, 1982; Nohria, 1992; Easton, 1992; Sako, 1992; Håkansson, and Snehota, 1995). Thus, the existence of strong bonds, either technological, knowledge, administrative or trust, which usually derive from historical and present incremental adaptations, provide a more stable and predicable structure that is able to bear change, and therefore affect positively the development of new adaptations (Easton, 1992). The closer the relationship the more likely it is that firms are willing to make bigger changes in their ways of working (Sako, 1992). However, the development of major adaptations requires not only the development of past and present rich and complex interactions but also the mutual expectations of future continuity of the relationship, without which there is no rationale to make investments in the relationship (Håkansson and Snehota, 1995). These expectations may be the result of formal agreements between the firms or emerge from the past and present continuity and stability of the relationship.

Inherent to any relationship is the tension between co-operation and conflict (Ford *et al.*, 1986). Conflict in a relationship is much linked to the division of benefits but the existence of a co-operative atmosphere enables the finding of constructive solutions to problems (Håkansson and Snehota, 1995). This is particularly important when the development of adaptations means a non-equitable share of benefits to both firms (Easton, 1992). In principle, the existence of strong bonds demonstrate a high level of co-operation, at least in the past.

The distribution of power/dependence - symmetrical or asymmetrical, and therefore the ability of one firm to pressurise, coerce or reward the other party may dictate the way the relationship operates and develops, and thus adaptations are made (Håkansson, 1982). The distribution of power between two firms derives partly from their transactional dependence, and partly from their positions on the network (Easton, 1992; Håkansson, 1982). In principle, the existence of high levels of mutual interdependence between the firms (social, technological, social, legal, etc.), and a co-operative attitude implies a reasonable symmetrical power/dependency.

Proposition 4

Close relationships enable the adoption and sophistication of electronic trading systems.

The existence of ties like joint product R&D programmes, quality accreditation, JIT deliveries, or personal mutual trust, provide a historical and present context which facilitate the development of further adaptations and therefore enable electronic trading development in general, and of sophisticated systems in particular.

As construction relationships are characterised by distance rather than closeness, it is expected that this factor hinders the adoption of electronic trading between construction firms, and constrains the development of sophisticated systems.

Proposition 5

Co-operation facilitates the adoption of electronic trading systems.

It is expected that the development of electronic trading is enabled by co-operation between the firms, and hindered by a latent or open conflict atmosphere. As generally recognised, the implementation of electronic trading systems requires a degree of co-operation and collaboration between firms, especially regarding systems with a wide range of information exchanged and integration, i.e. sophisticated systems (see e.g. O'Callaghan and Turner, 1995). A co-operative atmosphere between the firms is expected to be necessary in order to overcome implementation issues like legal and control aspects (Baldwin *et al.*, 1993), as well as to provide technical support and expertise, or free/subsidised software from the hub (Iacovou *et al.*, 1995). Obviously, co-operation regarding the development process can only be expected if there are mutual benefits with the implementation of electronic trading systems.

Many authors advocated that relationships between construction firms are far from co-operative, especially in relationships within projects based on traditional procurement systems (Latham, 1994; O'Brien, 1994). Thus, in many projects, there is often a latent conflict and firms co-operate to the minimum in order to finish the job (Bresnen, 1990). In these situations there is little possibility of adoption and development of any electronic trading, let alone sophisticated systems.

Proposition 6

Power/dependence enables the adoption and sophistication of electronic trading systems.

The existence of a leading firm with the ability to pressurise or coerce a potential target firm is an enabling factor concerning the development of electronic trading. Thus, if a leading firm has power over a target firm it is expected that electronic trading development is more likely to emerge than if leading and target firms have symmetrical power or if the target firm has more power than the leading firm. Moreover, if the leading firm has the ability to pressurise or coerce the target firm to adopt electronic trading, it is also expected that the configuration of the system is largely determined by the former. In principle, the larger the leading firm's degree of power the higher the ability to coerce or pressurise the target firm to implement a sophisticated system. However, there are limits to the use of the power dimension of the relationship. For example, in a situation where the leading firm can exert considerable coercion over the target firm but has a high degree of co-operation and closeness in the relationship, the ability to pressurise the target firm to adopt electronic trading or a sophisticated configuration may be constrained by the leading firm's interest in maintaining an atmosphere of co-operation and mutual trust and closeness.

Power/dependence situations between construction firms are usually restricted to the duration of each individual project, and tend to be formal and defined by clear pre-contractual conditions. Thus, there is a very restricted use of power by construction firms. The limited power that can be exerted is expected to be found between clients and architects/designers, contractors, project managers; between architect and designers; between contractors and subcontractors, builders' merchants, material suppliers. Management-orientated and integrative procurement systems are expected to provide a more adequate leadership capability, when combined the hierarchy with co-operation, to the adoption of electronic trading systems.

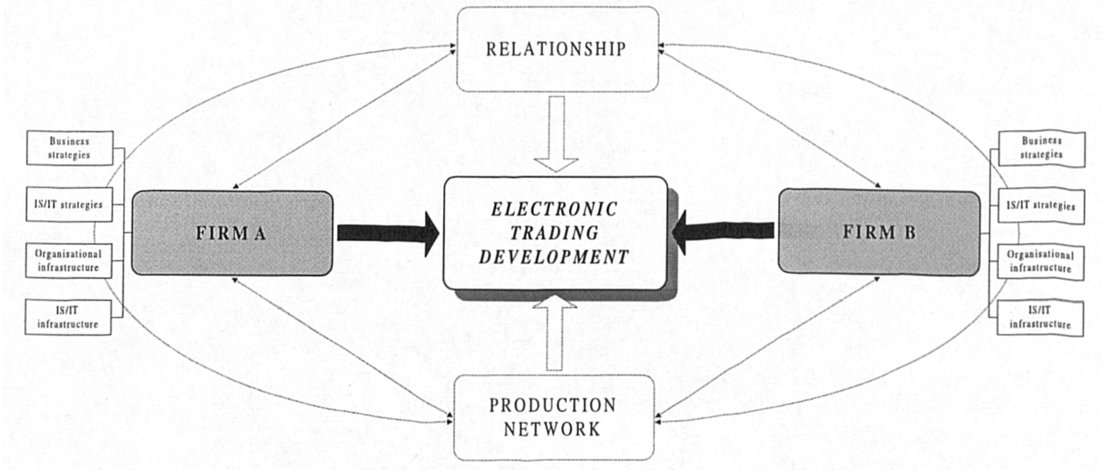
Proposition 7

Long-term relationships foster the adoption of electronic trading.

It is anticipated that mutual expectations of continuity and stability in the relationship will enable firms to develop electronic trading. As referred to before, the adaptations required for developing electronic trading are investments that both firms have to make and grounded on the future of the relationship. Without this expectation, firms will not be willing to invest and therefore to adopt electronic trading. The further firms expect to maintain the relationship the more likely they will be to develop sophisticated systems.

Due the high level of production uncertainty and one-off nature of projects, mutual expectations between construction firms are usually restricted to the duration of the project. Therefore, it is expected that typical current mutual expectations between construction firms are a hindrance to the development of electronic trading systems in general, and in particular of systems that go beyond the duration of the project. The low level of expectations does also imply that firms will not be willing to develop sophisticated systems. In situations where there are multi-project interactions and therefore mutual expectations of continuity, e.g. between some clients and contractors; architects and specialist designers; between some contractors and subcontractors, builders' merchants, material suppliers; between some project/contract managers and contractors, the likelihood of adoption of electronic trading increases.

5.3.2 - Determinant: internal features of individual firms



There is some research on how internal characteristics of firms influence the development of electronic trading and its configuration, though not from a relationship perspective and network approach (see e.g. Iacovou *et al.*, 1995; Bjorn-Andersen and Krcmar, 1995; O'Callaghan *et al.*, 1992; Emmelhainz, 1990). Thus, this work will not give too much emphasis to this factor, rather it will concentrate on relating this factor with the adopted relationship perspective and network approach, which contributes to an adaptation of Venkatraman's (1991) Strategic Alignment Model.

The implementation of electronic trading systems implies a set of adaptations in the internal characteristics of each firm. As argued before, the adaptations which are a function of the configuration of the system, can be categorised into four distinct domains: business strategy; organisation infrastructure and processes; IS/IT strategy; and IS/IT infrastructure and processes. In principle, sophisticated electronic trading systems where there is integration with internal systems, a wide range of information exchange, and internal process and system changes, will require bigger adaptations. However, for some firms the required adaptations for the implementation of sophisticated systems may be lower than for other firms which implement simple systems. The point to be made here is that the more the requirements of adoption and configuration of the system are aligned with each firm's different domains, the more likely the development of electronic trading.

Proposition 8

Business strategies fostering more close, co-operative and long-term relationships are expected to enable adoption and sophisticated electronic trading systems.

A major effect of electronic trading is that it reinforces the closeness, co-operation, dependence and long-term duration aspects of the relationship between the firms, especially when sophisticated systems are implemented (Cunningham and Tynan, 1993). Thus, it is expected that the adoption of electronic trading is enabled by business strategies, particularly, purchasing or sales strategies which are aligned with the above described potential effects of the development of electronic trading.

Current construction purchasing and sales strategies do not seem to be focused on the development of close, co-operative, dependent and long-term relationships, though there is some willingness to change current strategies (see e.g. Latham, 1994; Atkin *et al.*, 1995). This misalignment between the perception of the consequences and current strategies becomes a hindrance to the adoption of electronic trading systems by construction firms.

Proposition 9

The existence of an IS/IT strategy advocating the use of electronic trading systems and its alignment with the other firm strategy contributes positively to the adoption.

It is anticipated that the likelihood of firms adopting electronic trading increases if the IS/IT strategy of the firm considers (explicitly or implicitly) its implementation. However, it is important to note here that there must be a fit between the two firms' IS/IT strategy regarding electronic trading, particularly to the configuration strategy. For example if the electronic trading strategy of one of the firms is to implement EDI based on EDIFACT standards, and the strategy of the other is to implement an e-mail based system, this misfit may be an unsurpassable obstacle. Sophisticated electronic trading systems are likely to be developed where there is a greater alignment between the IS/IT strategies.

Although some large construction firms consider the development of electronic trading in their IS/IT strategies (see e.g. CICA and KPMG Peat Marwick, 1993; Akintoye and McKellar, 1997), most construction firms do not consider electronic trading a priority (see e.g. Atkin *et al.*, 1995; Shafagi and Betts, 1997). This is expected to hinder the development of electronic trading between construction firms.

Proposition 10

Large IS/IT infrastructure and resources enable the adoption and sophistication of electronic trading systems.

It is anticipated that the adoption of electronic trading is facilitated by the alignment between each firm's IS/IT infrastructure (hardware, software, communications) and skills (expertise, attitude) and the requirements from systems implementation. Thus, as suggested by some authors like e.g. O'Callaghan *et al.* (1992); Iacovou *et al.* (1995), it is expected that firms which have a high degree of computerisation, internal integration of IT systems, IT expertise and financial capability, and electronic trading systems experience, are more likely to adopt electronic trading, and develop sophisticated systems. Empirical studies suggest that these conditions are likely to be found mainly in large-size firms (Reekers, 1994). The point that needs to be made here is that it is not the size that maters, rather the internal IT capabilities.

Generally, construction firms are characterised by a low degree of IT capabilities and usage, in spite of recent improvements (CICA and KPMG Peat Marwick, 1993; Shafagi and Betts, 1997). Extensive and sophisticated internal use of IT can be found essentially in consultants like architects, specialist designers, quantity surveyors, and by large contractors (CICA and KPMG Peat Marwick, 1993). Still, basic systems like electronic integration between sites and head-offices or even between distinct functions of the firm are very limited and rare (Murray and Thorpe, 1996). Therefore, this factor is expected to hinder the development of electronic trading between construction firms

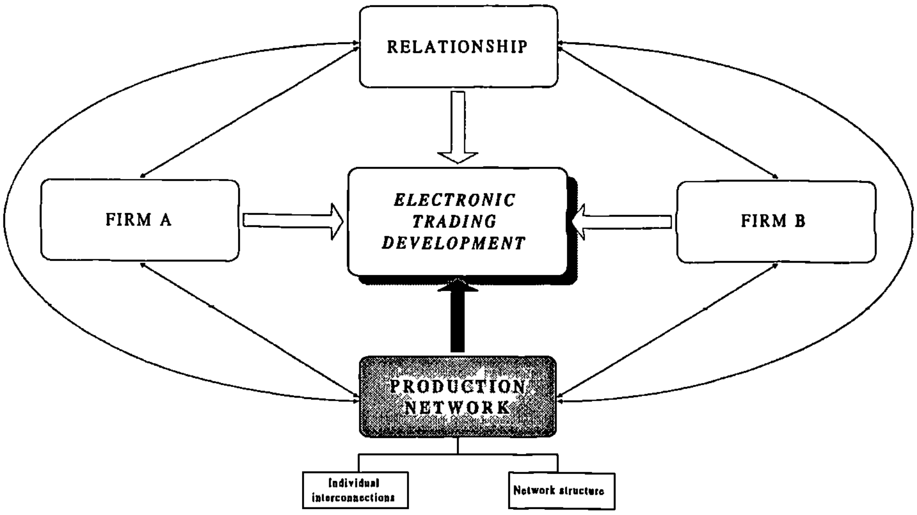
Proposition 11

Efficient administrative infrastructure enables the adoption of systems and of sophisticated configurations.

The existence of well standardised and efficient administrative processes and procedures, and motivated, open and aware management is expected to enable the development of electronic trading. Thus, the adoption of electronic trading, and particularly of sophisticated systems, calls for standardisation and rigour of a firm's administrative infrastructure, with an adequate, clear and efficient organisation structure, roles and responsibilities, and procedures (O'Callaghan and Turner, 1995). This, is particularly relevant when electronic trading is accompanied by other changes like Just-In-Time delivery (Reekers and Smithson, 1996). Moreover, it is important that firm's managers are highly committed to electronic trading, and are motivated to lead the surpassing of organisational and cultural barriers (Emmelhainz, 1990).

Several authors argue that the administrative structure of construction firms is neither as efficient as firms from other industries nor does construction have so highly motivated and skilful people (see e.g. Centre of Strategic Studies in Construction, 1988; Atkin and Pothecary, 1994). A typical example is the scarce application and success of production management philosophies like Total Quality Management, Lean production, Business Process re-engineering, which act at both production and administrative processes. Construction firms' low organisational infrastructure and process efficiency is particularly relevant at the level of small and medium size firms, like e.g. subcontractors (Hillebrandt and Canon, 1990; Stinchombe, 1959). Hence, especially for SMEs, this factor is expected to hinder the development of electronic trading by construction firms.

5.3.3 - Determinant: production network



The development of any business relationship is affected by the interconnections with other firms, organisation and relationships (Håkansson and Snehota, 1995). The generic consequences of these interconnections are threefold. Firstly, the stronger the interconnections of the relationship with other organisations and relationships, the more important will be the influence of interconnections and therefore of the network dimension (Easton, 1992). Secondly, the influence of the network structure on the development of a relationship is bigger when the evolving acts are directly linked with other firms and relationships (Easton and Araujo, 1992; Krackhardt, 1992). Thirdly, the influence of the structure of the production network on the development of a relationship can not be dissociated from the position of the relationship and firms on the aggregated structure (Johanson and Mattsson, 1987). Thus, it is now possible to describe the last set of propositions of this work regarding the decision process of adoption and configuration of electronic trading.

Proposition 12

Exclusiveness of the relationship gives support to the adoption and configuration decisions.

It is anticipated that the more electronic trading development between two firms is isolated from other firms, organisations and relationships, the higher the influence of the relationship and individual firm factors regarding the adoption and configuration, and therefore the less likely individual interconnections and the structure of the network will constrain or enable the development process. Thus, if the development of electronic trading between two firms is not linked with the development of electronic trading between those firms and other firms, it is expected that interconnections do not have a major role in the decision process of adoption and configuration. The high level of product, information, and financial interdependencies between construction firms in projects suggests that individual and aggregate interconnections are important for the development of electronic trading between firms in individual projects.

Proposition 13

The positioning of the leading firm on the core of the production system facilitates the adoption and sophistication of electronic trading systems.

It is anticipated that in situations where the leading firm is a core firm of a core-ring system and the development of electronic trading with a potential target firm is dependent upon the adoption by other firms, the stronger the leadership and hierarchical power, the bigger the leading firm's ability to convince ring firms to implement electronic trading and therefore, the higher the likelihood of adoption of electronic trading. Also, the degree of leadership and hierarchy is correlated with the development of sophisticated electronic trading systems as strong core firms are able to determine the direction of the system according to its interests. Moreover, individual interconnections lose importance in the development process where hierarchical power exists. If the leading firm is positioned in the ring of the system, the development of electronic trading is highly constrained. Thus, in ring systems, and where the decision regarding the adoption and configuration is dependent on the participation of other firms, strong co-operation and collaboration is required on the ring. Still, the opportunity of adoption and of sophisticated systems, is much reduced when compared with core-ring systems.

It was argued before that the structure of governance of construction networks tends to be of ring or core-ring type with a weak core which, therefore, is expected to hinder the adoption of electronic trading and of sophisticated systems between construction firms.

in construction networks where a core emerges, like e.g. in some projects with management-orientated or especially with integrative procurement systems, the likelihood of adoption of electronic trading and of sophisticated systems is anticipated to increase, particularly if the leading firm is the client, or other members of the core like the architect, or leading contractor/project manager.

Proposition 14

A small and homogeneous input-output structure of the production network contributes positively to the adoption and sophistication of electronic trading systems.

Where the development of electronic trading between two firms is dependent on the adoption by other firms of the network, it is expected that an input-output structure with many production units and firms involved and a large diversity of characteristics (size, technology, structure, strategies, etc.) constrains the development process. Firstly, because it should be considerably easier to 'convince' a small number of firms with the same characteristics to adopt electronic trading than a large group of firms with diversified features. Secondly, the configuration of an electronic trading system that has to be connected to many different firms can not be too sophisticated, or there is a strong possibility that many firms are not able to implement the system. Finally, there are considerable technical differences in the system itself if the system is to be used by a small number of firms, or by a large number (e.g. direct link or the use of a VAN, the capacity of the server, the communication link, etc.).

The number and diversity of firms in construction input-output structures vary considerably, essentially depending of the type and size of the project. In medium- and large-size construction projects, there is usually a large number of firms with a wide range spectrum of different characteristics: from small labour only subcontractors to the large client or contractors firms, from technologically advanced specialist contractors to the simple labour-only subcontractors. Thus, this number and diversity of firms in a construction I-O structure is expected to hinder the development of electronic trading and, especially of sophisticated systems. Electronic trading is more likely to emerge in those construction situations where a smaller number of input-output structures exist.

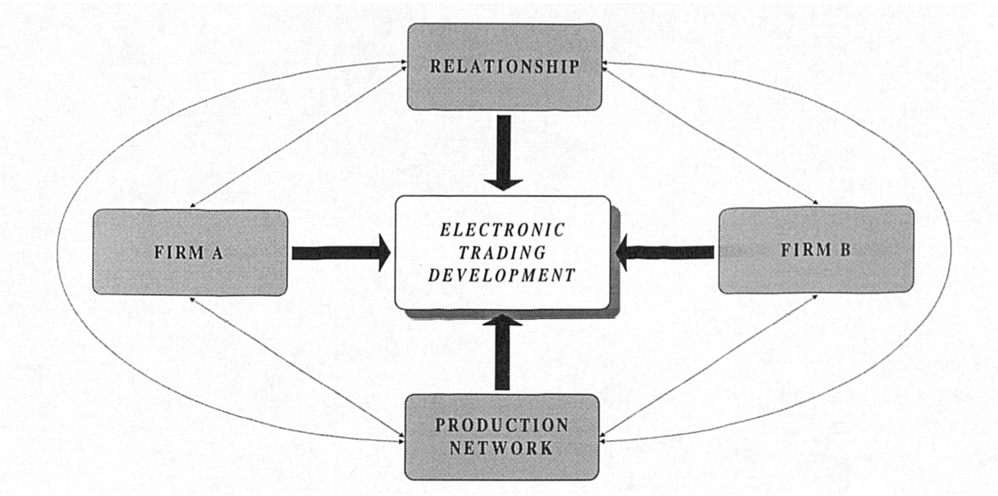
Proposition 15

The geographical agglomeration of the production system facilitates the adoption of electronic trading systems.

The geographical agglomeration of firms, especially within the same country, is anticipated to act positively regarding the development of electronic trading, in situations where the development of electronic trading between two firms is dependent of the adoption by other firms of the network. Thus, while for a technology like Internet it is not relevant whether firms are located on the same country or even in the same continent, technologies like EDI or e-mail may have some problems, especially if there is the requirement of multi-service providers (Graham *et al.*, 1994). Also, there are standards, especially EDI standards, that are only nationally recognised and the existence of firms from different countries may hinder the adoption and configuration of electronic trading systems. Finally, geographical dispersion may provide a hindrance for firms to meet to discuss problems regarding the implementation and on-going use of electronic trading.

As the production units and firms within construction tend to be localised within national boundaries, though generally dispersed, the territoriality of construction production networks is expected not to constrain the development of electronic trading systems.

5.3.4 - Interplay of the factors



As previously described, the decision of whether to adopt electronic trading and the configuration of the systems is influenced by the effect of the various factors, relationship, individual firms, and production network. The CONNET model suggests that the development of electronic trading results from the interplay of the various factors and variables. Thus, it is anticipated that in some situations, some specific variables more than others, leverage or limit the development of electronic trading. In other words, while in some cases certain variables may have a neutral effect over the development of electronic trading, other variables may have a strong enabling or constraining effect. The last proposition from the CONNET model considers this interplay of factors.

Proposition 16

The likelihood of electronic trading adoption and sophistication between two firms increases along with the rising number of enabling conditions.

In situations where most variables present an enabling pattern, it can be anticipated that electronic trading development is most likely to occur. Conversely, where most variables present a limiting pattern it is unlikely that electronic trading development occurs. This later situation seems to be the generic case in the construction industry. However, many situations, even in construction, are likely to have a combination of enabling and hindering patterns, which introduce a high degree of complexity to the theoretical analysis. Although it is outside the scope of this work to give a full detailed analysis of the enabling and constraining conditions provided by the association of variables, this will be partly explored in this work, as research will attempt to provide some empirical conclusions about the combining of variables to construction and non-construction situations. However, the combinations that positively and negatively determine the development of electronic trading will remain essentially empirical questions.

The summary of the variables, their influence and respective propositions is depicted on Table 5.1.

5.4 - Hypotheses

Having described the propositions, derived from the CONNET model, regarding electronic trading development and the basic assumptions which support the model, two hypotheses that derive from this analysis are stated. These shall be tested in this work. They result from the amalgamation of arguments from the propositions.

Hypothesis 1:

> *The adoption of electronic trading between two firms and the configuration of the systems is determined, i.e. constrained and enabled, by the complex interplay of the three major factors and respective characterising variables: the* ***relationship*** *between the firms - present exchange episodes, and perceptions regarding current power-dependence, co-operation, closeness and mutual orientation; the features of each* ***individual firm*** *- the business strategy, IS/IT strategy, organisational infrastructure and processes, IS/IT infrastructure and processes; and the* ***production network*** *where firms are embedded - individual interconnections, the input-output structure, territoriality, and the governance structure.*

Table 5.1 Summary of CONNET variables and propositions

Prop.	*Variable*	*Enable adoption & sophistication*	*Typical construction pattern*
Set 1 - Relationship			
1, 2	Information exchange	Intensive, complexity, frequency, regularity, type	Low regularity and frequency, limited to project duration
3	Product, financial exchanges	Intensive along with information exchanges	Intensive but low regularity and short duration
4	Closeness	Strong interdependencies like joint R&D, JIT, quality	Very low level of durable interdependencies
5	Co-operation	strong co-operation and collaboration	Latent or open conflict, co-operation at minimum levels
6	Power/dependence	Leading firm's power over the other firm	Low power/dependence between firms, usually restricted to project
7	Mutual expectations	Continuity and stability	Expectations restricted to the duration of the project
Set 2 - Individual firm			
8	Business strategy	Purchasing and sales strategies focused on closeness, dependence, co-operation and long-term relationships	Purchasing and sales strategies focus on short-term, Dutch-auction, and one-off.
9	IS/IT strategy	Priority to electronic trading, and alignment between electronic trading strategies	Low priority to electronic trading on IT strategies
10	IS/IT infrastructure	High degree of IT usage, IT integration, IT expertise, IT financial resources, electronic trading experience	Low IT capabilities. Consultants and large firms with higher levels of IT usage.
11	Organisational infrastructure and processes	Standardised and efficient administrative processes and procedures, and motivated, open and aware management	Inefficient administrative infrastructure and low motivation and skills
Set 3 - Production network			
12	Interconnections	Isolation of the relationship, exclusiveness	On project duration high levels of interdependencies
13	Governance structure	Leading firm positioned as the strong core of core-ring systems	Ring or core-ring system with weak core
14	Input-output structure	Small number of firms and low diversity	Large number of firms and high diversity
15	Territoriality	Geographical aggregation	Relatively aggregated territoriality
Set 3 - Production network			
16	Interplay of factors	Concentration of enabling factors	Few enabling factors

Hypothesis 2:

> *The adoption and sophistication of electronic trading systems between two construction firms emerge when the interplay of relationship, internal firms features, and network structure factors and variables has a clear enabling pattern. Variables' enabling patterns should be similar in construction and non-construction situations.*

Chapter 6 explains how in this work, the validation of the model and testing of the hypotheses is to be approached methodologically. The results and analysis of the empirical data collected shall be presented in Chapters 7 and 8.

5.5 - Summary

This chapter started by presenting the CONNET model, that is a conceptual framework of electronic trading development. The model is built upon three major factors - relationship, internal features of individual firms, and production network to each correspond to a set of variables. The assumptions on which the model is grounded were also described. These are based on the relationship perspective and network approach explained in Chapters 3 and 4. From the discussion on the previous chapters, the theoretical arguments of the CONNET model were put forward in the form of four sets of propositions, with a total of sixteen. These propositions are the theoretical core of this work, and it is based on them that the empirical data collection shall be conducted. From the amalgamation of the propositions two hypotheses that are tested in this research work are described. These, in summary, advocate that the adoption and configuration of electronic trading systems in general, and in construction, are determined by the complex interplay of the relationship, internal features of each firms, and the production network.

CHAPTER 6

RESEARCH APPROACH, STRATEGY, AND DESIGN

6.1 - Introduction

This chapter describes the research approach, strategy and design adopted in this study. In order to justify the options in this study, a review and discussion of research approaches, and main strategies is made. Based in the previous discussion, the nature of the theoretical model, and in the resource limitations, the research project design is discussed. Finally, data collection methods, and data analysis and interpretation techniques used in the empirical part of the research are described.

6.2 - Research approach in this work

6.2.1 - Positivist versus interpretative approaches

Every human action is, implicitly or explicitly, grounded on some philosophical perspective, and organisational and social research in general is no exception. The objective of this section is to clarify the philosophy or **research approach** supporting this work, but without arguing about merits of alternatives. This clarification is important in order to better understand the choices that were taken regarding the research strategy and design in this work and described in the following sections.

There are two generic distinct philosophical research approaches: the **positivist**, and the **interpretative**. The main assumption of the positivist approach, in its purest form, is that there exists an objective truth in the social world, which has certain properties that can be revealed through objective scientific methods. It often involves measuring the relationships between specific variables, and for this reason it is often designated as quantitative research (Easterby-Smith *et al.*, 1991; Evered and Louis, 1991). The generic research process of the positivist approach has several specific cornerstones. The two most important ones are researcher independence - the researcher must remain independent from the study object; and theory- or hypothesis-driven research - the research process should start with a theory/hypothesis and data must be collected to test its veracity (Easterby-Smith *et al.*, 1991; Evered and Louis, 1991).

The interpretative, phenomenological or qualitative approach is completely different from the previous as it advocates that reality is socially constructed by the individual rather than objectively determined (Filstead, 1978). Instead of gathering facts to measure how certain patterns occur and search for external causes to explain phenomena, research should focus on the appreciation of the different constructions and meanings of individuals and therefore try to understand and explain why people have different experiences (Easterby-Smith *et al.*, 1991; Evered and Louis, 1991). In this approach, it is considered that the researchers can not be independent from the situation they are studying and that theory is generated or grounded from the data collected (Glaser and Strauss, 1967). Research is more concerned with emergent themes and descriptions rather than hypotheses and theories (Cassel and Symon, 1994). The main features of each research approach are summarised in Table 6.1.

Table 6.1 Key features of positivist and interpretative approaches

	Positivist	*Interpretativist*
Basic beliefs	The world is external and objective	The world is socially constructed and subjective
	Observer is independent	Observer is part of what is observed
	Science is value-free	Science is driven by human interests
Researcher should	Focus on facts	Focus on meanings
	Look for causality and laws	Try to understand what is happening
	Reduce phenomena to simplest elements	Look at the totality of each situation
	Formulate hypotheses and test them	Develop ideas through induction from data
Preferred methods:	Operationalising concepts so that they can be measured	Using multiple methods to establish different views of phenomena
	Taking large samples	Small samples investigated in-depth or over time

Source: Easterby-Smith *et al.* (1991)

The arguments presented here regarding the positivist and interpretative approaches are indeed extreme or pure situations. Bryman (1988) states that there are two main distinct views regarding the 'conflict' over the two approaches. The first view stresses that the two approaches are epistemologically different and therefore it is not possible to either compare or combine them. The second view states that each approach is appropriate to different types of research problem, and that eventually it would be possible to design a research project which would combine the two approaches. In reality, the apparent incompatibility between them is blurred when it comes to actual research, as strategies and methods used by researchers are far from being so clearly distinct (Huberman and Miles, 1994; Easterby *et al.*, 1991).

6.2.2 - The 'positivist' approach in this work

As far as this research is concerned, the point to be made here is that though a 'positivist' approach has been adopted, this is far from being in its 'purest' form. Indeed, it lies in the continuum between positivist and interpretative approaches, since the research process is typically positivist but the data collection and analysis methodology was closer to the 'soft' approach. The initial stance in the work was to consider that research should be looking for a truth, even though one can not ever be sure of reaching the certainty about the truth (Popper, 1992). This had two obvious major impacts on the research project. Firstly, the researcher adopted a distant attitude towards the object of study, i.e. the development of electronic trading between firms, and therefore there was an inquiry from outside. Secondly, the design of the research project considered primarily that from theoretical analysis consistent hypotheses would be put forward along with sets of propositions, which should be confirmed (or not) by data collection.

It is important to stress here that the decision over the 'positivist' approach derived from the researcher's beliefs over what a research project should be rather than from the fact that the research problem of this work would fit better that kind of approach, as Bryman (1988) suggests. On the contrary, as the adoption of electronic trading is a complex process, involving several individuals over time and from distinct contexts, this suggests that qualitative methods would be required to capture the detail of the process (Cassel and Symon, 1994), and therefore the use an interpretative approach. In reality, as shall be discussed later, qualitative methods - case studies, were used as part of the research strategy but embedded in a 'positivist' framework (Yin, 1994). As shall be discussed further, the two things - 'positivism' and qualitative methods, are not necessarily in conflict.

6.2.3 - The research process

The **research process** of this study follows very much the traditional 'positivist' approach, and is summarised in Figure 6.1. Thus, in order to test the theoretical model against reality, case studies were conducted and data was collected. The data was then analysed through pattern-matching and interpreted, from which conclusions about the validity of the model and its limitations were drawn. The conclusions implied a series of corrections to the initial model, and also suggested a whole range of further propositions and paths to investigation. From the conclusions it was also possible to define the implications of this research work.

It is important to stress here that though it was intended to have as much as possible a linear research process, there was inevitably some degree of interaction, especially within the initial steps of the research, between the problem area and research question, literature review and definition of the theoretical model. Indeed, this was the most extensive phase, the refinement of the research questions, model and literature review. The outcome of this initial phase has been presented in the first four chapters of this work. In the remainder of this chapter and following chapters, the description of the practical part of this work and its link with the theoretical model is described.

6.3 - Research strategy: case studies

6.3.1 - Choosing the strategy

Having identified the research approach it is now important to describe the **research strategy**. The research strategy in this work is defined as the global framework of action to achieve the aims and objectives set at the outset of this work (stated on section 1.5). The strategy defines the overall configuration by which data collection and analysis will be conducted, "*what kind of evidence is gathered from where, and how such evidence is interpreted in order to provide good answers to the basic research question*" (Easterby-Smith *et al.*, 1991:21). As Allen (1996) puts it, strategy sets the amalgamation of tools, procedures, methods, etc., which are used to collect and analyse data. Thus, it is important here to distinguish strategy from **method**, as the latter in this work is identified as the individual data collection and analysis techniques which are used to achieve the strategy's objectives (see e.g. Yin, 1994; Allen, 1996).

According to Yin (1994), the research strategy should be chosen as a function of the research situation. Each strategy has its own specific approach to collect and analyse empirical data, and therefore each strategy has its own advantages and disadvantages. Although each strategy has its own characteristics, there are overlapping areas which brings complexity to the process of strategy selection. In order to avoid gross misfits between the desired outcome and the chosen strategy, Yin (1994:4) stresses that the **type of question posed**; the **control over actual behavioural elements**; and the **degree of focus on historical or contemporary events**, are the conditions which should provide the grounds to strategy choice. Table 6.2 depicts the outcome of the intersection between most common research strategies and the three conditions.

By defining the research questions as '*what* are the factors that determine the development of electronic trading ?' and '*how* do they influence the development process', it is easily concluded that the form of the questions on this work are of 'what' and 'how'. The 'what' question is of a exploratory nature, addressing the identification of variables rather than with a quantifying purpose (how many, how much), which according to Yin (1994) it is a type of question that can be addressed by all types of strategy. In reality, the 'what' part of the research questions is mainly addressed by the literature review, where the main factors and variables are identified and modelled. The 'how' dimension of the questions lead to an explanatory nature of research, which should be better served by the use of **case study, history** or **experiment** strategies.

Table 6.2 Relevant situations for different research strategies

Strategy	*Form of research question*	*Requires control over behavioural events?*	*Focuses on contemporary events?*
Experiment	how, why	yes	yes
Survey	who, what, where, how many, how much	no	yes
Archival analysis	how, why	no	yes/no
History	how, why	no	no
Case study	how, why	no	yes

Source: Yin (1994:6)

History is a research strategy that should be used when there is no access or control over behavioural events, and where the research deals with the historical past. A historical strategy is relevant when it is not possible to collect data from living individuals, and therefore the methods of data collection focus on past documents and other forms of historical evidence (Yin, 1994). Though it is possible to make historical research over present events (Bennett, 1991), this is likely to overlap with the case study strategy. The point to be made here is that as this research work focuses on very recent and present events, and where most individuals involved in the development process of electronic trading are likely to be able to provide data, the history strategy was considered as inappropriate for the current situation.

Experiment is a strategy where the researcher varies one or several independent variables whilst measuring the effects on the dependent variables, and keeping intervening variables constant (Bennett, 1991). This can be done isolated from the real world - laboratory experiments, or as more common in management research done on the real setting - field experiment or action research. Regarding this study, the major hindrance to the implementation of this research strategy is the sheer complexity, length and cost of the development process of electronic trading, and therefore the impossibility to control behavioural events related with the adoption process, i.e. relationships, network structures, IT and business strategies and infrastructures. Moreover, the access provided by the firms involved in this study, and in general regarding electronic trading issues, is very limited which contributes to the inadequacy of this type of research strategy.

Hence, it was concluded that case study was the most adequate research strategy. The preference of the case study strategy derives from the fact that the main research question in this work is in the form of 'how', and case studies provide the ability to examine contemporary events - the development of electronic trading between two firms, by dealing with a wide range of evidence - documents, interviews, and observations, but where the relevant behavioural aspects can not be manipulated (Yin, 1994:8).

6.3.2 - Conceptualising the case study strategy

There is no standard definition of what a case study is. Authors often have different and sometimes conflicting views about what a case study should be and even its basic assumptions. Case study research is often linked with 'qualitative' research especially in the form of ethnography, hermeneutics or phenomenology studies, where there is a concern of close-up detailed observation of the natural settings by the researcher and the attempt to avoid prior commitment to any theoretical model (see e.g. Van Maanen *et al.*, 1982; Miles and Huberman, 1994), i.e. 'interpretative' approach as defined in this work. However, another perspective on case studies is provided by Yin (1981, 1994) or Bryman (1989) who have a more 'positivist' approach by stating that explanatory case study research is driven by a theoretical model from where propositions should be tested, by qualitative, quantitative or both methods. Thus, this empirical work will follow Yin's perspective as it has become widely accepted in the scientific community (Hakim, 1987) and is aligned with the author's perspective.

Yin (1994:13) provides a technical definition of case study strategy:

> "*A case study is an empirical inquiry that investigates contemporary phenomenon within its real-life context, especially when the boundaries between phenomenon and context are not clearly evident.*"

Thus, the case study strategy should be chosen when it is important to cover contextual conditions as these are likely to be important to the phenomenon being studied. This is the case in this research study. The literature review has unveiled that the process in which construction firms decide whether to adopt electronic trading and its configuration is highly interlinked with contextual factors like relationships and network structure, and these are expected to be highly relevant to the phenomenon itself. Yin (1994:13) also states that " *The case study inquiry copes with the technically distinctive situation in which there will be many more variables of interest than data points, and as one result relies on multiple sources of evidence, with data needing to converge in a triangulation fashion, and another result benefits from the prior development of theoretical propositions to guide data collection and analysis* ". Yet again this hits the problematic issues of this work. Indeed, the necessary data to test the theoretical model and respective propositions put forward are unlikely to be found and collected seamlessly throughout a single collection method due to the large number of factors, variables and their interlinkages that are anticipated to influence the adoption and configuration of electronic trading between two companies. Multiple sources of evidence are required and still many variables will not be able to be completely covered by data collection due to time and access constrains. Multiple case studies will be conducted in order to cover as much as possible of the theoretical framework. The insufficient empirical cases in construction and the need to draw parallels with non-construction situations led also to the grounding of some data from cases outside the construction industry, as shall be further discussed later in this chapter.

6.3.3 - Critical aspects of the case study strategy

Case study research is often pointed out as a weak research strategy, that should be only used for exploratory studies and therefore scientific evidence is very weak. However, as

Hakim (1987) states, since Yin (1981) thoroughly structured and widely accepted generic design guidelines have been put forward which provide researchers with a sound framework for a case study strategy. This shall be addressed in the next section. Still, it is important here to review and explain some of the main criticisms of case studies.

6.3.3.1 - Generalisation

The possibility of making scientific or statistical generalisations is probably the source of the biggest criticism to case studies. In positivist approaches, it is often considered that conclusions of cases studies can not be considered valid unless they can be proved to be 'typical' of the phenomenon under study which can only be achieved by a representative survey (see e.g. Smith, 1991; Easterby-Smith *et al.*, 1991; Bryman, 1989). Obviously, this is not considered to be a problem in 'interpretative' approaches. Thus, case studies are used by some authors on an exploratory basis to support theoretical development, from which results will be validated by extensive surveys.

Yin (1981, 1994) along with other 'positivist' authors (see e.g. Hartley, 1994; Carrol and Johnson, 1992) have, however, argued that within case studies the type of generalisation which should be sought is analytical rather than statistical. Yin (1994:31) refers that

> " *the method of generalisation is 'analytical generalisation', in which a previously developed theory is used as a template with which to compare the empirical results of the case study. If two or more cases are shown to support the same theory, replication may be claimed.* "

Cases are not 'sampling units' or statistical populations and should not be chosen for that reason but chosen as researchers decide to make different experiments or surveys to validate propositions. Hence, theory development facilitates not only the data collection phase but also the level at which the generalisation of the case study occurs. This approach shall be assumed hereafter in this work. In that sense the multi-case study design in this work focused on generalising the theoretical framework of the CONNET model and not on statistical generalisation.

6.3.3.2 - Research quality

The case study strategy usually raises concerns about the lack of rigour of the data collection, analysis and description. Yin (1994) refers that sloppy research does sometimes occur, and that equivocal and biased views may influence the direction of conclusions, though this problem does not occur only in case studies. Indeed, the validity of data seems to be a primary concern regarding case study research. Miles and Huberman (1994) argue the fact that data collection depends on people's recollections of events; and warn against research where the investigator accepts too easily the information provided by some informants, failing to make cross-check examination. Another concern is pointed out by Easterby-Smith *et al.* (1991) who argue that data collection often overwhelms careful analysis and interpretation of its meaning, which leads to the fact that case studies may " *take too long and result in massive, unreadable documents* " (Yin, 1994:10). Finally, it is often stated that the rigour, and general results of case studies are much dependent of the resources and skills of the researcher. Thus, good case study research is likely to demand considerable time and human resource efforts, as well as some researcher's skills like the ability to question, listen, be flexible, and have sound knowledge of the subject (Yin, 1994; Smith, 1991; Hakim, 1987).

There is, however, a general consensus that the problems highlighted above can be partially overcome by a good and thorough case study research design, and the use of specific tools, techniques and procedures like e.g. pilot study, multiple sources of evidence, case study protocol, etc.(see e.g. Yin, 1994; Miles and Huberman, 1994; Easterby-Smith *et al.*, 1991). In this work the rigour of the research was considered a very important issue the following sections describe the various procedures that were attempted to assure the quality of the empirical research.

6.4 - Research case study design

6.4.1 - Research project design

Research design operationalises the strategy by defining an action plan for getting from the initial research questions to the conclusions (Yin, 1994). It includes the concrete steps which implement the methods of data collection, analysis and reporting based upon the identified research problem, questions and model, and therefore the design of the research must require a holistic view of the project (Allen, 1996; Easterby-Smith *et al.*, 1991). Yin (1994) stresses that as the main purpose of the research design is to help to avoid the misfit between empirical evidence and initial research questions, design becomes more logical rather than a logistical issue.

Hence, in the outset of the empirical work a detailed research project design was put forward, which is depicted in Figure 6.1. The design has some specific points that are important to highlight here. A crucial aspect of the design was to have a close linkage between the empirical part of the study (data collection and analysis) with the theoretical phase (research questions and model). Thus, this study started by a high-level literature and empirical search regarding the use of electronic exchange of information by constructions firms, from which emerged the lack of electronic trading between construction firms as the problem area. As stressed before, the aim of the study was not to provide the solution to the lack of electronic trading between construction firms, rather to develop models and propositions that help to understand the problem and therefore contribute to the definition of ways to overcome the problem. Two main research questions were then defined. A thorough literature review was conducted within construction management and IT, electronic trading, relationships and networks bodies of knowledge, from which it was possible to draw a model to address research questions - the CONNET model, and that was presented in the form of general hypotheses and sets of propositions. Based on these theoretical developments electronic trading between two firms was defined as the unit of analysis of the case studies. The necessity for multiple case studies to achieve literal and theoretical replication was also concluded, and the model provided the input to the selection criteria for the cases, i.e.

the number and type. Finally, the protocol of each case study was based on the research questions and propositions.

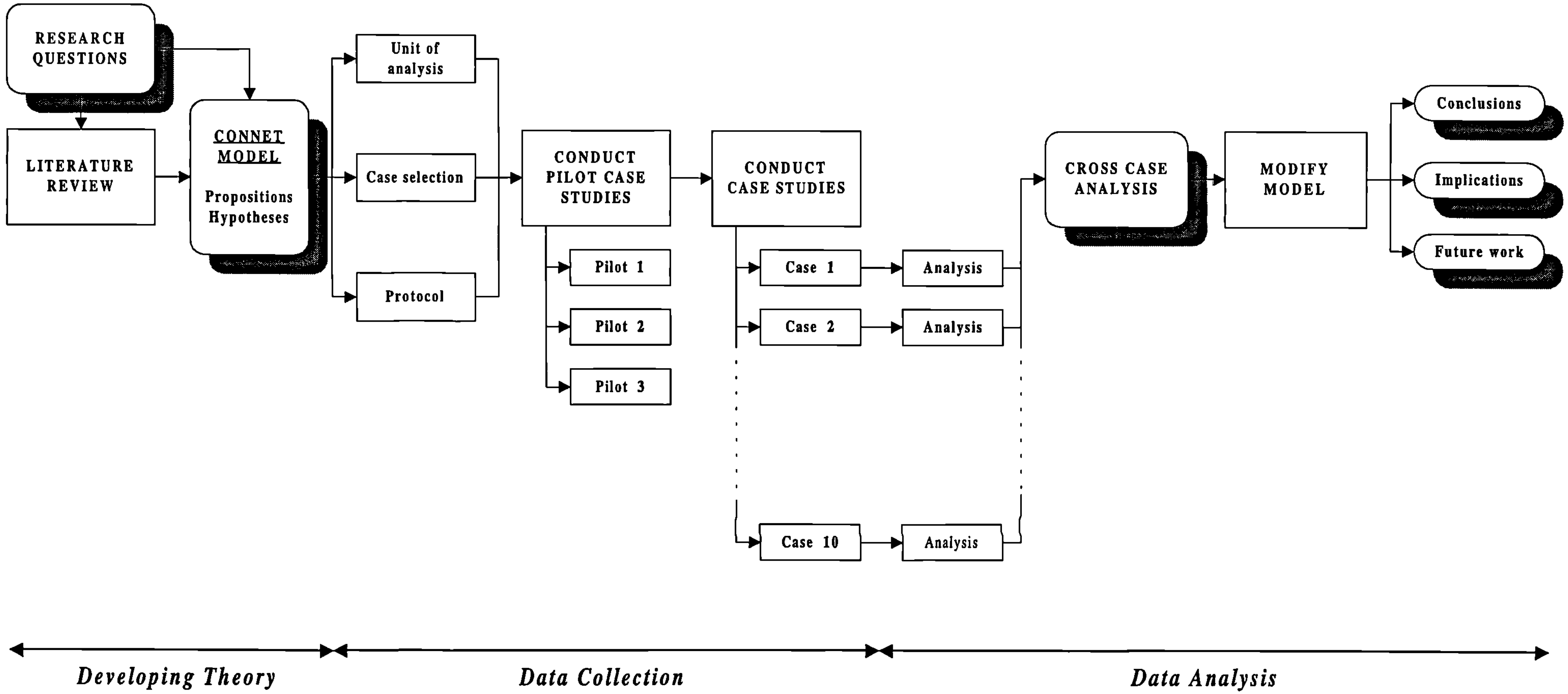
The design of the empirical research envisaged that due to the necessity of restricting data collection, pilot case studies would be required. Three pilot cases were conducted, in order to fully test the adequacy and refine the methods and techniques of data elicitation. The conduct of each case study is followed by a whole case analysis based on pattern-matching with theoretical propositions. Following the conduct and analysis of all case studies, a cross-case analysis is made where the validity of the whole CONNET model is assessed, and adjustments to the initial theoretical propositions are eventually made. Finally, conclusions are drawn regarding the initial objectives of this study, its implications and future research work. The justification and full description of the various elements and procedures of this design are presented in the remainder of this chapter.

6.4.2 - Selection of case studies

6.4.2.1 - Unit of analysis

The definition of what is the **'case'** or **unit of analysis** is of paramount importance to any research design (Yin, 1994). Miles and Huberman (1994:25) stress that in abstract terms, the 'case' is a *"phenomenon of some sort occurring in a bounded context*". However, the clear definition of the unit of analysis is often problematic. Yin (1994) suggests that in general terms, the definition of the 'case' is much linked to the way research questions have been posed. Similarly, Miles and Huberman (1994) advocate that the case is where the focus is. All sorts of unit of analysis can be considered, from individuals, to organisations, small groups, roles, events, etc. (Miles and Huberman, 1994; Yin, 1994; Smith, 1991). The boundary of the case is also important define as it determines the limits of data collection and analysis (Yin, 1994). Boundaries can be defined by the propositions set up in the theoretical framework (Yin, 1994), or by what will not be studied (Miles and Huberman, 1994).

Figure 6.1 - The research project design



Based on the arguments discussed above, in this work, it was considered that the unit of the analysis, and therefore the 'case', should be the **electronic trading between two firms**, i.e. the electronic exchange of information in a business relationship. The boundary of the case defines the factors which are expected to influence the development of the electronic trading configuration, therefore the internal characteristics of each individual firm, their relationship, and the network in which they are embedded, as the context. The time boundary of the 'case' is set as the time until implementation has occurred, and not afterwards.

Thus, the focus on electronic trading as the unit of analysis rather than on the individual firms derives mainly from the assumptions brought by the relationship perspective, which clearly advocates that investigation on inter-firm issues should bear in consideration the point of view of both participants in the phenomenon (see e.g. Håkansson, 1982; Yin, 1994). Similarly, a construction project as the unit of analysis would not be adequate, as apart from the above reasons, it was also considered important to bring situations from outside the construction industry, and situations where construction firms are not directly involved in projects, like e.g. between cement producers and ready-mix concrete manufacturers

6.4.2.2 - Multiple case studies

In this work a **multiple case studies design** was adopted in order to add confidence and achieve more robust conclusions. Thus, by looking at a range of similar and contrasting cases it was expected to strengthen the precision, validity, and the stability of the findings of the research (Miles and Huberman, 1994). The rationale behind the multiple case studies design was of the **replication**, which means that each case is selected so that it either produces similar results - **literal replication**, or for theoretically predicable reasons produces contrary results - **theoretical replication** (Yin, 1994).

Thus, by choosing a logic of replication for case studies rather than of 'sampling' it will be possible to achieve analytical generalisation, which is the core of the case study strategy. The generalisation from one case to the next in this work is made on the basis of a match with the CONNET model and its propositions and hypotheses, not to a larger universe, or as Miles and Huberman (1994:29) stress "*the choice of cases is made on conceptual grounds, not on representative grounds*". The implications are that, though in each case there are properties that are shared by many others, some properties that are shared by some others, and properties that are shared by no others, the multiple case study design produces the confidence that the CONNET model is generic because it predicts where the phenomena - electronic trading between two firms, is likely to be found as well as the conditions when it is unlikely to be found (Yin, 1994).

The selection of the number of cases for literal and theoretical replication is discretionary and judgmental, depending on the level of certainty that one wants to have about the results (Yin, 1994). However, the possibility of conducting multiple case studies is constrained by its requirement for extensive resources and time, especially in this work as each case requires data collection from two firms, which becomes a major issue for a single researcher. Another important issue to be considered is that, in principle, the adoption of many cases generally implies the trade-off that these can not be conducted in a very in-depth level (Miles and Huberman, 1994).

Hence, based on the previous considerations, it was considered in this work that the adequate number of cases, i.e. of the study of electronic trading between two firms, was ten. Regarding the adoption process, eight cases were selected for providing literal replication, four in construction situations and two in non-construction, and for theoretical replication were selected two construction cases where electronic trading was aimed at but was never implemented. As far as sophistication is concern, three construction cases and three non-construction cases were selected for literal replication, and for theoretical replication one non-construction and three construction cases were selected. The reasons behind the choice of the case studies are now presented in the following section.

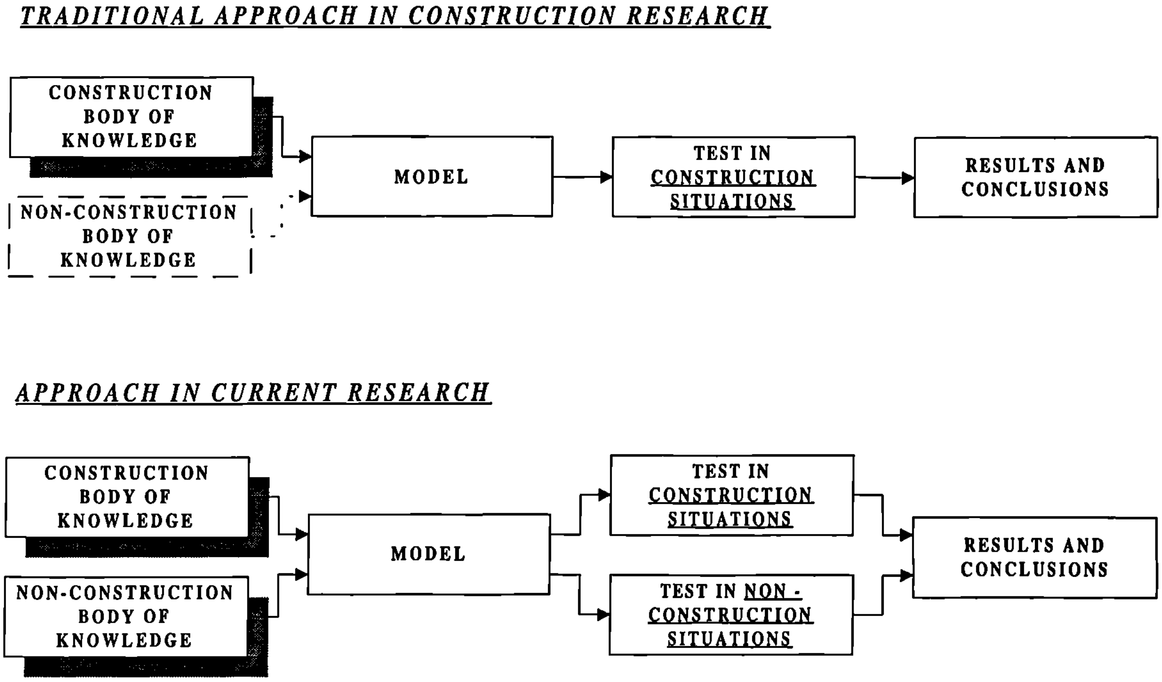
6.4.2.3 - Choosing the case studies

The selection of case studies must be purposeful rather than random in order to achieve the desired literal and theoretical replication objectives, and therefore avoid biased results that are likely when dealing with a small numbers of cases (Yin, 1994; Miles and Huberman, 1994). However, the selection process is often critically limited by the access that the researcher has to the cases, and once gained, the level of detail that access is able to be obtained to (Carrol and Johnson, 1992).

In this work, contrary to the initial expectations, it was difficult to have access to the desired cases. Reasons for this were threefold. Firstly, the number of construction firms which in reality had electronic trading were indeed much lower than expected, particularly outside relationships between builders' merchants and their suppliers. Though initial investigation through CITE suggested that potential cases of electronic trading between large contractors and their suppliers would exist, the reality was quite different. Many of the firms stating that they had implemented EDI only made either a full pilot and stopped, or were exchanging information electronically but through diskette or CD-ROM, which was not considered in this work as electronic trading. Moreover, some of the potential interesting cases were not interested in participating in the research. Secondly, although the initial purpose was to find a set of cases which would allow stability of some variables of the model (e.g. type of firms involved, electronic trading systems, etc.) and only variability in the most important factors, it was not possible to find such situations in construction which would demonstrate the amplitude of the propositions put forward by the CONNET model. Thirdly, it became obvious from the three pilot cases carried out initially and from the first full case study, that the type of information that would be necessary to make very detailed case studies was not easily accessible, mainly because information about inter-firm issues with customers, suppliers, etc. is still much considered as sensitive and therefore not to be revealed.

The difficulty of access to the sources therefore brought consequences to the case study design. First, instead of testing the CONNET model on a particular well-defined context by focusing data collection on a specific type of electronic trading (e.g. EDI) and on a specific type of relationship between construction firms (e.g. contractor-supplier/subcontractor) and drawing only in-depth explanatory conclusions, it was decided to relax the data focus. Thus, the model was tested not only upon a range of construction situations but it was also considered important to reinforce the conclusions by testing on manufacturing and service situations where electronic trading is widely implemented (see Figure 6.2). Therefore, the aim was to obtain not only vertical/explanatory but also horizontal/exploratory conclusions. The wide variation in the cases contributes also to enhance the generalisation of the CONNET model. Indeed, because conclusions in this work will be drawn upon construction and non-construction international empirical data, it can be possible to generalise the CONNET model beyond the construction sector and UK industries.

Figure 6.2 - Data validation of the model



Second, literal replication cases were selected based on their potential to demonstrate how certain factors determined the adoption and sophistication of electronic trading systems between firms. This implied studying electronic trading cases: *i*) with distinct types of systems - EDI, e-mail based system; *ii*) embedded in different types of construction relationships - contractor / trade contractor, contractor / consultant, builder's merchant / cement producer; etc.; *iii*) between non-construction firms. Third, for theoretical replication cases were selected where firms were on the brink of developing electronic trading but which ended up by not implementing the systems, and cases where the degree of sophistication was very limited. Fourth, due the difficulty of obtaining access to some data, the need to conduct several case studies, and the emergence of exploratory conclusions, the level of detail of the cases studies had to be partially sacrificed, though maintaining much of the richness of data which characterises the case study strategy.

A final issue about the selection of cases concerns the fact that all non-construction cases are situated in Portugal, while the constructions cases are from UK, which can lead to the argument that the results may be biased by different cultural, socio-economic, and technological environments. However, as discussed before, the relationship perspective and network approach - and therefore the CONNET model, considers that the effects of those 'environmental issues' are embedded in the pattern of the variables and are not considered as influencing factors *per se*. In other words, the pattern of the variables in the CONNET model partially 'reflect' what is traditionally designated as environmental factors. The point to be made here is that those cases were selected based on the pattern of their variables.

So it may be asked, why were these cases studies conducted in Portugal? - Although the logic behind the selection of cases has been put forward, it is important also to acknowledge that in some situations the case access was given by the author's network of friends and evolving contacts, as advocated by many authors (see e.g. Miles and Huberman, 1994; Easterby-Smith *et al.*, 1991; Carrol and Johnson, 1990). In that sense, because the author had easy access to automotive and retailing firms in Portugal which were in conformance with the purpose of the cases, and as it was assumed that the geographical location would not introduce interference to the results, those non-construction cases were considered valid to the study. Nevertheless, it is believed that Portuguese case studies are indicative of UK manufacturing and service practice, as demonstrated by the comparison of the case studies in this work with other studies describing examples in the UK (see e.g. Atkin *et al.*, 1995).

6.4.3 - Data collection

6.4.3.1 - Case study protocol

In order to enhance the research project reliability a **case study protocol** was prepared. Thus, for each case study, and based on Yin's (1994) framework, a document was produced that described the:

1. Generic project objectives, relevant issues being studied, why that particular case study was selected, how does it links with the other cases and with the study in general;
2. Procedures for conducting the case study, like e.g. persons to be interviewed, documents to be sought, researcher procedures, letters to ask and provide access, schedule, notes, operational procedures, etc.;

3. Specific questions to be addressed by the case study, and possible sources of answer to those questions. Also the specific questions to be asked of each interviewed person;

4. Basic outline of the case study report, structuring the description and analysis of the case study.

It is important to point out here that in elaborating the case study protocol it was considered important to stress for each research issue its linkage with the theoretical propositions and hypotheses so that a chain of evidence could be maintained, and therefore enhance the reliability of the cases study (Yin, 1994).

6.4.3.2 - Pilot case study

In this work three pilot case studies were conducted before the field data collection was initialised. The conduct of pilot cases is seen as a crucial step in order improve the quality of the case study research, especially concerning the data collection phase (Miles and Huberman, 1994; Easterby *et al.*, 1991; Yin, 1994). The main objective of pilot cases is to refine the data collection plans " *with respect to both the content of the data and the procedures to be followed* " (Yin, 1994:74). Due to the number of topics addressed by the CONNET model, the refinement of data collection and procedures was of paramount importance and which was addressed by three distinct pilot cases studies.

The pilot case studies were selected based on convenience and easiness of access. Two case studies were conducted between construction firms - one between a concrete manufacturer and a cement producer where an EDI system was implemented, and the other between a large contractor and a tool and equipment hirer that were aiming to implement an EDI system. A third case study was conducted between a large retailer and a supplier that had implemented a partly integrated EDI system. The pilot cases focused essentially on refining the method of linking the desired outcome in terms of the overall research propositions and the field interview questions and collection of documents. Because the pilot studies had relaxed controls it was possible to test different ways to elicit relevant information, like e.g. try different sources (IT, purchasing, or sales people), different methods (open interviews, semi-structured interviews, close questionnaires), or different procedures (with and without tape recorder). The combination of a solid and comprehensive theoretical framework, provided by the CONNET model, and the extensive piloting of the empirical research resulted in it being possible to be very precise in the data collection process in the real cases studies, avoiding much of the redundancy and complexity usually associated with case study strategy.

6.4.3.3 - Multiple sources of evidence

One of the strengths of the case study approach over other strategies is the possibility of using **multiple sources of evidence** (Yin, 1994). The major advantage of using more than one source of evidence is the process of triangulation, where any conclusion is much more convincing if supported by corroborative different sources (Hakim, 1987; Yin, 1994). Another advantage of using multiple sources of evidence is the possibility for the researcher to cover a broader range of issues. Multiple sources of evidence can, however, be achieved through different but complementary ways: *i*) use of multiple data collection methods; *ii*) use of different sources, like e.g. distinct people in a company or on different companies. This shall now be further discussed.

Bryman (1987) suggests several data collection methods for qualitative research: semi-structured, structured, and unstructured interviews; survey questionnaire; participant and structured observation; and archival analysis. In this work, **interviews**, either semi-structured or structured were the core of the data collection. For each case, the initial interviews were semi-structured and the objective was to obtain the richest picture as possible of the development of electronic trading, though following a specific reasoning provided by the relationship, firm and network themes. These interviews used both face-to-face meetings and tape recording. Following these initial interviews, several structured interviews were conducted with the purpose of addressing particular and key issues raised during the semi-structured interviews. Most of these interviews were also face-to-face and tape recorded but in some situations, especially when the inquiry was very specific, phone interviews occurred as well as written questionnaires (conducted through mail, fax, or often electronic mail).

Bias is often referred as the major problem of interviews as a data collection method (Yin, 1994; Miles and Huberman, 1994; Easterby *et al.*, 1991). Interviews' data is subject to bias due to the human interaction of the interviewing process, to the fact that data obtained is limited to the spoken contact, and to inferences made by the researcher. However, it is generally accepted that a good design of the empirical process and of the questions can overcome the problem (Yin, 1994). In this research work, this problem of bias when conducting interviews was addressed by several procedures and techniques. Firstly, the conduct of three extensive and in-depth pilot case studies allowed the narrowing of the focus of the questions and tests of their relevance to the subject. Secondly, within each firm, interviews were made to several people involved in the development of electronic trading (e.g. IT, finance, purchasing, sales personnel), allowing the triangulation of the data. Thirdly, as electronic trading is a dyadic process, it was considered crucial to collect evidence from personnel in both firms involved. Fourthly, when conducting case studies, documents like reports were often gathered which were used to address interviewed bias.

6.4.4 - Data analysis and interpretation

6.4.4.1 - Problems with data analysis

Qualitative data focuses on 'words' deriving from the interviews and documentation obtained during the data collection phase of the research, and according to Yin (1994), one of the most difficult and least developed aspects of case studies is precisely the analysis of the data (Yin, 1994). The major problem is that data centred on 'words' is likely to be the subject of interpretation. As Miles and Huberman (1994:10) stress " *the apparent simplicity of qualitative 'data' masks a good deal of complexity, requiring plenty of care and self-awareness on the part of the researcher* ". Often, the lack of hard data leads to biased interpretations, e.g. interviewees own quantitative interpretation; what people say is not always what they do; the processing of information (e.g. writing-down the taped interviews) is influenced by the researchers treatment; etc. Although this problem may be partly addressed by the use of multiple sources of evidence, as discussed above, there is also considerable effort to be made in the data analysis phase if one aims to have objective results.

These problems of data analysis are important in this work because much of the data collected in the case studies can be considered 'soft'. Indeed, right from the initial pilot cases it became evident that it would be very difficult to collect 'hard' data about the various themes which this research was focusing on, particularly about the characteristics of the relationships, and the network in which they were involved. There are two main reasons for the lack of available 'hard' data. Firstly, many companies claim that they do not have specific measurements about the relationships with other firms. Secondly, when instigated to open the databases to the researcher's own analysis of the 'hard' data on the themes, access was basically denied as it was claimed that it was 'sensitive' information. Thus, the point to be made here is that data in the case studies was based on complex, rich, but 'soft' data which required extra efforts in the rigour of analysis and careful consideration about possible alternative interpretations.

6.4.4.2 - Analytic strategy: pattern-matching

The generic strategy of analysis in this work was based on the theoretical propositions, as suggested by Yin (1994). Thus, as the CONNET model and its propositions were the basis for the definition of objectives and design of the case studies, and therefore the data collection, they also guide the case study analysis. Propositions helped to focus on relevant data and organise the case study by identifying variables and allowing their measurement. The organisation allowed the application of the **pattern-matching logic**, which is a technique that " *compares an empirically based pattern with a predicted one (or with several alternative predictions)* " (Yin, 1994:106). Hence, the CONNET model has predicted the overall pattern of outcomes to the set of non-equivalent variables (related with relationship, individual firms, and network) in the situation where firms adopt electronic trading and its configuration, as well as the different outcomes for the situation of non electronic trading development (see Chapter 5), which is going to be compared with the obtained empirical results (see Chapters 6 and 7). The eventual pattern matching in both situations will give a literal and theoretical replication to the case studies.

6.5 - Summary

This chapter started by stressing that in this work a 'positivist' approach was adopted. It was argued the preference in this work for the case study strategy, deriving from the type of research question, the timing of events, and behaviour manipulation. It was advocated that in this work the aim is to achieve analytical generalisation rather than statistical generalisation. The traditional concerns about the lack of rigour of data collection and analysis were discussed. The research design was then presented and described. It was stressed that the unit of analysis, i.e. the case, is the incidence of electronic trading between two firms, and that a multiple case-study design was adopted. Literal and theoretical replication is the rationale behind the choice regarding multiple case studies. Due to difficulty of access to case studies, it was decided to test the model upon a range of construction and non-construction situations, which allows a broader generalisation of the CONNET model though not testing it in so much depth.

The necessity of a case study protocol in order to enhance the research reliability and the conduct of three pilot cases were also advocated as crucial for the purpose of refining the data collection plans. Interviews - semi-structured and structured, was the main data collection method chosen in this study, and that multiple sources of evidence were used for obtaining triangulation of data collection. A major point made was the 'soft' nature of the data collected. Finally, it was stressed that the strategy for data analysis and interpretation was pattern-matching, which compares the empirical data with the results predicted theoretically by the CONNET model.

CHAPTER 7

INTRA-CASE ANALYSIS

7.1 - Introduction

This chapter presents the results and conclusions from the intra-case analysis. For each of the ten case studies, a summary of the data collected is presented, along with the summary of the analysis and respective conclusions. Following this, the cross-case analysis is described in the next chapter.

7.2 - Presentation of case studies

7.2.1 - Generalities

This chapter presents a summary of the descriptions along with the analysis of each of the ten cases studies that ground and test the theoretical propositions. The description of the data collected is highly summarised, and in order to facilitate the understanding of the link with the theory and the pattern-matching, data is already processed, structured and organised around the variables identified by the CONNET model, and generally depicted in the tables. The analysis presented in the following sections highlight the major issues that were found to be relevant to the focus of the work, i.e. which factors have influenced the development of electronic trading between the firms and how.

7.2.2 - Summary of the case studies

Having described the rationale and framework behind the selection of the case studies in Chapter 6, it is important now to briefly highlight the main features of the case studies that will be described and analysed. These are depicted in Table 7.1. In designating the cases, the first firm listed is usually the leading firm, and the second the target firm. However, on the last two cases, there were no leading firms, though the supplier CAS can be considered as the firm with a higher interest in the subject.

Table 7.1 Generic features of case studies

Nr.	*Case (firms)*	*Industry*	*Type of firms*	*Size of firms*	*Electronic trading system*
1	AutoEuropa - SA1	Automotive (Portugal)	Auto assembler - subcontractor	Very large - Large	Two EDI - based systems
2	AutoEuropa - SA2	Automotive (Portugal)	Auto assembler - subcontractor	Very large - Large	EDI - based
3	Sonae - SS1	Retailing (Portugal)	Retailer - manufacturer/supplier	Very large - Medium	EDI
4	Sonae - SS2	Retailing (Portugal)	Retailer - supplier/distributor	Very large - Medium	EDI
5	Bovis - CB	Construction (UK)	Construction manager - consultant	Large - Medium	E-mail based project management information system
6	Bovis - SB	Construction (UK)	Construction manager - supplier/consultant	Large - Small	E-mail based project management information system
7	Blue Circle Cement - BBM	Construction (UK)	Supplier/manufacturer - builders merchant	Large - Large	EDI
8	Blue Circle Cement - BRM	Construction (UK)	Supplier/manufacturer - manufacturer	Large - Medium	EDI
9	CAS-LCEC	Construction (UK)	Supplier/manufacturer - civil engineering contractor	Large - Large	EDI pilot
10	CAS-LCC	Construction (UK)	Supplier/manufacturer - construction contractor	Large - Large	EDI pilot

The cases were not selected based on a 'representative' approach, rather they were selected based on their explanatory characteristics for the purposes discussed in the previous chapter, i.e. to cover as many factors and associations between factors as possible. Thus, the four non-construction cases, two in the automotive industry and two in the retailing industry, were selected because they are good cases to illustrate how specific factors determine the development of electronic trading, and not because they are typical examples of their industries. Similarly, the six cases involving construction firms can not be considered either representatives or typical examples of the development of electronic trading in their five classes of interactions (contract manager - consultant; contract manager - suppliers; builders merchants - supplier; manufacturer-supplier; contractor-supplier), they rather depict different good explanatory situations regarding the development of electronic trading involving construction firms and how different factors determined the adoption and configuration of the systems. The first eight cases are presented for the literal replication of the CONNET model regarding adoption, while the last two correspond to the theoretical replication cases, i.e. where there was no electronic trading but for theoretically predicted reasons. As far as sophistication is concerned, cases 1, 2, 3, 5, 6 and 8 are used for literal replication regarding sophistication while the remaining cases address theoretical replication. Cases 1, 3, 4, 7, 8, 9, 10 addressed the exchange of commercial and managerial information, and cases 5 and 6 addressed mainly technical information. Although there was an interest in studying the electronic exchange of bill of quantities, it was found that there were no firms engaged on that process.

Finally, two points should be made here. The first point addresses the partly anonymous characteristic of the cases. Apart from the two last cases where the total anonymity of the firms involved was demanded (maybe because of their failure to adopt electronic trading), in the remaining cases at least one of the firms is well identified (the anonymous are hidden behind acronyms/abbreviations). The reason behind the fact that one of the firms involved in the case should be kept anonymous emerged mainly from the procedure adopted by the researcher aiming to assure firms of their protection of the data collected and thus fostering a more free expression of interviewees' views. Thus, people from firms involved can easily identify themselves but it will be difficult for others to do the same.

The second point relates to the fact the same firm is used in two distinct case studies, and thus, in the ten case studies fifteen and not twenty different firms are involved. There are two main reasons for this. Primarily, the use of the same firm for two distinct cases, as discussed through the cross-case analysis, was used to reinforce the idea of the dyadic electronic trading as the adequate unit of analysis of the problem. The factors enabling or hindering the development of electronic trading systems and its configuration between firm A and firm B may be different from the factors determining electronic trading between firm A and C. Thus, case studies involving the same firm were selected considering the importance of contrasting different situations rather than obtaining 'statistical generalisation'. Secondly, the use of the same firm on different case studies has significantly contributed to improving the quality and depth of information collected, in the face of the desired number of case studies, based on the assumptions (described above) that this approach would not bias results regarding analytical generalisation. The cases studies were conducted during 1996 and early 1997.

7.3 - Analysis of case studies

7.3.1 - Case study 1: AutoEuropa-SA1

7.3.1.1 - Background

This case describes the adoption and development of electronic trading between AutoEuropa - a producer of Multi Purpose Vehicles - MPV (e.g. Ford Galaxy or Volkswagen Sharan), with an approximate annual turnover of £2.6 billion, and one of its subcontractors, SA1 - a Portuguese subsidiary of a large French industrial group. AutoEuropa is a joint venture between Ford and Volkswagen where each firm holds 50% of the interest in the company, and with the plant situated in Portugal. SA1 is an exclusive subcontractor to AutoEuropa with a plant installed in the industrial park, supplying bumpers, grilles, carpets, and other plastic parts.

AutoEuropa and SA1 work on an advanced lean production and zero inventory stock philosophy which is supported by IT-enabled complex programming, order management, forecasting, in-plant vehicle control systems and extensive use of electronic exchange of information. The set of technologies and systems is designated by 'In-Line Vehicle Sequencing - ILVS'.

7.3.1.2 - Configuration of the electronic trading system

Table 7.2 summarises the most important characteristics of the electronic trading systems in place between the two firms.

Table 7.2 Configuration of electronic trading systems between AutoEuropa and SA1

Systems	*Description*
System 1	
Technology	EDI based on dial-up connections to mailbox. Translation, communication and application software developed by Ford but can be used for other purposes with modifications.
Standards	ODETTE, and universal to automotive industry.
Information exchanged	'Releases' with forecasts of monthly product needs for next 6 months; 'daily call-in' which states the daily requirements on 12 days time scale; 'self-billing invoices' an invoice of the products supplied though issued by AutoEuropa for supplier confirmation.
Frequency	'Releases' and 'self-billing invoices' every month; 'daily call-in' issued daily.
Direction of flow	One-way only, from AutoEuropa to SA1.
Communication network	FORDNET, a private internal communication network of Ford.
Integration	Fully integrated and seamless flow from AutoEuropa; stand-alone PC for SA1.
System 2	
Technology	EDI-based on Unix client-server, continuous automatic connection to mailbox. Translation, communication and application software developed by Ford exclusively for ILVS.
Standards	ODETTE based but with proprietary characteristics.
Information exchanged	'call-in' with the sequenced product deliveries to shop-floor.
Frequency	Every 2 minutes.
Direction of flow	One-way only, from AutoEuropa to SA1.
Communication network	Optical-fibre communication network internal to AutoEuropa and industrial park.
Integration	Fully integrated and seamless flow from AutoEuropa, integrated with stand-alone shop-floor LAN on SA1.

Electronic trading systems implemented between AutoEuropa and SA1 are of a high degree of sophistication due the very high frequency and complex commercial and management information exchanges and technology used. Systems are considered 'best-in-class', in spite of not being fully integrated by one of the firms.

7.3.1.3 - Summary of the case

A summary of the data collected in the case study between AutoEuropa and SA1 is described in Tables 7.3; 7.4; and 7.5.

Table 7.3 Data regarding relationship between AutoEuropa and SA1

Variable	*Summary of data collected*
Information exchanged	There is a very intensive exchange of highly structured and complex information, especially from AutoEuropa to SA1. Call in is made regularly every 2 minutes, and information with supply needs are exchanged daily and monthly. Invoicing is sent monthly. 'Soft' information regarding processes is also widely exchanged.
Product, financial exchanges	SA1 delivers to AutoEuropa sequenced products every 90min. A complex set of products which overall can be produced in 3000 different combinations. A very intense financial exchange, £400 million/annum.
Closeness	Extremely high degree of closeness between the two firms. SA1 production systems are 100% committed to AutoEuropa and installed on its industrial park. AutoEuropa owns some of the tools of SA1, and has freely supplied part of the electronic trading systems. High levels of trust exist, as SA1 does not even verify self-billing invoices by AutoEuropa.
Co-operation	Companies have high-levels of co-operation with each other in order that both firms achieve their objectives. AutoEuropa is concerned about SA1 profitability and SA1 is concerned about future sales of MPV. Both firms have joint workshops in order to improve quality, reduce prices, redesign of the products, etc..
Power/dependence	SA1 produces exclusively for AutoEuropa, and is its sole subcontractor for that type of products. In spite of mutual interdependency, AutoEuropa is the clear leader in the relationship since it dictates the way of working, quality systems, logistics, etc.. Pressure is balanced with high co-operation.
Mutual expectations	Although recent, the relationship is characterised by stability and continuity. Mutual expectation of trading for a very long time, contractual agreement of 7 years.

Table 7.4 Data regarding internal features of AutoEuropa and SA1

Variable	*Summary of data collected*
AutoEuropa's business and IT strategy	Purchasing strategy to develop long-term, close and collaborative relationships with suppliers, but simultaneously being very demanding regarding continuous quality improvements, and price reduction. Suppliers on industrial park have to work based on 'In-Line Vehicle Sequencing' philosophy. The IS/IT strategy focus on full information storage and exchange done through IT, both internally and externally with suppliers and dealers.
AutoEuropa's IS/IT infrastructure	Full IT integration, based on PCs, mini-computers, mainframes, LANs, private WAN. Access to large IT department, specialised consultants and Ford's European central IT department. No paper exchange, unless extremely necessary. IT and electronic trading systems expenditure insignificant when compared with other investments.
AutoEuropa's organisational infrastructure and processes	World class lean production, logistics, and administrative infrastructure and processes, designed from clean sheet and aimed at supporting the ILVS philosophy, sequenced and fully automated. Electronic links is the enabler of the production, logistic, and administrative processes.
SA1's business and IT strategy	Develop trustful and co-operative relationships with customers, both at top and operational levels. Where possible install plant near assembler's plant. IS/IT strategy aims at achieving full information and IT integration internally, and also electronically exchanged with AutoEuropa, and suppliers.
SA1's IS/IT infrastructure	Currently working on implementing full internal integration, followed by the integration of AutoEuropa's information exchanges with internal systems. Very small IT department. Very low expenditure with electronic trading systems as AutoEuropa paid for most of the necessary investment so far.
SA1's organisational infrastructure and processes	Central administrative and essentially production and logistic processes and infrastructure designed to optimise ILVS. High levels of automation on the production line. Administrative processes are not current concern.

Table 7.5 Data regarding AutoEuropa's and SA1's production network

Variable	*Summary of data collected*
Input-output system	Mostly medium-sized highly technological firms some of which are involved in other production systems of Ford and Volkswagen. There are also some very large firms. Most already had an electronic trading capability and many had EDI with Ford or Volkswagen before. SA1 belongs to the main group of ten suppliers of the production system, which have similar electronic trading systems. SA1 parent firm is involved in other production systems of French assemblers.
Governance structure	AutoEuropa has considerable power and co-ordination leadership to impose ways of working, like electronic trading systems, JIT, ILVS, product quality, and prices to their suppliers, individually and as a whole. Decision making regarding internal functions of suppliers, especially those on industrial park, are much determined by AutoEuropa. Though SA1 parent group has considerable power over their suppliers, regarding Ford and Volkswagen they have little negotiation power.
Territoriality	A mix between geographical agglomeration and dispersion. Ten suppliers are installed in the industrial park next to AutoEuropa plant, whilst others are located across Europe in France, Germany, Spain, etc. SA1's parent firm activities are centred mainly in France.
Interconnections	AutoEuropa to Ford and Volkswagen, and SA1 with parent firm - group leader, which define in general the overall strategies and policies of the firms.

7.3.1.4 - Analysis of the case

The development of a sophisticated electronic trading system was fundamentally required for the intense, complex, highly structured and very frequent information exchanges from AutoEuropa to SA1 due to the ILVS approach and high frequency of product exchanges. Different types of information and frequency exchanges required two separate system configurations, one more sophisticated (system 2) and another more simple and traditional (system 1). AutoEuropa and SA1 recognise that without both electronic trading systems it would not be possible to have the ILVS production approach, though system 2 is clearly more crucial.

AutoEuropa has paid most of the costs of the development and implementation of the electronic trading system (software, communications network, implementation), and SA1 investment was minimal, related with hardware only (server, PCs, printers).

However, regarding this case the overall cost is insignificant for three main reasons. Firstly, AutoEuropa's investment was shared with the deployment of electronic trading systems with other suppliers. Secondly, compared with the investments that both firms had to make on buildings, equipment, tools, and other technological issues the costs of electronic trading systems are very insignificant. Thirdly, the overall electronic trading systems costs are not relevant when compared with the financial exchanges between the two firms.

AutoEuropa exert its power over SA1 by stressing that a pre-condition for trading was the implementation of the electronic trading system, though at the same time there was a co-operative attitude by freely installing the system and providing maintenance. SA1 was willing to adopt the electronic trading system and other of AutoEuropa's demands due to the long-term, financially intense and co-operative characteristics of the relationship. An example of the importance of the relationship is the fact that SA1 does not verify the self-invoicing from AutoEuropa, trusting their values. The adoption of electronic trading is in part the result of intentional purchasing and IT strategies from both firms which seek to develop close, long-term, co-operative relationships and fully automated and paper-less information flows. Although the former strategy has been fully implemented, the objectives of the later have only been partially achieved. While AutoEuropa has been able to implement production, logistic, and central administrative infrastructure and processes along with a fully externally and internally computerised, large, distributed and integrated IS/IT infrastructure, SA1 has not been able to integrate both parts of the electronic trading system with AutoEuropa with internal applications. The reasons are twofold. Firstly, while AutoEuropa processes require full IT integration without which they are not able to perform either on production, logistics, or administrative functions, SA1's processes would be more efficient with integration of information electronically exchanged with AutoEuropa. Other internal applications, can still operate without its full integration. Secondly, AutoEuropa' large internal IT department, its access to specialised IT consultants, and support of Ford's central European IT department meant that the IS/IT infrastructure was highly developed and ready to use from the first day of production, whereas SA1 IS/IT infrastructure has been slowly implemented, supported by an internal IT department of two people, which implied a prioritisation of objectives. External integration was not the first priority. The exception was the systems that are needed to receive information from AutoEuropa and which were mainly implemented by assembler's personnel.

AutoEuropa's electronic trading system with SA1 is similar to other suppliers. System 2 is the same for all suppliers based in the industrial park. The combination of the sophisticated and simple EDI system, which is the basis of the ILVS and JIT approach, was implemented due to AutoEuropa's hierarchical power and leadership to convince all ten industrial park suppliers to use these advanced systems and all other six hundred suppliers to use the basic EDI system. Without the adoption by all suppliers of those configuration, the electronic trading system between AutoEuropa and SA1 would not be the same. The necessity of achieving a full commitment from suppliers to electronic trading and the ILVS and JIT requirements of individual and overall system reliability and ability to cope with the demanding conditions of the information exchange episodes, led AutoEuropa to balance the 'pressure' over suppliers with a co-operative attitude by supplying the software, communications network, implementation of the system, and for maintenance support to suppliers on the industrial park.

The overall easy acceptance by the suppliers of electronic trading systems was also facilitated by the fact that most are medium-size technologically advanced firms, many of which had previously implemented simple EDI systems with Ford. It is important to stress that for most suppliers, the adaptations and investments required for electronic trading systems were insignificant when compared with changes and investments required for complying with ILVS and price, quality, and logistical demands.

Finally, the geographical distribution of suppliers was an important factor for the configuration of the system as those suppliers installed on the industrial park had to implement both the sophisticated and simple EDI systems (the choice of which suppliers would be in the industrial park was based on the type of product supplied). Moreover, the existence of a European-wide dispersed network of several hundred suppliers and the required tight co-ordination of the overall production system and information exchanges was one of the triggers for the necessity of a full automated system, and implied the use of Ford's European-wide communications network - FORDNET, in order to achieve reliable and non-expensive electronic trading.

7.3.1.5 - Conclusions

This case study demonstrates that although the main rationale behind the adoption of a sophisticated EDI-based electronic trading systems between the auto assembler and a subcontractor is the intense and frequent exchange episodes of management and commercial information to support the assembler's production and logistics processes, its development is also embedded in a relationship where there is large financial exchange and rich and complex interdependencies, supported by stability and continuity in the relationship. This implied that the investment for the sophisticated electronic trading system is minimal when compared with other mutual investments, especially for the subcontractor as it was AutoEuropa that fully supplied the system. Thus, the case demonstrates that the clear leadership of AutoEuropa determined the configuration of the systems though requiring mutual co-operative and collaborative attitudes. The case stresses that development of the sophisticated system was facilitated by AutoEuropa's IT capability and that certain configuration issues like integration with internal systems are much determined by the internal characteristics of the individual firms, like IT strategy and infrastructure. The development of electronic trading between the two firms is connected to the adoption by other firms. It was crucial that AutoEuropa's leading role was capable of imposing on suppliers an EDI system configuration. This was facilitated by the other firms' previous electronic trading experiences and expertise. Geographical dispersion compounded with demanding co-ordination and control mechanisms was an important enabling factor for AutoEuropa's strategy to convince suppliers to adopt electronic trading along with its overall configuration.

7.3.2 - Case study 2: AutoEuropa-SA2

7.3.2.1 - Background

This case describes the adoption and development of electronic trading between AutoEuropa - a producer of Multi Purpose Vehicles - MPV (e.g. Ford Galaxy and Volkswagen Sharan) with an approximate annual turnover of £2.6 billion, and one of its subcontractors, SA2 - a Portuguese batteries manufacturer with an annual turnover of

£80 million. AutoEuropa is a joint venture between Ford and Volkswagen where each firm holds a 50% of interest in the company, and with the plant situated in Palmela - Portugal. SA2 is the third largest European battery manufacturer with three plants European-wide, and is the sole battery supplier to AutoEuropa with a plant installed in Lisbon.

AutoEuropa and SA2 work on an Just-In-Time basis which is supported by IT-enabled complex programming, order management, forecasting and the use of electronic exchange of information. JIT between the two firms supports AutoEuropa's production philosophy of 'In-Line Vehicle Sequencing - ILVS' with industrial park suppliers.

7.3.2.2 - Configuration of the electronic trading system

Table 7.6 summarises the most important characteristics of the electronic trading system in place between the two firms.

Table 7.6 Configuration of electronic trading system between AutoEuropa and SA2

Systems	*Description*
Technology	EDI based on dial-up connections to mailbox. Translation, communication and application software developed by Ford but can be used for other purposes with major modifications.
Standards	ODETTE, and universal to the automotive industry.
Information exchanged	'Releases' with forecasts of monthly product needs for next 6 months; 'daily call-in' which states the daily requirements on 12 days time scale; 'self-billing invoices' an invoice of the products supplied though issued by AutoEuropa; 'advanced shipping notes' which states the type and quantities of the products sent daily to plant.
Frequency	'Releases' and 'self-billing invoices' every month; 'daily call-in' and 'advanced shipping notice' issued daily.
Direction of flow	Two-way, from AutoEuropa to SA2 are sent 'Releases', 'daily call-in' and 'self-billing invoices', and from SA2 'advanced shipping notes'.
Communication network	FORDNET, a private internal communication network of Ford.
Integration	Fully integrated and seamless flow from AutoEuropa; stand-alone PC for SA2.

The electronic trading system implemented between AutoEuropa and SA2 has a medium degree of sophistication since it allows exchange of four distinct types of information, two directions of flow, a high frequency but is only partly integrated. It is, however, similar to many sophisticated 'traditional' EDI systems.

7.3.2.3 - Summary of the case

A summary of the data collected in the case study between AutoEuropa and SA2 is described in Tables 7.7; 7.8; and 7.9.

Table 7.7 Data regarding relationship between AutoEuropa and SA2

Variable	*Summary of data collected*
Information exchanged	There is frequent exchange of highly structured information in both directions. A daily call-in is received by SA2 every morning with the required delivery for that day and very accurate forecast for the next 11 days. Advanced shipping notices are sent to AutoEuropa in the afternoon after supplies have been sent. Every month a forecast for the 6 months is sent. Invoicing is sent monthly. 'Soft', transparent information is also exchanged.
Product, financial exchanges	SA2 delivers batteries to AutoEuropa daily upon request (JIT basis). Little complexity of set of products. Medium intensity of financial exchange, £2.9 million/annum.
Closeness	SA2 production systems required major changes to supply to AutoEuropa due to demands in terms of product technical specification, quality, and JIT production and productivity requirements. These adaptations were partially financed by AutoEuropa which has also freely supplied part of the electronic trading systems - software and implementation.
Co-operation	Companies co-operate with each in order to improve product quality and for increasing levels of SA2 productivity, having joint workshops to discuss the issues. AutoEuropa is concerned about SA2 profitability but pays little more than production costs and SA2 is concerned about maintaining the relationship as it provides an excellent source of know-how and access to new markets.
Power/dependence	AutoEuropa is the major individual customer to SA2 and contributes considerably to its annual sales. Although SA2 is AutoEuropa's sole battery supplier, the assembler can easy shift to a competitor. Though there is interdependency, AutoEuropa is the clear leader in the relationship. Pressure is balanced with co-operation.
Mutual expectations	Although recent, relationship characterised by stability and continuity. Mutual expectation of trading for a long time, but there are annual contractual agreements.

Table 7.8 Data regarding internal features of AutoEuropa and SA2

Variable	*Summary of data collected*
AutoEuropa's business and IT strategy	Purchasing strategy to develop long-term, close and collaborative relationships with suppliers, but simultaneously being very demanding regarding continuous quality improvements, and price reduction. Suppliers outside industrial park have to work on a JIT basis. The IS/IT strategy focus on full information storage, and exchange done through IT, both internally and externally, with suppliers and dealers.
AutoEuropa's IS/IT infrastructure	Full IT integration, based on PCs, mini-computers, mainframes, LANs, private WAN. Access to both large IT department, specialised consultants and Ford's European central IT department. No paper exchange, unless extremely necessary. IT and electronic trading systems expenditure insignificant when compared with other investments.
AutoEuropa's organisational infrastructure and processes	World class lean production, logistics, and administrative infrastructure and processes, designed from clean sheet and aimed at supporting the ILVS philosophy, sequenced and fully automated. Electronic links are the enabler of the production, logistic, and administrative processes.
SA2's business and IT strategy	In order to evolve to a European-wide battery supplier SA2's business strategy is to obtain state-of-the-art know-how at all levels: production, administrative, commercial, logistical, etc. IS/IT strategy aims at implementing a totally new IS/IT infrastructure to achieve full integration internally. There is no formal strategy concerning electronic trading systems, though there is the intent to internally integrate AutoEuropa's electronic trading system.
SA2's IS/IT infrastructure	Current systems are old, all stand-alone, and a miscellany of distinct proprietary systems. Very small IT department (1 person) most necessities are contracted out. Very low expenditure with electronic trading systems as AutoEuropa paid for most of the necessary investment so far, had only to buy a PC and pay dial-up connections to mailbox.
SA2's organisational infrastructure and processes	New production processes were implemented in order to cope with JIT deliveries to AutoEuropa. Administrative and organisational processes requiring great improvements. Electronic trading systems did not require any significant changes in administrative processes, working on a stand alone basis, like a fax.

Table 7.9 Data regarding AutoEuropa's and SA2's production network

Variable	*Summary of data collected*
Input-output system	Mostly medium-size highly technological firms which are involved in other Ford and Volkswagen production systems. There are also some very large firms. Most already had a electronic trading capability. SA2 belongs to the ring of 600 hundred suppliers of AutoEuropa's production system outside the industrial park, all with similar EDI systems. SA2 is involved mainly with car parts retailers production systems both in Portugal and France, none with EDI.
Governance structure	AutoEuropa has considerable power and co-ordination leadership to impose ways of working, like electronic trading systems, JIT, ILVS, product quality, and prices to suppliers, individually and as a whole. Decision making regarding internal functions of suppliers are much determined by AutoEuropa though they tend to be limited on suppliers outside the industrial park. SA2 has little influence on the production systems in which they are involved.
Territoriality	A mix between geographical agglomeration and dispersion. Ten suppliers are installed in the industrial park next to AutoEuropa plant, whilst others are located across Europe in France, Germany, Spain, etc. SA2 business is mainly concentrated in Portugal and France.
Interconnections	AutoEuropa to Ford and Volkswagen which define in general the overall strategy and policies of AutoEuropa, and SA2 with a strategic partner that help technically.

7.3.2.4 - Analysis of the case

The relatively medium complexity, but highly structured and daily frequency of information exchange episodes between AutoEuropa and SA2 led to the development of a traditional EDI system. In spite of the electronic trading system supporting the JIT approach it is not crucial since the logistical system can be implemented by fax or phone, due to the relative simplicity of the information exchanged.

AutoEuropa paid for the development of the software and its implementation within both firms, though the costs for this specific relationship are minimal as the software was implemented in six hundred suppliers. SA2 investment in electronic trading systems consisted of the purchase of a PC, modem and the communications costs of accessing the mailbox (local call). Compared with the financial exchanges and investments in the production line, SA2 expenditure on the electronic trading system is insignificant. Along with important changes in product design, quality, price and JIT deliveries, electronic trading systems were a pre-condition for the development of the business relationship between AutoEuropa and SA2. However, these demands were accompanied by strong co-operation and a collaborative attitude by both firms, with AutoEuropa assisting financially, as well as a mutual expectation of a long-term relationship.

For AutoEuropa, the adoption of the electronic trading system is in part the result of the purchasing strategy which seeks to develop close, long-term, co-operative relationships and an IS/IT strategy that aims at full automation and paper-less information flows. Both strategies have been fully implemented by AutoEuropa which has been able to implement 'world-class' production, logistics and administrative infrastructure and processes along with fully externally and internally integrated IS/IT infrastructure, supported by a large internal IT department, specialised consultants and Ford's European central IT department. The integration of internal applications to electronic trading systems to suppliers like SA2 are fundamental for AutoEuropa to achieve lean administrative functions since without them it would require the allocation of dozens of employees just for sending faxes and phoning.

SA2 adoption of electronic trading resulted only from the pre-conditions set by AutoEuropa. Although the current IS/IT strategy defines the implementation of a whole new fully integrated IS/IT infrastructure to replace the old, stand alone, and miscellaneous proprietary systems, it does not identify the objective of electronic trading with either customers or suppliers. However, due to the perspective of long-term trading with AutoEuropa and its overall importance, there is the intent of integrating information exchanged electronically with AutoEuropa with the new internal system. Integration is not seen as crucial because the relatively low frequency and complexity of the information exchanged allows the manual processing by a unique person. Moreover, integration with existing systems would be technically very complex, if not impossible, and would not bring any tangible benefit.

The configuration of the electronic trading system between AutoEuropa and SA2 is similar to the system that links the former with six hundred other suppliers. AutoEuropa's capability to convince all suppliers to implement electronic trading systems enabled the ILVS and JIT approach and therefore triggered the implementation of the existing system with SA2. However, in order to achieve the full commitment from all suppliers to electronic trading, the requirements of information exchange episodes, and the need for reliability led AutoEuropa to balance the 'pressure' over suppliers with a co-operative attitude by supplying the software, communication network - FORDNET, and the implementation of the systems. Moreover, the fact that most suppliers (large-, medium-, and small-sized) are technologically advanced, have implemented EDI systems before with Ford or Volkswagen, and need to make major changes and investments to comply with AutoEuropa's production demands has facilitated the adoption of electronic trading systems.

Finally, the need for tight co-ordination and control mechanisms imposed by the ILVS and JIT approach due the geographically dispersed production system was one of the triggers to the development and implementation of sophisticated systems with all suppliers. This has also led to the use of the private European-wide communication network FORDNET.

7.3.2.5 - Conclusions

This case demonstrates that for the development of sophisticated but traditional EDI-based system for the exchange of management and commercial information between AutoEuropa and the supplier SS2, and when the benefits of the electronic trading system are only to the assembler (as the system is part of its overall IS/IT strategy and infrastructure with all suppliers which supports administrative, logistical and production processes), its adoption is much enabled by AutoEuropa's clear leadership in the relationship and its internal IT and administrative and functional infrastructure. The case highlights the fact that the investment in the electronic trading system was mainly made by AutoEuropa, which supplied software on a co-operative basis, established a communication network and implemented the whole system. The costs of doing this are insignificant in comparison with other IT and inter-firm investments. These are embedded in the overall close, co-operative, and envisaged long-term relationship between the two firms. The case illustrates that the integration of the EDI system with internal applications is much dependent on the IS/IT strategy and infrastructure of each firm.

The case also demonstrates the importance of the leadership of a co-ordinating firm in situations where the adoption of electronic trading systems between the two firms is partly interconnected with other firms. In this case, AutoEuropa's need for a co-ordination and control due the geographical dispersion of its suppliers' plants. The leadership role was facilitated by the other firms' previous electronic trading experience and know-how.

7.3.3 - Case study 3: Sonae-SS1

7.3.3.1 - Background

This case describes the adoption and development of electronic trading between Sonae - the largest retailer in Portugal - 10% of total retailing sales nation-wide with an approximate annual turnover of £1.2 billion and 106 supermarkets/hypermarkets, and one of its suppliers, SS1 - a Portuguese 'pasta', cookies and flour-based food manufacturer with an annual turnover of £16 million supplying mainly to Portuguese retailers.

7.3.3.2 - Configuration of the electronic trading system

Table 7.10 summarises the most important characteristics of the electronic trading system in place between the two firms.

Table 7.10 Configuration of electronic trading system between Sonae and SS1

Systems	*Description*
Technology	EDI based on dial-up connections to mailbox. Use of commercial translation and communication software developed by a third-party software house and consultant, which can be easily updated and used with other firms.
Standards	EDIFACT and Codipor (Portuguese EAN code provider).
Information exchanged	'Purchase orders' stating the products, quantities and warehouse to be delivered next day; 'acceptance of order' stating if it can deliver the requirements of the order and modifications; and 'invoices' sent after products have been delivered.
Frequency	'Purchase orders' issued twice per week on specific days and hours, 'acceptance of order' on the same day of receiving the orders, and 'invoices' twice per week after delivering each supply.
Direction of flow	Two-way, from Sonae to SS1 'Purchase orders' are sent, from SS1 to Sonae 'acceptance of order' and 'invoices'.
Communication network	GEIS - commercial communications network.
Integration	Fully integrated and seamless flow from Sonae to SS1 and vice-versa.

The electronic trading system implemented between Sonae and SS1 has a medium degree of sophistication as it allows exchange of three distinct types of information, two directions of flow, and is fully integrated, though it has a low frequency of exchanges.

7.3.3.3 - Summary of the case

A summary of the data collected in the case study between Sonae and SS1 is described in Tables 7.11; 7.12; and 7.13.

Table 7.11 Data regarding relationship between Sonae and SS1

Variable	*Summary of data collected*
Information exchanged	At least twice a week on specified days and hours Sonae sends purchase orders to SS1, though in emergencies purchase orders can happen any day by fax or phone. For every purchase order SS1 sends an acknowledgement of the order and the invoice after deliveries. Information exchanges are thus highly structured but very simple. Other less structured information exchange episodes do also occur through fax or phone. Some 'soft' information is also exchanged.
Product, financial exchanges	SS1 delivers products usually twice a week to warehouses. Little complexity of product exchanges. Compared with other suppliers, SS1 has medium financial exchanges with Sonae though for SS1 it is important for its annual turnover.
Closeness	SS1 made, through the duration of the relationship, some changes in the characteristics and price of the products, and in logistic and administrative processes to cope with some of Sonae's demands.
Co-operation	SS1 has always co-operated with Sonae's innovation initiatives like integrated logistics or EDI, in order to improve the interface of processes. Sonae recognises SS1 as one of the suppliers with which it is possible to test and implement innovation, and it is on the top of the list to implement the new logistic approach of Efficient Customer Response (ECR).
Power/dependence	SS1 is much more dependent on Sonae than vice-versa, but there is neither a high dependency nor a coercion power from Sonae regarding initiatives. However, SS1 recognises the importance of complying with Sonae's requirements to maintain good relations and because they are usually reasonable, and Sonae is reducing its supply base.
Mutual expectations	SS1 and Sonae maintain a 12 year relationship, initiated with the retailer's operations. There is the mutual expectation of continuity and above all of development of a closer and more co-operative relationship. Contract agreements are annually negotiated.

Table 7.12 Data regarding internal features of Sonae and SS1

Variable	*Summary of data collected*
Sonae's business and IT strategy	There is a current strategy of dramatically improving performance of interdependent processes with suppliers which will lead to several changes. Thus, there is the policy of centralisation of functions like ordering, inventory control, invoicing checking, negotiations, etc. The purchasing strategy focus is on two main aspects: reduce dramatically the number of suppliers (more than 50%) and develop closer relationships - like integrated logistics, EDI, ECR, etc. with the most important ones. IS/IT strategy focus on full information integration, internally and externally through EDI with all suppliers.
Sonae's IS/IT infrastructure	Mostly IT integrated between the various hypermarkets/supermarkets and central services. Fully integrated on central services based on IBM's AS400. Externally, some EDI systems and the remaining with EDIFAX. Large IT department with 50 people, 7 of which dealing only with EDI. Specialised IT consultants are also used. Expenditure on EDI represents 5% of total IT expenditure.
Sonae's organisational infrastructure and processes	Recently implemented an infrastructure with centralised functions like ordering, inventory control, invoice checking, negotiations, and central warehouses instead of the old decentralised, store-based management. The aim is to have higher control and transparency. Sonae acknowledge that its internal administrative and logistical processes have not yet reached 'world-class' standards.
SS1's business and IT strategy	Improve internal processes to cope with new challenges by clients; developing closer relationships with customers in general and with Sonae in particular. Purchasing strategy aims also to develop closer relationships with suppliers. The IT strategy is to have IT applications integrated, both internally and externally. Current focus is primarily to obtain EDI integration with customers, following EDI with suppliers.
SS1's IS/IT infrastructure	Information flows between internal functions of the firm are essentially automated, and are based on IBM AS400 and PCs. EDI systems only with Sonae though there is financial EDI with banks and suppliers. EDI like other IT systems are developed, implemented and maintained by IT consultant. EDI with Sonae represents small percentage of overall IT expenditure.
SS1's organisational infrastructure and processes	Major efforts in the last years in improving administrative infrastructure and interface processes like negotiation, sales, logistics, etc. in order to cope with current and future demands from customers. Existing infrastructure and processes are far from 'world-class' but are in the lead regarding similar Portuguese firms.

Table 7.13 Data regarding Sonae's and SS1's production network

Variable	*Summary of data collected*
Input-output system	Great heterogeneity among the 2200 suppliers of Sonae: few large-size and advanced technologically, some subsidiaries of multinationals, many medium-size and many others small-size with basic administrative infrastructures. Only 56 suppliers adhered to the EDI initiative, representing less than 10% of total exchanges, and very few had EDI experience before. SS1 deals with all 5 major retailers in Portugal and wholesalers, none of which have EDI.
Governance structure	Sonae has some strong leadership with part of the small- and medium-size suppliers over whom it has some coercion power. With most suppliers there is a leadership capability for implementing innovative logistic initiatives but essentially based on co-operation rather than pressure. Still, able only to convince 2% of suppliers to use EDI. SS1 has little influence on the production systems involved.
Territoriality	There is a geographical concentration within Portugal of firms involved in the production systems of Sonae and SS1.
Interconnections	Sonae and SS1 have a common IT consultant - AAA which has largely facilitated the development and partially determined the EDI configuration. Sonae has strong links with Codipor a Portuguese organisation for, amongst other things, defining standards and fostering EDI for Portuguese firms leading to the adoption of EDIFACT universal standards.

7.3.3.4 - Analysis of the case

Sonae and SS1 have chosen to adopt an EDI system to exchange highly structured and simple elements of information exchange episodes. The system is not, however, crucial for the interaction between the two firms as the administrative and logistical processes were similar before the EDI development. Moreover, the EDI system has not yet been able to totally emulate the old paper system as it does not work for emergency requests and deliveries, or exchange other structured information like remittance advice.

Each firm paid for the development and implementation of the EDI translation and communication software, the integration with internal applications, and communication network costs with the VAN. Although for Sonae the overall EDI initiative implied an investment that represents 5% of the total IT expenditure, the cost of the single link with SS1 was insignificant. For SS1, the twelve thousand pounds spent so far with EDI development are not considered too relevant especially as they regularly invest in innovation. Both firms stress that return on investment can only be achieved in the very long-term and if other firms also adopt EDI (suppliers and customers respectively).

As far as Sonae is concerned, the development of EDI with SS1 is part of the IS/IT strategy aiming to achieve full automation with suppliers. This strategy results from a threefold business strategy: *i*) dramatically improve interface processes with suppliers; *ii*) halve the number of suppliers and develop closer relationships with those remaining; *iii*) obtain better internal and external control and transparency of processes. These strategies and the development of EDI systems in general, were enabled by its recently improved organisational infrastructure and processes, where the main issue regarding electronic trading was the shift to centralised functional and administrative management, supported by an integrated IS/IT infrastructure with local stores and warehouses. Still, EDI with suppliers is mainly an initiative of Sonae's strong IT department, supported by an IT consultant - AAA, and is not yet seen as Sonae's initiative.

SS1's adoption of the electronic trading system with Sonae was enabled by three main factors. Firstly, a relationship in which SS1 has been eager to implement logistical and other innovations suggested by Sonae. Because it was amongst the first EDI implementations in Portugal, there were initial concerns about legal issues but the trust component of the relationship overcame these concerns. Secondly, the recent improvements in the administrative infrastructure and processes (integration of disparate activities, and seamless flow across sales, accounts and inventory functions) along with a strategy of fostering close relationships with customers in general and Sonae in particular. Thirdly, an IS/IT strategy of full internal and external paper-less information flows, which is supported by an internally integrated IS/IT infrastructure and a specialised IT consultant (same as Sonae). Thus, SS1's ready acceptance and implementation of an electronic trading system which allows automatic ordering, acceptance and invoicing through an integrated EDI system was possible mainly by the alignment of the firm's strategies and infrastructures with the system's requirements, and therefore, its implementation implied minor changes only.

The development of an EDI-based electronic trading system between Sonae and SS1 was partially triggered and facilitated by their common IT consultant - AAA. Sonae hired AAA's services and bought its EDI software to implement electronic trading systems with its suppliers (for AAA, Sonae was the first large-scale EDI customer). The need for a set of firms to make real tests on initial stages of implementation, led AAA to suggest SS1, since they were their main general IT consultant and were aware of their willingness towards electronic trading. Thus, the interconnections of the two firms with AAA along with the issues previously discussed before led to the development of one of the first EDI linkages in the retailing industry in Portugal. However, the linkage of Sonae with other suppliers implied changes in the configuration of the system shifting from a direct dial-up telecommunication link to the use of the services of a VAN.

Sonae decided to adopt universal EDIFACT and Codipor standards (standards based on EDIFACT and EAN codes specific to Portugal) with the objective of fostering as much as possible the adoption of EDI by its suppliers. Indeed, Sonae recognises that there is a great heterogeneity in terms of size, technology, IT and organisational infrastructures and processes on its 2200 suppliers, which hinders the large scale dissemination of EDI, and that many of these firms are likely to be pressurised by other customers to adopt EDI, and therefore by adopting universal standards they hope to be contributing to ease the suppliers' burden and facilitate dissemination. Moreover, leadership capability over suppliers by Sonae has been usually based on co-operation rather than coercion due to the lack of hierarchical power over many of the firms. The absence of a more pressuring attitude towards EDI, is related in part with the lack of commitment of the purchasing function who have not yet embrace the EDI potential, and thus EDI is still mainly an IT department initiative. This contributes to the low take-up by a larger number of suppliers (only 2%). Although there was no formal or informal definition of a critical number of users for individual EDI developments, the low success hinders the development of a more sophisticated systems with users like with SS1. Sophistication of systems is also hindered due to the reasonable fragmentation of the suppliers, since 56 EDI links represent less than 10% of total information exchanged and turnover with suppliers, which does not allow Sonae to concentrate development efforts.

As far as SS1 is concerned, there is the perception that in a foreseeable future other main customers will require EDI systems, which is desired by SS1, and therefore the choice regarding the EDI software (which accepts multi-versions of EDFICACT standards, and multi-networks) is likely to be the most adequate to cope with such a forthcoming situation.

7.3.3.5 - Conclusions

This case demonstrates the development of an EDI-based system on a retailer-supplier relationship where commercial and management information exchange episodes were neither complex nor very frequent and therefore where electronic trading brought little direct benefits *per se*. From the case emerges the very important role of the overall IS/IT strategy as well as the existence on an adequate administrative and IT infrastructure by both firms for the adoption of a medium sophistication configuration of electronic trading system, especially for a fully integrated system. The importance of the co-operative nature of the relationship and previous joint initiatives between the two firms to the adoption and development process is also highlighted.

The case demonstrates that the development of electronic trading systems between Sonae and SS1 was directly influenced by a third-party, in this case a common IT consultant that not only facilitated the adoption but also partially determined the configuration of the system. The case also shows that the adoption of electronic trading systems by other firms to both Sonae and SS1 is important to obtain tangible benefits, which influences the definition of the communication network as well as of the standards. Finally it is argued that with Sonae's loose co-ordinating role as the leading firm over the large and heterogeneous network of suppliers (partly resulting from the purchasing strategy), the rate of adoption by other firms has been very slow.

7.3.4 - Case study 4: Sonae-SS2

7.3.4.1 - Background

This case describes the adoption and development of electronic trading between Sonae - the largest retailer in Portugal - 10% of total retailing sales nation-wide with an approximate annual turnover of £1.2 billion and 106 supermarkets/hypermarkets, and one of its suppliers, SS2 - a Portuguese subsidiary of one of the largest US multinationals, selling cleaning and related products with an annual turnover of £19 million.

7.3.4.2 - Configuration of the electronic trading system

Table 7.14 summarises the most important characteristics of the electronic trading system in place between the two firms.

Table 7.14 Configuration of electronic trading system between Sonae and SS2

Systems	*Description*
Technology	EDI based on dial-up connections to mailbox. Sonae has a commercial EDI translation and communication software developed by a third-party software house and consultant. SS2 system was developed internally based on an application of another subsidiary of the parent firm.
Standards	EDIFACT and Codipor (Portuguese EAN code provider).
Information exchanged	'Purchase orders' stating the products, its quantities and warehouse to be delivered to next day; 'invoices' sent after products have been delivered.
Frequency	'Purchase orders' issued once per week on specific days and hours, and 'invoices' once per week after delivering each supply.
Direction of flow	Two-way, 'Purchase orders' are sent from Sonae to SS2, 'invoices' from SS2 to Sonae.
Communication network	GEIS - commercial communications network.
Integration	Sonae' systems are fully integrated; SS2 receives EDI messages on a stand alone PC and sends information through an integrated system.

The electronic trading system implemented between Sonae and SS2 can be considered as having a simple configuration, as it allows the exchange of only two distinct types of information, has a low frequency of exchanges, and works partly on a stand alone basis.

7.3.4.3 - Summary of the case

A summary of the data collected in the case study between Sonae and SS2 is described in Tables 7.15; 7.16; and 7.17.

Table 7.15 Data regarding relationship between Sonae and SS2

Variable	*Summary of data collected*
Information exchanged	Every Wednesday Sonae sends purchase orders to SS2, though in emergencies purchase orders can happen any day by fax or phone. For every purchase order SS2 sends by fax an acknowledgement of the order, and through EDI the invoice after deliveries. Information exchanges are thus highly structured but very simple. Other less structured information exchange episodes do also occur through fax. Some 'soft' information is exchanged though very rarely.
Product, financial exchanges	SS2 delivers products usually every Thursday to warehouses. Little complexity of product exchanges. Compared with other suppliers, SS2 has medium financial exchanges with Sonae though for SS2 it is important for its annual turnover.
Closeness	SS2 has made only few and small changes in logistic and administrative processes to cope with some of Sonae's demands.
Co-operation	SS2 has co-operated in some initiatives with Sonae in order to improve interface processes. SS2 stresses the importance of providing customer satisfaction.
Power/dependence	SS2 is much more dependent on Sonae than vice-versa. Sonae does sometimes try to exert buying power but there is neither a high dependency nor a coercion power from Sonae.
Mutual expectations	SS2 and Sonae maintain a 12 year relationship, initiated with the retailer's operations. There is the mutual expectation of continuity and above all of developing a more co-operative relationship with new future logistical initiatives. Annual contract agreements.

Table 7.16 Data regarding internal features of Sonae and SS2

Variable	*Summary of data collected*
Sonae's business and IT strategy	There is a current strategy of dramatically improving performance of interdependent processes with suppliers which lead to several changes. Thus, there is the policy of centralisation of functions like ordering, inventory control, invoicing checking, negotiations, etc. Purchasing strategy focus on two main aspects: reduce dramatically the number of suppliers (more than 50%) and develop closer relationships - like integrated logistics, EDI, ECR, etc. with the most important ones. IS/IT strategy focus on full information integration, internally and externally through EDI with all suppliers.
Sonae's IS/IT infrastructure	Mostly IT integrated between the various hypermarkets/supermarkets and central services. Fully integrated central services based on IBM's AS400. Externally, some EDI systems and the remaining with EDIFAX. Large IT department with 50 people, 7 of which deal only with EDI. Specialised IT consultants are also used. Expenditure with EDI represents 5% of total IT expenditure.
Sonae's organisational infrastructure and processes	Recently implemented an infrastructure with centralised functions like ordering, inventory control, invoice checking, negotiations, and central warehouses instead of the old decentralised, store-based management. The aim is to have higher control and transparency. Sonae acknowledge that its internal administrative and logistical processes have not reached 'world-class' standards.
SS2's business and IT strategy	Main strategic decisions are taken by European central management. The core strategy is to obtain maximum customer satisfaction, and be in the leading-edge regarding product, logistic, and administrative processes. IS/IT strategy is to have internal IT applications integrated. EDI with customers is not included in the priorities.
SS2's IS/IT infrastructure	Information flows between internal functions of the firm, and with other subsidiaries and the parent firm are mainly exchanged electronically, and are based on IBM AS400, workstations and leased lines. EDI systems only with Sonae. EDI like other IT systems are developed, implemented and maintained by the IT department with 7 people and supported by the expertise from other subsidiaries and parent firm. EDI with Sonae represents very small percentage of total IT expenditure.
SS2's organisational infrastructure and processes	Existing infrastructure and processes are far from 'world-class' but are considered very efficient. However, some changes in the order receivable, stock inventory and logistical processes are required for enabling fully integrated EDI.

Table 7.17 Data regarding Sonae's and SS2's production network

Variable	*Summary of data collected*
Input-output system	Great heterogeneity on the 2200 suppliers of Sonae: few are large-size and advanced technologically, some subsidiaries of multinationals, many others medium- and small-size with basic administrative infrastructures. Only 56 suppliers adhered to the EDI initiative, representing less than 10% of exchanges, and very few had EDI experience before. SS2 deals with retailers and wholesalers in Portugal but none has EDI, and has very few local suppliers as it receives products from plants in the UK and Holland.
Governance structure	Sonae has some strong leadership with part of the small- and medium-size suppliers over whom it has some coercion power. With most suppliers there is a leadership capability for implementing innovative logistic initiatives but essentially based on co-operation rather than pressure. Still able only to convince 2% of suppliers to adopt EDI. SS2 does not have any significant influence on the production system in which it is involved.
Territoriality	Sonae is geographical concentrated in Portugal. SS2 focus its operations on Portugal though as part of a multinational firm it is also geographically dispersed across Europe and US.
Interconnections	Sonae has a strong connection with an IT consultant - AAA which has influenced EDI configuration. Sonae and SS2 have links with Codipor a Portuguese organisation for defining standards and fostering EDI. Linkage between Sonae and SS1 has influenced SS2 to adopt EDI.

7.3.4.4 - Analysis of the case

The adopted EDI system between Sonae and SS2 partly emulates their highly structured but simple information exchange episodes. The current interaction processes between the two firms are, however, similar to the processes before the adoption. Electronic trading systems are considered neither critical nor very important for the relationship. Much of the structured information exchanges episodes are still paper-based, and exchanged through fax or phone.

Sonae's investment regarding the development of the electronic trading system with SS2 was minimal, since the expenditure with the EDI translation and communication software as well as the integration with internal applications and communication costs with the VAN are shared by its links with other suppliers - which anyway represented only 5% of total IT expenditure. Sonae stresses that return on investment can only be achieved in the long-term and when most of the other suppliers also adopt EDI.

For SS2 the investment with EDI was considered insignificant. However, it was recognised that the costs associated with the required changes in order receivable, stock inventory, and logistical processes and interface software between the EDI system and respective internal applications necessary for a fully integrated sophisticated EDI system would be quite significant. Because as far as SS2 is concerned the main benefit from EDI derives from better customer satisfaction (consequently the expectation of continuity and better trade), it was decided to adopt the simplest configuration and therefore the lowest cost possible that would respond to Sonae's requirements.

The development of EDI with SS2 is part of Sonae's IS/IT strategy aiming to achieve full automation with all suppliers. This strategy results from a threefold business strategy: *i*) dramatically improve interface processes with suppliers; *ii*) halve the number of suppliers and develop closer relationships with those remaining; *iii*) obtain better internal and external control and transparency of processes. These strategies and the development of EDI systems in general, were enabled by its recently improved organisational infrastructure and processes, where the main issue regarding electronic trading was the shift to centralised functional and administrative management, supported by an integrated IS/IT infrastructure. Still, EDI with suppliers is mainly an initiative of Sonae's strong IT department, supported by an IT consultant, lacking full commitment of the purchasing department. This implies that final configurations of the various electronic trading systems are different, mainly because they are much dependent on suppliers' strategies.

The adoption of the EDI system by SS2 was mainly enabled by two factors. Firstly, SS2's concern with achieving customer satisfaction, especially for important business relationships like the one with Sonae. Thus, customer's requirements are addressed as much as possible. Secondly, there was available, on the other subsidiaries of the parent firm, a large body of expertise in electronic trading in general and EDI in particular. This helped determine the configuration of the system and supported its implementation. However, current strategies and organisational infrastructure regarding processing of orders, stock inventory, and logistics are not aligned with the requirements of EDI systems (despite current internal IS/IT infrastructure being reasonably integrated and the existence of a qualified IT department), which hindered the development of a more sophisticated system configuration. These hindering conditions are reinforced by the fact that SS2's IS/IT strategy does not consider EDI with customers to be a priority.

The development of electronic trading between Sonae and SS2 was partially influenced by interconnections of those firms with Codipor - an organisation responsible for setting EDIFACT standards for Portugal and fostering dissemination of electronic trading, and of Sonae with another supplier, SS1, the linkage described in another case study in this work. Thus, the development of EDI between Sonae and SS2 was triggered by the participation of SS2 in a Codipor workshop to motivate the implementation of EDI and where the success case of electronic trading between Sonae and SS1 was described. Based on the description of their linkage and being aware of Sonae's interest in developing EDI with other suppliers, SS2 decided to respond positively and therefore adopt an EDI system with a minimal configuration that would cope with Sonae's requirements.

Codipor has also influenced the configuration of the EDI system as Sonae decided to adopt their EDIFACT-based standards and messages with the objective of fostering the adoption of EDI by its suppliers as much as possible. Indeed, Sonae recognises that there is a great heterogeneity in terms of size, technology, IT and organisational infrastructures and processes within its 2200 suppliers, which hinders the large scale dissemination of EDI, and that many of these firms are likely to be pressurised by other customers to adopt EDI, and therefore by adopting universal standards they hope to be contributing to ease suppliers' burden and facilitate dissemination. Moreover, leadership capability over suppliers by Sonae has been usually based on co-operation rather than coercion due to the lack of hierarchical power over many of the firms. The absence of a more pressuring attitude towards EDI, which is related in part with the lack of commitment of the purchasing function, who have not yet embrace the EDI potential, and thus EDI is still mainly an IT department initiative. This contributes to the low take-up by a larger number of suppliers (only 2%). Although, there was no formal or informal definition of a critical number of users for individual EDI developments, the low success level hinders the development of a more sophisticated systems with users like with SS2. Sophistication of systems is also hindered due to the reasonable fragmentation of the suppliers, since 56 EDI links represent less than 10% of total information exchanged and turnover with suppliers, which does not allow Sonae to concentrate development efforts.

For SS2, the adoption of EDIFACT and Codipor standards is not perceived as very advantageous. Although there are possibilities of developing EDI systems with other customers, SS2 is sceptical that they will adopt exactly the same standards and messages or communication network as Sonae, and therefore, changes to current EDI software will always be required. Nevertheless, SS2 recognises the potential advantage of the use of Codipor's standards and acknowledge Sonae's efforts to ease the suppliers' burden regarding the adoption of electronic trading.

7.3.4.5 - Conclusions

This case study analysed the development of a simple EDI system between a large retailer like Sonae and one of its suppliers, which is embedded in a relationship characterised by low complexity and frequency of commercial and management information exchanges, as well as low financial and simple product exchanges. The implementation of the electronic trading system does not bring any tangible benefit *per se* to either firm. The case demonstrates that for each firm the enabling factors that determine adoption and the configuration of the system are completely different. Thus, while on one hand the EDI system derived from Sonae's IS/IT strategy, supported by an adequate administrative, logistical and IT infrastructure that allowed full integration, on the other hand electronic trading is enabled by SS2's co-operative attitude towards the business relationship, while its IT and particularly administrative infrastructures hinder the development of a more sophisticated system - enabling it only to cope with customer's minimal requirements.

This case also demonstrates the importance that interconnected relationships and organisations have on the decision regarding the adoption and configuration of the electronic trading system, in this case how Codipor - an organisation responsible for defining standards, and a successful EDI relationship between Sonae and another supplier - SS1, has influenced SS2. Finally it is argued that the loose co-ordinating role of Sonae, partly a result of the lack of commitment from the purchasing department, over a large and heterogeneous network of suppliers implied the adoption of universal standards in order to foster the dissemination of electronic trading systems and therefore raise potential benefits.

7.3.5 - Case study 5: Bovis-CB

7.3.5.1 - Background

This case describes the development of electronic trading between Bovis - a large UK construction management services firm with £192 million of annual turnover with main activities centred in the UK but also with many projects running across Europe and world-wide; and CB - a medium-size UK building services consultant with £8 million of annual turnover, essentially established in the UK market on a nation-wide scale though it is also involved in some projects in Asia. The case focuses on an electronic trading system implemented as part of a project management information system on a very large (£350 million) out-of-London retail development - BWP, where Bovis is the appointed construction management firm and CB the building services consultant responsible for the design of the M&E, HVAC, fire, etc. services. The duration of the construction project is three years.

7.3.5.2 - Configuration of the electronic trading system

Table 7.18 summarises the most important characteristics of the electronic trading system in place between the two firms.

Table 7.18 Configuration of electronic trading system between Bovis and CB

Systems	*Description*
Technology	Hummingbird system - an e-mail based construction project management information system using client-server technology. Use of workstations, servers, Kilostream lines, Microsoft Mail and Office, AutoCAD, and other applications like browser, image entry and sign-off. CB accesses Bovis's central server of the project where information is published and downloads it to its own system. Electronic trading system developed by Bovis.
Standards	A proprietary system integrating several proprietary technologies like Microsoft, AutoCAD, and Rasterex products.
Information exchanged	The main components of the system allow formal exchange of drawings in the form of AutoCAD plot files, red line comments on the drawings, and sign-off of the drawings, which is dealt with by specific software. Other components of the system allow the exchange of CAD files, specifications, reports, general correspondence, architects instructions, request for information, submission records, all through pre-defined Office templates.
Frequency	Depending on the type of information, but usually several times per day information is down- and up-loaded. There is no regularity and specific frequency of exchanges.
Direction of flow	Two way, information is uploaded by the different consultants on Bovis's server, Bovis reviews it and sends an e-mail message to CB highlighting the existence of the information on the server. Then CB downloads information to its workstations, processes it, and uploads information again to the Bovis server.
Communication network	British Telecom Kilostream communications network.
Integration	Fully integrated though on a project stand-alone basis, i.e. information flows from Bovis project specific server equipped with whole range of software for managing a project (not integrated with Bovis internal system) to dedicated high spec workstations of CB for the project.

The electronic trading system deployed between Bovis and CB (along with other firms involved in the project) is a very sophisticated system, as it allows fully integrated two-way information exchange episodes of different types, i.e. technical, design, engineering with high complexity, little formal structure, two-ways and on a very high frequency. However, it is not a permanent IT infrastructure as it is deployed for the duration of the BWP project only.

7.3.5.3 - Summary of the case

A summary of the data collected in the case study between Bovis and CB is described in Tables 7.19; 7.20; 7.21.

Table 7.19 Data regarding relationship between Bovis and CB

Variable	*Summary of data collected*
Information exchanged	Very intense technical, engineering and design information exchanges between Bovis and CB, exchanged several times per day, and also very complex and with little formal structure. Most information is originally sent by the other consultants and client, though passing through Bovis for checking. Only information related with payments and 'soft' information is not exchanged electronically.
Product, financial exchanges	For Bovis, financial exchanges are only with the client and are very intense. CB services are not directly with Bovis, rather with the client, to whom they deliver building services designs. Also financial exchanges are with the client, and these are very significant, around 9 million pounds in three years. Thus, there are no direct product/service and financial exchange episodes between Bovis and CB.
Closeness	CB had to make some internal changes in order to be able to work with the system but these are only specific to the project. Relationship between Bovis and CB is characterised by personal closeness and trust but at project level. There is a close relationship between CB and P&O (the parent firm of Bovis) regarding serial shopping developments projects.
Co-operation	High degree of co-operation between Bovis and CB, at all levels. Common attitude of continuous improvement, challenging working practices, joint resolution of problems and decision-making regarding project operations. Highly co-operative attitude also in the adoption and development of the electronic trading system.
Power/dependence	No direct power/dependence relation as there are no direct financial or product exchanges between Bovis and CB in this or other projects. However, CB recognises the importance of co-operating with Bovis because they are a major player in the UK construction industry, they often work together. Also important is client's pressure over CB.
Mutual expectations	Interactions between CB and Bovis are always project-based and not direct. There are expectations of interacting together again on future different projects, especially with clients with serial projects.

Table 7.20 Data regarding internal features of Bovis and CB

Variable	*Summary of data collected*
Bovis's business and IT strategy	Business strategy focus on developing close partnerships especially with clients but also with consultants and suppliers. In each project the aim is to have continuous improvement, challenging working practices and joint decision-making. For projects over 50 million pounds there is the strategy of suggesting to the client and project team the use of the Hummingbird system. The IS/IT strategy is to replace all information storage and exchange on paper by similar processes but based on IT, both internally and externally. Also provide the client with the best support possible from leading-edge IT.
Bovis's IS/IT infrastructure	Heterogeneous IT platform but basically all integrated. All sites electronically linked with central offices to access most relevant information, and every employee connected to e-mail. For large projects use of the Hummingbird system which provides project and site managers with total autonomy. Large IT department (20 people) with large expertise in several areas of IT; links with IT consultants with whom there is joint R&D for leading-edge IT applications.
Bovis's organisational infrastructure and processes	In the recently implemented infrastructure, central offices provide the necessary support to project sites, which are very much autonomous regarding decision making. Central infrastructure make strategic choices while sites are fully responsible for operations. This infrastructure has been enabled by IT.
CB's business and IT strategy	The main business strategy is to become a large company and continue to get large projects. Also, make a especial effort to maintain current serial large clients like P&O, BT, Sainsbury as they are the basis of their turnover and have world-class requirements which pull CB to the leading-edge of building services. The IS/IT strategy is to maintain its advanced position regarding the use of IT, and gain expertise on electronic links, especially on Internet and Intranets.
CB's IS/IT infrastructure	90% of all information is processed by IT. IT platform is a compound of very high spec hardware and software, there is extensive use of e-mail between people in all levels in the firm and with on-going clients like Sainsbury, and there are ISDN links between regional offices and central services. Hummingbird system implied the acquisition of 6 workstations and accelerated the implementation of Microsoft-based products. There is a small central IT management but with very good IT expertise.
CB's organisational infrastructure and processes	Regional offices are much autonomous and there is a decentralised functional management. Production processes are perceived as very good, demonstrated by the fact that has a medium-size consultant they are able to cope with very large projects. Administrative processes are considered not important, unlikely to be world-class.

Table 7.21 Data regarding Bovis's and CB's production network

Variable	*Summary of data collected*
Input-output system	Great diversity in the type, size, and infrastructures of the firms involved on the BWP project and using the Hummingbird system. Core group of firms interacting through the whole duration of the project include the client, Bovis, CB and 9 other consultants. Suppliers raise the number of firms involved (though for variable periods of time) to about 200. Most firms are connected to the Hummingbird system. Bovis has 9 other projects running with the Hummingbird system, on one of which CB is also involved.
Governance structure	Client has a very hands-on approach on the BWP project, but with a strong co-operative attitude with Bovis and the leading architect. The three firms together form a clear leadership in co-ordinating the remaining consultants and suppliers, being able to influence the way firms operate, are organised, and innovate, though as much as possible on a co-operative basis, especially with the other consultants. As one of the consultants CB contributes to the decision-making in some issues, including the deployment of Hummingbird system on the project and its configuration.
Territoriality	There is a general concentration of firms around London, though some firms are geographically dispersed across UK. Hummingbird system allows consultants to be geographically dispersed across the UK, regardless of whether they are in Europe or elsewhere in the world.
Interconnections	Interaction between Bovis and CB is much influenced by other firms, especially by the client and the remaining consultants. Their influence was particularly evident regarding the development of the electronic trading system, along with individual influences from one IT consultant and BAA.

7.3.5.4 - Analysis of the case

The deployment of the Hummingbird system linking Bovis and CB was triggered by the large volume and high complexity of technical, design and engineering information exchange episodes between design team, client, and construction manager, and therefore, between Bovis and CB. Apart from 'soft' information, all information exchanges between Bovis and CB are through electronic trading systems. The Hummingbird system not only connects Bovis and CB but it is also the project management information system which electronically links most parties involved on the BWP project.

Bovis's investment regarding the development of the electronic trading system with CB was minimal. Indeed, the Hummingbird system has been developed over ten years with incremental changes. Bovis' investment, amounts to 25 man years and refers mainly to the costs of development and internal use, the former being partially paid through a joint R&D with another client and by its use on many other current projects. Thus, for the BWP project, Bovis' expenditure in using the system is minimal since the client paid the costs related to servers, implementation, training, and maintenance of the system; the consultants incurred costs related with network management, communications and license to use the software (inputted by one software house). The main direct benefits for Bovis are better information and process co-ordination and control, and indirectly an increase in commissioned projects due the excellent reputation of the system. Direct benefits in the BWP project itself relate with the raising of the performance of the project information management (in time, errors, etc.), which brings operational advantages such as better ability to cope with project changes and thus to obtain more flexibility; a high transparency for the design/construction processes which unifies the project team and considerable improvements in traditional adversarial relationships between the parties. These advantages directly benefit the client, leading to financial savings of £800,000 just due to reduced mail/delivery and reprographic costs, but also indirectly by a higher quality and faster construction.

Because Bovis has fully supplied the system and implemented it, for CB, the investment into an electronic trading system was of only £15,000 consisting of 6 high spec workstations, plus another £1,500 for software, and non-quantified costs for the use of a Kilostream line. Major costs also relate to the loss of productivity due to the learning curve of the use of the system and adaptations in the way of working. However, compared with the £9 million turnover for the project, the expenditure for the adoption of the Hummingbird system is considered insignificant. Moreover, the operational benefits brought by the system - e.g. dramatic improvements in information exchange quality (faster, error-free, transparency, etc.) and the possibility of a higher number of changes; and the emerging strategic benefits - e.g. the ability to cope with what is perceived as the future in design/construction processes, learning to work in a non-adversarial , co-operative, trustful way through electronic trading systems, surpassed the potential direct and indirect costs of implementing the system.

For Bovis, the deployment of the electronic trading system derived from its IS/IT strategy. This is that for projects over £50 million (for less the parties' investment may not be worthwhile), that are fast-track or when team members are geographically widely-dispersed, Bovis suggest to the client and design team the use of the Hummingbird system. This replaces the traditional paper-based project information storage and exchange by using IT, both for internal Bovis processes and externally with the client, consultants and suppliers. This strategy is aligned with a business strategy of providing the best service to the client, through developing and fostering close partnerships amongst project members which enable continuous improvements and challenging working practices. The implementation of these strategies are supported by: *i*) a decentralised management infrastructure providing project decision-making autonomy to site managers though supported by close interaction with central staff; and *ii*) an extensive and integrated IT infrastructure, supported by a strong IT culture, with available leading-edge expertise on a large and resourceful IT department that has to cope with providing initial implementation support and training to more than 200 firms using the Hummingbird system on BWP project, and external IT consultants with whom Bovis work closely. There is the idea to implement, in the future, permanent electronic trading systems with some clients and consultants, especially those who are recurrent in projects, through there are no plans to do the same with suppliers.

The adoption by CB of the Hummingbird system was directly enabled by three main factors. First, the client's pressure for all consultants to adopt the Hummingbird system suggested by Bovis, in spite of this there was no contractual obligation regarding this matter. Second, CB's business strategy of being in the leading-edge of building services firms and getting involved on large projects, which implies the ability to cope with innovative ways of working, especially co-operative environments. The generally very co-operative atmosphere with Bovis and the client, and in particular the implementation of the system dissipated any initial concerns about legal issues (which were never formalised). Third, the adoption of the Hummingbird system appeared at a time where CB's IS/IT strategy pointed towards the internal development of expertise regarding electronic links, like e-mail, Internet, Intranet, in order to keep its advanced position in terms of IT use. The implementation of the electronic trading system was facilitated by the fact that there was previous extensive IT use and expertise for processing internal information as well as some experience in using e-mail with other clients. Still, the Hummingbird system implied the allocation of 6 high specification workstations to work only to the BWP project and the acceleration of the planned shift to Microsoft applications, which was considered initially as a small hindrance to the development process.

The development of electronic trading systems between Bovis and CB was also directly determined by the interconnections of these firms with the client and the remaining consultants. Bovis' suggestion for the use of Hummingbird system on the BWP project (the system's first full scale implementation) was supported by the full commitment of the client, CB and the other consultants, but also from most of the 200 potential suppliers. The commitment requirement was problematic since there was a great diversity regarding their interactions and involvement in the project (product/service, information, financial, duration), as well as their size, internal infrastructures, IT capabilities, strategies, and therefore disparate attitudes towards the implementation of the system. This was even more problematic because when Bovis was appointed to the project as the construction manager, the architect and consultants were already working together, and thus Bovis had little or no hierarchical power over them. However, this situation was overcome by the client's approach, which from the beginning fostered innovation on the BWP project, especially concerning the use of world-class products, processes and thus IT and electronic links. The initial steps of the client and Bovis' efforts were convincing the leading architect to adopt the system, since there was no contractual obligation for this. Together, the three firms used a mix between power pressure (e.g. suggesting that in future projects only consultants able to cope with electronic trading systems would be likely to be selected) and strong co-operation (through e.g. jointly deciding on some aspects of the systems' configuration and its supply and implementation). Through these they were able to convince the remaining core design team members, including CB. Bovis assured client and consultants, that those suppliers suggested by them were very likely to adopt the system, and thus tendering documents for trade contractors stated the mandatory adoption of the Hummingbird system (more hierarchy less co-operation).

The configuration of the electronic trading system is also connected to Bovis's IT consultant - ITC, since many of the technical characteristics of the system are based on its software. This connection is especially relevant because the long-term and close relationship between the two firms led to the adoption of ITC software by CB and other consultants that demand much communication bandwidth for file exchange when compared with other similar commercial products. This implied use of Kilostream lines rather than ISDN and also entailed higher communication costs. Finally, it is important to stress that the current generic configuration of the Hummingbird system evolved from a prototype developed from a joint R&D program between Bovis and British Airports Authority - BAA, before the BWP project, having thus, an indirect influence on the adoption and configuration of electronic trading systems between Bovis and CB.

7.3.5.5 - Conclusions

This case demonstrates that for a greater intensity and frequency of core product and information exchange episodes between client, construction manager and consultants on large projects based on a construction management procurement system related to technical, design and engineering information, it is important that the development of an electronic trading system using an e-mail based technology, enables better exchange and processing. The case demonstrates that the implementation of the very sophisticated temporary system between construction manager - Bovis, and a consultant - CB, required the full commitment of the whole project team, and the leadership role of the client was crucial. This was balanced with a co-operative attitude from the construction manager and leading designer. The hierarchical but co-operative client approach was important to assure parties against a traditional adversarial atmosphere (thus overcoming implicit legal issues concerns). The case stresses that the leadership from the client becomes especially important because the system was developed between Bovis and CB, who do not have regular direct financial exchanges, and thus the necessary investment is only insignificant when compared with the direct financial exchanges of both firms with the client.

The case also demonstrates the importance for the development of the highly sophisticated electronic trading system of partnership, co-operation, transparency in strategies of the construction manager towards other project team members, a proactive attitude towards the use of IT and especially having an integrated IT system available which is supplied and easily deployed by all members of the project, requiring minimal investment from them. The development process is facilitated by Bovis supporting extensive IT infrastructure and expertise, and the implementation by CB of a co-operative and eager attitude and IT expertise. Finally, the case illustrates that indirect relationships with BAA and an IT consultant contributed to determine the adoption and configuration of electronic trading systems.

7.3.6 - Case study 6: Bovis-SB

7.3.6.1 - Background

The development of an electronic trading system between Bovis - a large UK construction management services firm, and SB - a small-size UK design and consulting engineers (civil and structural) firm is the focus of this case. Bovis has a £192 million annual turnover with core activities centred in the UK but also with several projects across Europe and world-wide, and SB has an annual turnover of only £250,000 and six employees, with its main activities in the UK but with two projects running in the Bermuda and the Middle-East. The electronic trading system is deployed on a very large - £350 million out-of-London retail development - BWP, where Bovis is the appointed construction manager, and SB was suggested by Bovis and selected by the client and design team to make design and detailing as a pre-cast cladding manufacturer for the project. The duration of the BWP project is three years and SB's involvement on the projects is about two years.

7.3.6.2 - Configuration of the electronic trading system

Table 7.22 summarises the most important characteristics of the electronic trading system in place between the two firms.

Table 7.22 Configuration of electronic trading system between Bovis and SB

Systems	*Description*
Technology	Hummingbird system - an e-mail based construction project management information system using client-server technology. Use of workstations, servers, ISDN lines, Microsoft Mail, AutoCAD, and other applications such as browser, image entry and sign-off. SB accesses Bovis's central server where information is published and download to its own system. The electronic trading system has been developed by Bovis.
Standards	A proprietary system integrating several proprietary technologies like Microsoft, AutoCAD, and Rasterex products.
Information exchanged	The main components of the system allow formal exchange of drawings in the form of AutoCAD plot files, red line comments on the drawings, and sign-off of the drawings which are dealt with by specific software. The Hummingbird system could allow the exchange of other information but this does not occur with SB.
Frequency	Depending of the type of information, but usually information is down- and up-loaded daily.
Direction of flow	Two way, information is uploaded by the different consultants on Bovis's server, Bovis reviews it and sends an e-mail message to SB highlighting the existence of the information on the server. SB downloads information to its networked workstations, processes it, and uploads information again to Bovis' server.
Communication network	British Telecom ISDN lines.
Integration	Fully integrated though on a project stand-alone basis, i.e. information flows from Bovis project specific server equipped with a whole range of software for managing a project (not fully integrated with Bovis internal system) to SB's dedicated networked workstations for the project.

The electronic trading system deployed between Bovis and SB (along with other firms involved in the project) is a very sophisticated system, as it allows technical, design, engineering information exchange episodes with high complexity, low structures, in two directions of a high frequency. Still, the configuration of the system deployed between the two firms is simpler than its potential, since Bovis has implemented the Hummingbird system with other firms on the same project exchanging a richer content of information. Moreover, it is not a permanent IT infrastructure as it is deployed for the duration of SB's participation on the BWP project.

7.3.6.3 - Summary of the case

A summary of the data collected in the case study between Bovis and CB is described in Tables 7.23; 7.24; 7.25.

Table 7.23 Data regarding relationship between Bovis and SB

Variable	*Summary of data collected*
Information exchanged	Intensive engineering and design information exchanges between Bovis and SB, exchanged daily, and also complex and with little structure. Most information is originally sent by the other consultants and manufacturer, passing through Bovis for checking. 90% of information exchanges are done electronically, only technical information like e.g. specifications or architect instructions or information related with payments and 'soft' information is not exchanged electronically.
Product, financial exchanges	Bovis has financial exchanges only with the client, and these are very intense. SB services are not directly with Bovis, rather with the client, to whom they deliver designs. Financial exchanges are with the client, and these are very significant for SB in the light of their annual turnover, around £190.000. Although there are no direct product/service and financial exchanges, it was Bovis who pre-selected and suggested the commissioning of the work to SB to the client and design team.
Closeness	SB had to make internal changes in their ways of working in order to be able to use the system but these are only specific to the project. The relationship between Bovis and SB is characterised by personal closeness and trust at project level, along with some non-project social and technical interaction, which emerged from the several projects where both firms are involved together. This does not affect Bovis' independence on pre-selection.
Co-operation	High degree of co-operation between Bovis and SB, at all levels. Common attitude of continuous improvement, challenging working practices, joint identification of problems regarding project operations. Co-operative attitude also in the adoption and development of the electronic trading system.
Power/dependence	Although there are no direct financial or product exchanges between Bovis and SB in this or other projects, Bovis is able to exert pressure and power over SB due to its role in suggesting its services to clients and design teams. Moreover, SB recognises the importance of co-operating with Bovis because they are a major player in the UK construction industry and they often work together on disparate projects.
Mutual expectations	Interactions between SB and Bovis are always project-based. There are expectations of interacting together again on future projects.

Table 7.24 Data regarding internal features of Bovis and SB

Variable	*Summary of data collected*
Bovis's business and IT strategy	Business strategy focus on developing close partnerships especially with clients but also with consultants and suppliers. Procurement strategy stresses having high flexibility to provide to the client the best supplier for the job. For each job a set of suppliers are selected based on rigid criteria to tender or negotiation. For projects over 50 million pounds there is the strategy of suggesting to the client and project team the use of the Hummingbird system. This can also be used by suppliers also. The IS/IT strategy is to replace all information storage and exchange on paper by similar processes but based on IT, both internally and externally. Current strategy does not foresee permanent IT infrastructure with suppliers, though there is a possibility with clients and consultants.
Bovis's IS/IT infrastructure	Heterogeneous IT platform but basically all integrated. All sites electronically linked with central offices to access most relevant information, and every employee connected to e-mail. For large projects use of the Hummingbird system which provides project and site managers with total autonomy. Large IT department (20 people) with large expertise in several areas of IT; links with IT consultants with whom there is joint R&D for leading-edge IT applications.
Bovis's organisational infrastructure and processes	In the recently implemented infrastructure, central offices provide the necessary support to project sites, which are very much autonomous regarding decision making, like e.g. supplier selection. Central infrastructure make strategic choices while sites are fully responsible for operations. This infrastructure has been enabled by IT.
SB's business and IT strategy	The main business strategy is to get large projects and be very specialised to compete based on differentiation. The IS/IT strategy is to slowly achieve internal IT integration and gain expertise on electronic links, especially using e-mail and the Internet.
SB's IS/IT infrastructure	Information flows are partly electronic and partly paper-based. All six employees have a PC which are all currently networked, internally, and through the Internet. The Hummingbird system required the acquisition of 1 workstation along with network and ISDN hardware and software. Managing IT is done informally by partners. Limited available IT expertise, especially concerning electronic trading systems.
SB's organisational infrastructure and processes	Management and organisation of the firm is done on an informal basis due to the very small number of employees and structure. Concern with the production processes and many administrative processes are done by a sole employee.

Table 7.25 Data regarding Bovis's and SB's production network

Variable	*Summary of data collected*
Input-output system	Great diversity in the type, size, and infrastructures of the firms involved on the BWP project and using the Hummingbird system. Core group of firms interacting through the whole duration of the project include the client, Bovis, and 10 consultants. Suppliers, like SB, trade contractors, manufacturers, etc. raise the number of firms involved (though for variable periods of time) to about 200. Most firms are connected to the Hummingbird system.
Governance structure	Client has a very hands-on approach on the BWP project, but with a strong co-operative attitude with Bovis and the leading architect. The three firms together form a clear leadership on co-ordinating the remaining consultants and suppliers, being able to influence the way firms operate, are organised, and innovate, though as much as possible in a co-operative basis, especially with the other consultants. SB has no role on decision-making on the project, although there is a general co-operative attitude with project team members. Implementation of the Hummingbird system and its configuration was imposed from the tender documents.
Territoriality	There is a general concentration of firms around London, though some firms are geographically dispersed. Hummingbird system allows consultants and suppliers to be geographically dispersed across the UK, Europe or the world,
Interconnections	Interaction between Bovis and SB is much influenced by other firms, especially by the client and the consultants. Their influence was particularly evident regarding the development of electronic trading system, along with individual influences from one IT consultant and BAA.

7.3.6.4 - Analysis of the case

The development of the electronic trading system between Bovis and SB was embedded in the deployment of the Hummingbird system on the BWP project, connecting client, Bovis, design team consultants and most suppliers (e.g. consultants like SB, trade contractors or manufacturers). SB participation on the BWP project derives from a pre-selection made by Bovis on its purchasing/procurement databases, where after tendering and negotiation (stating clearly the need to adopt the Hummingbird system), Bovis, the client and design consultants commissioned the work of SB. The linkage of SB to the system was considered compulsory due to the large volume and complex design and engineering information exchanges expected between SB, Bovis, the design team and manufacturer. About 90% of the overall information exchanges between Bovis and SB are made through the system.

For Bovis, the investment with the specific electronic trading system with SB was insignificant since it is embedded in the implementation of the Hummingbird system on the BWP project, where the client paid the costs related with servers, implementation, training and maintenance of the system, and suppliers paid the cost related with their hardware, software (e.g. the license of using a software inputted by a software house) and communication costs. The investment made by Bovis related to the development of the system itself, is considered as quite significant although it has been spread over a ten year time period and has been partially paid through a joint R&D project with another client. The Hummingbird system directly benefits Bovis by improving BWP's project information and process co-ordination and control, and indirectly by an increase in commissioned projects due the excellent reputation of the system. As far as the BWP project is concerned, the overall increase in the performance of the project information management (in time, errors, etc.) led to higher flexibility and thus enhanced the ability to cope with project changes. The system also provided a high design/construction process transparency which considerably improved traditional adversarial relationships between parties. Regardless of these advantages, the electronic trading system has directly benefited the client, leading to savings of £800,000 due to reduced mail/delivery and reprographic costs.

SB has invested about £3,000 in the implementation of the Hummingbird system (mainly on software and communications), which represents 60% of SB's overall direct investment for the BWP project. This investment was considered relevant considering the size of the firm, but well justified due to the £190,000 turnover from the BWP project. SB recognises that the Hummingbird system brought operational benefits to the firm through improving overall information exchanges, especially those related with elimination of paper, speed of exchanges, reduction of errors, and considerable reduction in reprographic costs. However, the system also had some problems concerning using a browser for drawings with comments as it is very time consuming (ISDN did not have the adequate bandwidth though it was recommended by Bovis), thus reducing potential benefits.

Grounded in the objective of developing close partnerships amongst project members and thus achieving process improvements and challenging working practices, Bovis IS/IT strategy stresses that for projects over 50 million pounds, fast track or when members are geographically dispersed, the client and design team should be advised to implement the Hummingbird system. The system enables the replacement of traditional paper-based project information storage and exchange by IT, both on Bovis internal processes and between the client, consultants and some suppliers. The implementation of the Hummingbird system is generally facilitated by: *i*) decentralised management infrastructure providing project decision-making autonomy to site managers though supported by close interaction with central staff; and *ii*) extensive and integrated IT infrastructure, supported by a strong IT culture, available leading-edge expertise on a large and resourceful IT department that has to cope with providing initial implementation support and training to more than 200 firms using the Hummingbird system on the BWP project, and external IT consultants with whom Bovis works closely. Regarding the adoption by suppliers, like SB, this is facilitated by a proactive purchasing strategy of providing site managers (who pre-select suppliers) with a careful analysis of suppliers' technical, technological, and management capabilities, as well a rigorous and up-to-date assessment of their performance on previous projects. For each project the site manager evaluates suppliers according to a pre-defined criteria and suggests a set of suppliers who are perceived as being competent for the job. Although there is the idea to implement permanent electronic trading systems in the future with some clients and consultants, especially those who are recurrent in projects, there are no plans to do the same with suppliers.

SB's adoption of the Hummingbird was pre-determined in the tender documents, where it was clearly stated that the selected firm would have to exchange information electronically, and specifying Hummingbird's requirements. The decision to tender and acceptance of the job was not taken without some initial concerns. Firstly, the implementation of the system would require the acquisition of software and hardware, and links with a communication network. SB was unaware of their likely total costs. Secondly, the disruption of the normal way of working that the Hummingbird system could introduce to a very small-sized organisation. Thirdly, the lack of internal IT expertise to set up and develop the system, despite the fact that SB had been previously involved on projects where e-mail and the Internet were used. These concerns were outweighted by the recognition of the importance of: *i*) the turnover derived from the BWP project as it would represent a large percentage of total turnover; *ii*) not 'disappointing' Bovis as they were pre-selected by them and thus needed to maintain the good relationship, as they are a very important customer and the majority of major construction projects that SB is involved in also involve Bovis. Moreover, the implementation of the system was largely done by Bovis's personnel which overcame any lack of expertise.

The development and configuration of the electronic trading system between Bovis and SB was also directly determined by the interconnections of these firms with the client and the design team, and indirectly by Bovis' links with an IT consultant and another client. Thus, the implementation of the Hummingbird system on the BWP project and therefore with SB was only possible after Bovis convinced the client to be fully committed to the use of the system. The client's approach of fostering innovation, use of world-class products, processes, IT and electronic links from the beginning of the project led to the choice of Bovis (and its Hummingbird system) as the construction manager. After having 'buy-in' from Bovis, the client had a crucial and very proactive role, using its hierarchical power but also with a co-operative attitude, in convincing the design team to be fully committed to the system. Bovis, the client and the ten consultants discussed and jointly decided, on a co-operative basis, which of the two hundred suppliers involved in the BWP project should implement the system, along with some issues related to the configuration of the system, e.g. levels of access, functionality, type of information exchanged, communication channels, etc.. Thus, as far as SB is concerned, there was the decision that they should implement the system, but restrict the level of access to the comments on the drawings and only to those that directly impact on SB's design.

The decision that suppliers should adopt the Hummingbird system was grounded in the assurances given by Bovis to the client and consultants that the firms on the database had been evaluated on their technical and technological capabilities and Bovis had the capability to convince suppliers to adopt and be fully committed to the system. However, there was a certain degree of risk in this assurance by Bovis, as there was no previous full scale experience and there was a great diversity regarding their interaction and involvement in the project (product/service, information, financial, duration) as well as their size, internal infrastructures, IT capabilities, and strategies.

The configuration of the electronic trading system connecting Bovis and SB is also connected to an IT consultant - ITC, since the long-term and close relationship between ITC and Bovis led to the adoption of a CAD plot file software produced by the former. This software demands too much communication bandwidth for file exchange, especially when compared with other similar commercial products, which on an ISDN line (recommended by the consultant and Bovis) makes the use of the system by SB very time consuming, disrupting their normal way of working.

Finally, the development of the electronic trading system between Bovis and SB is indirectly connected to the client British Airports Authority (BAA) because the current generic configuration of the Hummingbird system evolved from a successful prototype developed from a joint R&D program between Bovis and BAA, just before the BWP project.

7.3.6.5 - Conclusions

This case describes the development of an electronic trading system which is part of an e-mail based project management information system, which exchanges complex design and engineering information between a civil engineering consultant, a supplier on a large project, Bovis the construction manager, the client and other members of the design team. The case demonstrates that the implementation of Bovis's sophisticated system on the project, and particularly between Bovis and the supplier SB required the prior full commitment of the client, and then of the whole design team, where the client exerted a leadership role balanced with a co-operative attitude. The implementation of the Hummingbird system in general and with SB in particular was only possible due to Bovis' co-operative and transparent business attitudes, along with a proactive initiative towards the use of IT and its extensive IT infrastructure and expertise, which provided suppliers (and client and consultants) with the availability of an integrated IT system which firms have only to learn how to use.

The case also demonstrates that the initial concerns of SB towards the implementation of the system, due their internal IT and production infrastructures, were overcome by the importance of financial exchanges with the client, and also with the importance of maintaining the good relationship with Bovis, by not disappointing them. This may reflect Bovis's assurance that suppliers would respond positively to tenders, and therefore that it has a clear leading role over its suppliers. Finally, the case demonstrates that the client and design team have directly influenced the adoption and configuration of the system between Bovis and SB, and how the indirect relationship between Bovis, BAA and the IT consultant had also contributed to the development of the system.

7.3.7 - Case study 7: Blue Circle Cement - BBM

7.3.7.1 - Background

This case describes the recent development of an electronic trading system between Blue Circle Cement (BCC), the largest UK cement producer and distributor with an annual turnover of £300 million, and one of its customers, BBM a large UK builders merchant, with an annual turnover of £500 million.

7.3.7.2 - Configuration of the electronic trading system

Table 7.26 summarises the most important characteristics of the electronic trading system in place between the two firms.

Table 7.26 Configuration of electronic trading system between BCC and BBM

Systems	*Description*
Technology	EDI based on dial-up connections to mailbox. Both firms use commercial translation and communication software, but from different software houses. Both software have multi-standard capability and multi-network access via a VAN bridge.
Standards	The standard used for information exchange between the two firms is TRADACOMS (EDIFACT-based). Each firm has EDI with other firms using the same and other standards.
Information exchanged	'Invoices' is the only information exchanged between the two firms.
Frequency	Usually 6 times per month, though sometimes on a daily basis, depending on the volume of product exchange and invoice processing.
Direction of flow	One-way only, BCC sends 'invoices' to BBM.
Communication network	GEIS - Tradanet , a commercial communication network much used by the UK retailing industry.
Integration	Both firms have the EDI system fully integrated with their internal applications.

The electronic trading system developed between BCC and BBM can be considered as having a simple configuration as it exchanges one type of information, one-way only, has a medium/low frequency of exchanges, but is fully integrated.

7.3.7.3 - Summary of the case

A summary of the data collected in the case study between BCC and BBM is described in Tables 7.27; 7.28; and 7.29.

Table 7.27 Data regarding relationship between BCC and BBM

Variable	*Summary of data collected*
Information exchanged	There is an intense exchange of commercial information between the two firms, with purchase orders received often on a hourly basis, though it is variable, through phone or fax. Invoices are usually sent by BCC 6 times per month (though often on a daily basis) and are always exchanged through EDI without paper parallel systems. There is some exchange of 'soft' information concerned mainly with improvements to logistical processes. BBM represents 4% of the total issued invoice volume of BCC, while the latter represent about 1% of BBM's received invoices.
Product, financial exchanges	BCC delivers more than 100 daily cement supplies to the various BBM regional warehouses, representing 40% of BBM's cement supplies. Financial exchanges with BBM are about 3-4% of BCC total turnover. There are very high volume and stable product and financial exchanges between the two firms.
Closeness	There are close personal relationships between personnel of BCC and BBM, both at the senior level and at the operational level, including between IT departments. There are no specific changes to production or logistical processes in either of the firms, but there was a joint administrative information management initiative.
Co-operation	Both firms look to find win-win situations in their interactions, co-operation as much as possible with each other when problems arise.
Power/dependence	Although BCC represents a large percentage of BBM's total cement supply, this is seen as an easily accessible commodity that can be purchased anywhere else. BBM is considered a good individual customer but not too important. Thus, none of the firms is particularly dependent on the other, and there is no power pressure between either of the firms.
Mutual expectations	BCC and BBM have maintained a very long relationship over more than 10 years. There is mutual expectation of the continuity of the relationship and of the development of joint initiatives like improving EDI transactions and new inventory control.

Table 7.28 Data regarding internal features of BCC and BBM

Variable	*Summary of data collected*
BCC's business and IT strategy	The firm seeks to be at the leading-edge regarding production methods, management systems (like JIT, TQM, etc.) and the environment. The sales strategy focuses on developing closer relationships with main customers through formal and informal partnerships, and thus working together for joint improvements in quality, costs, inventory control, administrative issues (e.g. EDI), etc. IT strategy aims to achieve full internal IT integration, and full automation (ordering, invoicing, payments, etc.) through EDI with main customers.
BCC's IS/IT infrastructure	There is a high level of IT use and integration between the various functional applications, especially between the sales, distribution and accounts applications which allows the full automation of administrative interaction with customers (if desired). Commercial applications run on a central mainframe and office applications on networked PCs. Regional offices and local warehouses are electronically linked with a central office through leased lines and ISDN. Medium-size IT department (10 people) but highly skilled. When necessary hire of IT consultants. Expenditure with EDI considered minimal.
BCC's organisational infrastructure and processes	Functions are mostly decentralised to regional offices, like production, distribution, inventory control, engineering, and sales and contracts though these last two are centrally co-ordinated by account managers. Administrative processes are processed centrally through direct IT links with regional offices. Current organisation and process infrastructure have emerged from a redesign of the sales processes and supporting IT, bearing in consideration at the time the possibility of enabling EDI. Administrative processes are considered world-class but production and logistic processes have scope for improvement.
BBM's business and IT strategy	Focus of the business strategy is to have continuous improvements, and one of the elements of this policy is to develop closer and longer-term agreements with main customers, but also, though on a low priority, with main suppliers, like e.g. BCC. Current purchasing strategy stresses the developing with suppliers of a common information infrastructure, fostering win-win situations. IT strategy is to have full IT integration, with current focus on the implementation of EDI with suppliers and customers.
BBM's IS/IT infrastructure	Information processing and flow within and across functions is fully IT integrated and mostly automated. Commercial systems are based on Unix and office processing uses PCs and LANs, leased lines and ISDN. There is also extensive use of informal e-mail, and the Internet. Large central IT department, highly skilled and independent of IT consultants. Investment with EDI not relevant.
BBM's organisational infrastructure and processes	Functions like purchasing, inventory control, order processing, logistics, etc., and administrative functions are centralised at head office. Electronic links with regional offices and warehouses support centralised decision-making. Although processes are not considered world-class, there is a program of continuous improvement that is being implemented.

Table 7.29 Data regarding BCC's and BBM's production network

Variable	*Summary of data collected*
Input-output system	BCC has 40 main customers (which account for 90% of turnover) out of 2000. Most main customers are process and technologically advanced. EDI links with 12 customers, 2 of them with full administrative integration and automation (builders merchants). BBM has several thousand suppliers, some local others nation-wide. Medium heterogeneity in the characteristics of the suppliers. EDI systems with about 30 suppliers (all invoice exchange) and with 3 customers.
Governance structure	Despite BCC's 45% of market share, business is done through a co-operative attitude. BCC tries to have a leadership role with main customers by suggesting improvements and new approaches to them, but is often conditioned by customers reply. BBM has a certain degree of power over many of the suppliers, but it is unusual to lead to coercion or pressure other than is normal in negotiations. There is no particular pressure to implement management systems, like quality issues or even EDI, though it usually co-operates when the opportunity emerges.
Territoriality	There is a geographical concentration in the UK of BCC's and BBM's operations, customers and suppliers.
Interconnections	The participation of BCC in MERNET and especially in CITE has partially contributed to the EDI initiative in general. For BBM it was its participation on MERNET that facilitated the development of EDI in general.

7.3.7.4 - Analysis of the case

The recent development of the EDI system between BCC and BBM aims to replace the old paper-based invoice system, the fairly simple and highly structured components of the information exchanges episodes. The system is not considered crucial for the interaction between the two firms since the EDI system only partly automates the old mail system and there were no significant changes in the administrative, production, or logistical processes.

Each firm was responsible for the development and implementation of the EDI system and for its respective costs. For both firms, there was a smooth adoption of this specific EDI system, since the EDI translation and communication software, integration with internal system and communication network (VAN) were previously used by EDI systems with other firms. Thus, the costs to implement the single connection were insignificant, also due to data structures already being harmonised before EDI implementation. However, while BCC had to adapt the translation and communication software to the use of a different standard and bridge to a different network, BBM implementation had no special requirements. Although the aggregation of the EDI systems with other firms implied an important effort on time, personnel, and money to both BCC and BBM, it is considered minimal in comparison with the total expenditure with other internal IT issues. Regarding the legal aspects of the EDI system, they were never discussed, nor is there a special agreement, because problems have always been resolved through joint co-operative attitudes over the more than ten years of relationship.

BCC's aim for developing an EDI system is mainly to improve trading relationships with customers and reduce processing and communication costs, and thus, the individual EDI system with BBM contributes tangibly to this objective since they represent 3%-4% of the total turnover and about 4% of total volume of invoices. It is recognised that if the level of automation on this link was higher (as BCC wished), including purchase orders, delivery notes, remittance advice, the savings could be far greater. For BBM, the direct benefits of this link were minimal since BCC represents only 1% of total invoice processing volume, and the aim is to obtain operational efficiency and thus reduce costs. Benefits are perceived as being achieved only in the long-term and with the overall aggregation of main suppliers and customers. For both firms, the return on the investment for the EDI system is partly reassured by the expectations of future long-term trading derived from the past long-term duration of the relationship.

As far as BCC is concerned, the development of EDI with BBM is embedded in its generic strategy of seeking alignment with leading-edge technology and management systems like e.g. JIT or quality. This leads to a sales strategy of fostering closer relationships especially with the 40 main customers, like BBM, with whom there are long-term, intense information, product, and financial exchanges. Following this business objective, EDI with BBM derives from the IS/IT strategy of achieving full internal IT integration (basically accomplished) and external full automation with customers through EDI (ordering, invoicing, payments, etc.). This strategy, and particularly the EDI objectives, are enabled by the redesign of the processes and IT infrastructure related with sales, which occurred a few years ago. Thus, the integration between the sales, distribution, and accounts functions and IT applications, with the deployment of a central mainframe system, considered EDI and allows full automation with customers if desired. This automation is also possible because of redesigned processes between regional offices and local warehouses which became electronically linked with central applications. Thus, EDI automation with customers is facilitated by a current world-class IT and administrative infrastructure, supported by a small, highly skilled IT department, working together with the sales and accounting departments.

For BBM, the adoption of EDI with BCC derived mainly from the suggestion and insistence of the later. BBM's priority goes to developing closer relationships and EDI with customers, but the relative low success of such an initiative (only 3 customers with EDI) led to looking at improvements with suppliers also, especially those with over 100 transactions per day. EDI with suppliers, and therefore with BCC, has been facilitated by a previous improvement program that developed a common information management infrastructure and a formally stated protocol of win-win situations. However, the existing simple invoice system configuration results from the fact that EDI has been essentially an IT department initiative with the collaboration of the accounting department. Thus, due to the current level of information and financial exchanges, the stable and continuous institutional relations, and the good personal relationships between people from the IT departments of both firms, BCC had suggested the development of a full automated trading cycle and therefore a very sophisticated EDI system, similar to systems that BCC has with other firms. However, this was hindered by the lack of proactive support by BBM's purchasing department which has refused the implementation of an EDI system on the grounds that there are many exceptional situations to be dealt with automatically. This implied that BBM developed simple invoice based EDI systems with BCC and its other suppliers. Moreover, BBM's full automation could be enabled by current centralised and fully IT integrated administrative functions and processing, and its implementation supported by its large central IT department.

The development of the electronic trading system between BCC and BBM was indirectly influenced by the interconnections of these firms with CITE and MERNET.

Thus, the participation of BCC on CITE, has triggered and supported the firm's initial EDI initiatives since 1992, and also to choose CITE EDI standards. More recently, BCC has also adhered to MERNET - an EDI initiative of the Builders Merchants Federation (BMF), which enabled the EDI link with BBM. Indeed, BBM's participation in MERNET has supported its EDI strategy and contributed to a shift in focus from the low success EDI initiative with customers to the largely available EDI willing suppliers. It was the participation of both firms on MERNET (BBM is not involved in CITE) that fostered the development of the EDI system and defined the TRADACOMS EDI standards and GEIS Tradanet VAN (mainly because these were the standards and network that most retailing users adopted and thus were recommended by MERNET). Although BCC would have preferred to adopt CITE standards and the Harbinger network since most of its other customers used them, this was not a major issue in itself as its EDI translation software has multi-standard and multi-communication network capability. Moreover, initial MERNET-agreed standards were only about invoice exchange, which reinforced the BBM position of deploying an invoice system configuration, despite other standards that were available from CITE.

BCC did not constrain the development of individual EDI systems to the reaching of a critical mass of users. Indeed, each EDI system with a customer is, in that sense, independent from others. Still, initial studies demonstrated to BCC the existence of potential EDI interested customers. Currently, BCC has EDI systems with 12 customers (6 builders merchants and 6 ready-mix and product manufactures), which account for 50% of total invoice volume exchange and turnover. With two of the builders merchants, BCC has implemented a fully automated system. EDI systems with customers derive essentially from BCC leadership and suggestion, and are grounded in the long-term co-operative relationships, in which the link with BBM is a typical example. In spite of having a 45% market share, BCC does not try to use any supplier power to pressure customers. Co-operation is the main governance mechanism in most relationships. Even if BCC desired to pressure customers, it would be very difficult as cement supply is mainly a commodity and thus customers can easily change to a competitor.

BBM has adopted the EDI system with BCC regardless of its adoption by other suppliers. Still, there was the perception that many suppliers were willing to develop EDI with BBM, and therefore it is not necessary to exert any pressure on suppliers. Currently 30 suppliers have or are adopting EDI systems, which corresponds to 35% of total invoice exchange. Moreover, the degree of power that BBM has over many suppliers is rarely used, and it is unusual for any form of pressure or coercion to be exercised over them. BBM does not usually have a role of leadership in the implementation of inter-firm management systems, like e.g. quality, logistical or EDI issues, though it co-operates and collaborates when the opportunities emerge.

7.3.7.5 - Conclusions

This case demonstrates that the adoption and configuration of the simple EDI system, exchanging electronically only a small part of the intense structured information exchange episodes between BCC and BBM, resulted mainly from a misalignment between the BCC's IT and sales strategy and BBM's IT department willingness, and BBM's purchasing strategy and procedures. Thus, in spite of intense information, product and financial exchange episodes, a long-term and co-operative relationship, and full internal IT integration and central administrative infrastructure in both firms that enable full automation of structured information exchanges, BBM's purchasing department strategy and procedures hindered its implementation.

The case also demonstrates the importance for EDI adoption and configuration between the two firms of their indirectly connected links with third-party organisations that foster EDI dissemination and definition of standards, CITE and MERNET. These organisations not only triggered the development of EDI initiatives but have also provided the standards, and suggested the VAN and software to be used.

7.3.8 - Case study 8: Blue Circle Cement - BRM

7.3.8.1 - Background

This case describes the recent development of an electronic trading system between Blue Circle Cement (BCC), the largest UK cement producer and distributor with an annual turnover of 300 million pounds and one of its customers, BRM, a medium/large size UK aggregates and ready mix concrete manufacturer, with an annual turnover of 80 million pounds.

7.3.8.2 - Configuration of the electronic trading system

Table 7.30 summarises the most important characteristics of the electronic trading system in place between the two firms.

Table 7.30 Configuration of electronic trading system between BCC and BRM

Systems	*Description*
Technology	EDI based on dial-up connections to mailbox. Both firms use the commercial translation and communication software, though BCC's has multi-standard capability and multi-network access via VAN bridge, and BRM's does not.
Standards	The standard used for information exchange between the two firms is a subset defined by CITE of EDIFACT 92.1. BCC has EDI with other firms using the same and other standards, though BRM always uses the same standards.
Information exchanged	'Invoices' sent after products have been delivered, and 'credit notes' sent stating that payment has been made.
Frequency	Usually invoices are exchanged twice a week, though rarely on daily basis, depending on the volume of product exchange and invoice processing. Credit notes are normally exchanged once per month.
Direction of flow	Two way, BCC sends 'invoices' and receives 'credit notes' from BRM.
Communication network	Both firms use Harbinger, a commercial communication network much used by the firms in the CITE initiative.
Integration	Both firms have fully integrated the EDI system with their internal applications.

The electronic trading system developed between BCC and BRM can be considered as having a relatively sophisticated configuration as it exchanges two types of information, two-way, has a medium/low frequency of exchange, and is fully integrated.

7.3.8.3 - Summary of the case

A summary of the data collected in the case study between BCC and BRM is described in Tables 7.31; 7.32; and 7.33.

Table 7.31 Data regarding relationship between BCC and BRM

Variable	*Summary of data collected*
Information exchanged	There is an intense exchange of commercial information between the two firms, with purchase orders sometimes received more than once per day, through phone or fax. Invoices are sent by BCC usually twice per week and are always exchanged through EDI without parallel paper systems. Credit notes are usually sent once per month. These two types represent 30% of information exchanges between the two firms. Little exchange of 'soft' information concerned mainly with joint identification and resolution of problems. BRM represents 1% of the total issued invoice volume of BCC, while the latter represent about 2% of BRM's received invoices and credit notes.
Product, financial exchanges	BCC delivers daily cement supplies to BRM's plants, representing 40% of its cement supplies, and 5% of total supplies. Financial exchange with BRM is about 1% of BCC total turnover. High volume, predictable and stable product and financial exchanges between the two firms.
Closeness	There are good personal relationships between personnel of BCC and BRM, mainly at the operational level, including between IT departments. There are no specific changes to production or logistical processes in either of the firms.
Co-operation	Both firms look for joint resolution of problems; co-operation with each other when problems arise as much as possible. BCC co-operates with BRM in order to achieve continuous decreases on price, and particular specifications of product.
Power/dependence	Although BCC represents a large percentage of BRM's cement supply, this is seen as an easily accessible commodity that can be purchased anywhere else. BRM is considered as a good individual customer. Neither of the firms is highly dependent on the other, and there is no power pressure from either of the firms.
Mutual expectations	BCC and BRM have maintained a long-term relationship over more than 15 years. There is mutual expectation of the continuity of the relationship and of the development of joint initiatives like improving EDI transactions.

Table 7.32 Data regarding internal features of BCC and BRM

Variable	*Summary of data collected*
BCC's business and IT strategy	The firm seeks to be at the leading-edge regarding production methods, management systems (like JIT, TQM, etc.) and the environment. The sales strategy focuses on developing closer relationships with main customers through formal and informal partnerships, and thus working together for joint improvements in quality, costs, inventory control, administrative issues (e.g. EDI), etc. IT strategy aims to achieve full internal IT integration, and full automation (ordering, invoicing, payments, etc.) through EDI with main customers.
BCC's IS/IT infrastructure	High level of IT use and integration between the various functional applications, especially between the sales, distribution and accounts applications which allows the full automation of administrative interaction with customers (if desired). Commercial applications running on central mainframe and office applications on networked PCs. Regional offices and local warehouses electronically linked with central office through leased lines and ISDN. Medium-size IT department (10 people) but highly skilled. When necessary hire of IT consultants. Expenditure with EDI considered minimal.
BCC's organisational infrastructure and processes	Functions are mostly decentralised to regional offices, like production, distribution, inventory control, engineering, and sales and contracts though these last two are centrally co-ordinated by account managers. Administrative processes are processed centrally through direct IT links with regional offices. Current organisation and process infrastructure has emerged from a redesign of the sales processes and supporting IT, bearing in consideration at the time the possibility of enabling EDI. Administrative processes are considered world-class but production and logistic processes have scope for improvement.
BRM's business and IT strategy	Focus of the business strategy is the improvement of interface processes with suppliers and customers. This implies developing more co-operation with interacting parties. Current purchasing strategy stresses developing conditions with suppliers to obtain continuous decrease of prices, and having a better control and transparency of activities. IT strategy is to reach a higher level of IT internal integration across functions and plants, and also focus on the implementation of EDI firstly with suppliers and, if possible, with customers.
BRM's IS/IT infrastructure	Information processing is mainly done through IT applications but flows within and across functions are only partly IT integrated and automated. Accounting, sales and purchase applications are mainframe based while office processing use PCs and LANs. Leased lines and ISDN between some plants and central office. Large central IT department, 25 people, highly skilled and independent of IT consultants. Investment with EDI not relevant individually, but overall are a cost to bear in consideration due to the tight budget.
BRM's organisational infrastructure and processes	Functions like sales, inventory control, logistics, etc., and most administrative functions are centralised in head office. However, purchasing and ordering are partly decentralised to local offices and plants. Electronic links with local offices and plants give a support to centralised decision-making but there are important gaps. Administrative processes are not considered streamlined, requiring some major changes to achieve desired performance. Production and logistical processes are also not leading-edge.

Table 7.33 Data regarding BCC's and BRM's production network

Variable	*Summary of data collected*
Input-output system	BCC has 40 main customers (which account for 90% of turnover) out of 2000. Most of main customers are process and technologically advanced. EDI links with 12 customers, 2 of them with full administrative integration and automation (builders merchants). BRM has 9000 suppliers, some local others nation-wide. Medium heterogeneity on the characteristics of the suppliers. EDI systems with 5 suppliers (invoice exchange), representing 20% of supplies and 10% of information exchanges.
Governance structure	Despite BCC's 45% of market share, business is done through co-operative attitude. BCC tries to have with main customers a leadership role by suggesting them improvements and new approaches, but is often conditioned by customers reply. BRM has a certain degree of power over many of the suppliers, but there is only pressure regarding price. There is no particular pressure to implement management systems, like quality issues or even EDI, though it fosters and co-operates to the implementation.
Territoriality	There is a geographical concentration on UK of BCC's operations, and on Midlands and East Anglia on BRM's operations.
Interconnections	The participation of BCC in EDICON and especially BCC and BRM involvement on CITE has partially contributed to the EDI initiative in general, and to standards, software and VAN choice.

7.3.8.4 - Analysis of the case

The development of an EDI system aims to automate the structured paper-based and commercial components of information exchanges between BCC and BRM. The current simple configuration allows the exchange of about 30% of that type of information exchange, though it is recognised that there is clear scope for further automation, particularly at the ordering process. However, the automated system are not considered to be very important for the interaction between the two firms, since there were no major changes in the administrative, production or logistical processes related with the EDI system.

Each firm was responsible for the development and implementation of the EDI system components, and paid the respective costs. For BCC the implementation of the system with BRM corresponded only to 2 man week of effort, due the previous reasonable EDI experience and the fact that EDI translation and communication software, integration with internal systems and VAN were previously used by EDI systems with other customers, and thus it was it was perceived as insignificant. For BRM, the EDI system with BCC was the first to be implemented, which implied a great resource effort (time, personnel) and considerable expenditure, especially concerning the integration with internal systems, bearing in consideration the tight IT budget. However, this effort and expenditure has facilitated the deployment of EDI systems with other firms. Although the expenditure with EDI was not considered too important when compared with other IT investments, the lack of tangible return made it a risky investment, particularly because there was no assurance that other firms would also adopt this system. Legal aspects were never an issue due to the traditionally co-operative way of resolving problems between the two firms over the more than fifteen years of their relationship.

Developing EDI with customers like BRM is perceived by BCC as a way to improve trading relationships, but also contributes to reduce information processing and communication costs. In that sense, BCC's EDI system with BRM is seen of medium importance since the invoice and credit notice exchanges between the two firms represent about 1% of total volume and of total financial exchanges. As the return on the investment is perceived as happening only in the long run, the duration of the relationship of fifteen years provides the grounds to expect that it is worthwhile to invest in this EDI system. It is believed that truly important savings could be achieved if the level of automation is raised with e.g. purchase orders and orders acknowledgement, as BCC wished for. For BRM, since information and financial volume with BCC corresponds to 2% of total volume with suppliers, the main objectives of the implementation of the EDI system are operational, such as elimination of paper work, elimination of errors and labour savings, but also strategic in improving a trading relationship through higher transparency. In that sense, the past long-term duration of the relationship reassures the worthiness of the investment.

BCC's generic strategy of seeking alignment with leading-edge technology and management systems like e.g. JIT or quality, was the main trigger to the development of EDI with BRM. This leads to a sales strategy of fostering closer relationships especially with their 40 main customers, like BRM, with whom there are long-term, intense information, product, and financial exchanges. Aligned with this business objective, EDI with BRM derives from an IS/IT strategy that aims to go beyond the accomplished full internal IT integration, and extend integration to customers through EDI systems (ordering, invoicing, payments, etc.). This strategy, and particularly the EDI objectives, are enabled by the redesign of the processes and IT infrastructure which occurred a few years ago and which focused on sales activities. Thus, the integration between the sales, distribution, and accounts functions and respective IT applications, along with the deployment of a central mainframe system, had EDI requirements and allowed full automation with customers if desired. This automation is also possible because in the redesign process, regional offices and local warehouses became electronically linked with central applications. Thus, EDI automation with customers is facilitated by a current world-class IT and administrative infrastructure, supported by a highly skilled medium-size IT department, working together with the sales and accounting departments.

Although BRM's IT strategy defined the interest of developing EDI systems with customers and with suppliers, this was not put into action until the suggestion and insistence came from BCC. People from the IT department were interested and willing to develop a more sophisticated EDI configuration, that eventually permitted the automation of the whole trading cycle, as people from BCC desired due to the importance of the exchange episodes, but there were two main hindrances. Firstly, BRM top management considered that the resources and expenditure needed were too large for the actual capabilities of the firm, especially taking into consideration the risk of the investment. Thus, it was decided to phase the implementation, starting first with the configuration that would require less internal changes (receiving invoice and sending credit notes), and only if successful thinking about developing a more sophisticated configuration. Secondly, invoice processing and payments were the only administrative processes that were centralised, reasonably streamlined, and internally fully integrated and automated, which was perceived as a fundamental condition to be able to take real benefits from electronic linkage with suppliers. Purchasing and order processing were partly centralised, and partly decentralised to local plants and offices, and they were neither fully processed through computers, nor was there electronic integration between the local purchasing applications and central applications. An EDI configuration that would support automated purchasing and ordering requires major administrative and IT changes that, though desired and foreseen by top management, are not perceived as a priority at this moment.

The involvement of both firms in the CITE initiative was an important contribution to both the adoption but also the configuration of the EDI system. Thus, it was through CITE that it triggered the development process between the two firms, more precisely that BCC suggested to BRM the implementation of the EDI system. Moreover, it was through CITE meetings that IT managers from both firms developed strong personal relationships, which facilitated the development process. For BCC, it was also CITE that triggered the firm's initial EDI initiatives (in 1992) and gave technical support to the selection of standards, EDI software and VAN. The same situation happened to BRM but three years later, and it was in the development of the EDI system with BCC that the technical support was very important since it was its first.

In the IT strategy of BCC the development of individual EDI systems was not constrained by the existence of a critical mass of EDI users, though initial studies had demonstrated the existence of potential EDI-interested customers. Thus, the EDI system with BRM is reasonably independent from EDI systems with other firms. Currently, BCC has EDI systems with 12 customers (6 builders merchants and 6 ready-mix and product manufactures), which account for 50% of total invoice volume exchange and turnover. With two of the builders merchants, BCC has implemented a fully automated system. EDI systems with customers derive essentially from BCC leadership and suggestion, and are grounded in the long-term co-operative relationships, like the one with BRM. BCC is an important party in many production systems, mainly with builders merchants, ready-mix and product concrete manufacturers, and in spite having a 45% share of the cement market, the main governance mechanism in production systems is proactive co-operation. Even if BCC desired to pressure customers, it would be very difficult as cement supply is mainly a commodity and thus customers can easily change to a competitor.

For BRM the adoption of the EDI system with BCC was done independently to the adoption by other firms, though there was a desire that other suppliers and also customers would also adhere to the initiative. After the adoption of the EDI system with

BCC, BRM was the leading firm in the development of systems with the other four cement suppliers, with interactions and characteristics very similar to BCC. Together, the five cement suppliers represent to BRM 20% of the total supply turnover and about 10% of the total information volume. Despite no defined critical mass of EDI users, it is informally considered that there should be a much higher level of adoption of more sophisticated configurations with current EDI users, particularly with BCC, are to be developed. Although BRM has some power over a large number of suppliers, this is usually used to obtain continuous decrease of prices, and has not yet been used to pressure firms to develop EDI systems and rarely used over other inter-firm management systems like e.g. quality, logistics, etc.. Still, in general terms, the governance mechanism is usually co-operation with suppliers rather than coercion.

7.3.8.5 - Conclusions

This case demonstrates that the adoption and configuration of a relatively simple EDI system, that exchanges invoices and credit notes between the cement supplier BCC and the ready mix concrete manufacturer BRM, result essentially from the lack of adequate administrative and IT infrastructure. Thus, while the information, product, financial exchanges, long-term and co-operative atmosphere, and BCC internal characteristics would enable the development of a sophisticated system between the two firms, this was hindered by BRM's need for major changes and a lack of resources prioritised to cope with such a system.

The case also illustrates the importance that the CITE initiative had as a contact point but also to provide technical support to both firms regarding the software, VAN, and in proving the EDI standards to be used.

7.3.9 - Case study 9: CAS- LCEC

7.3.9.1 - Background

This case describes a failed adoption of an electronic trading system between LCEC - one the ten largest large civil engineering contractors in the UK with an annual turnover of £300 million, and CAS - a large UK ready-mix concrete and aggregate supplier with a £210 million annual turnover. LCEC operates mainly in the UK but also has world-wide operations, while CAS is a UK subsidiary of a similar very large firm in the US. Although a pilot for an EDI-based system was developed by the firms, the full implementation of the system never occurred and this case study addresses the reasons that led to failure.

7.3.9.2 - Designed configuration of the electronic trading system

Table 7.34 summarises the most important characteristics of the designed electronic trading system tested in the pilot implementation.

Table 7.34 Configuration of designed/pilot electronic trading system between CAS-LCEC

Systems	*Description*
Technology	EDI-based on dial-up connections to VAN mailbox. Both firms intended to use Harbinger, a commercially available translation and communication software.
Standards	Developed by CITE based on EDIFACT 92.1
Information exchanged	'Invoices' issued after deliveries.
Frequency	Depending on the projects, not on a regular basis.
Direction of flow	One-way, invoices sent from CAS to LCEC.
Communication network	GEIS - commercial communications network.
Integration	The LCEC EDI system was integrated with one of the accounting applications, and CAS had integrated it with internal applications though for pilot purposes only.

The design and pilot of the electronic trading system between LCEC and CAS had a very simple and basic EDI configuration, since it allowed the exchange of one type of information, one-way, and it was partly integrated. It is also important to note that there was no aim to further develop a sophisticated configuration in the foreseeable future.

7.3.9.3 - Summary of the case

A summary of the data collected in the case study between CAS and LCEC is described in Tables 7.35; 7.36; and 7.37.

Table 7.35 Data regarding relationship between CAS and LCEC

Variable	*Summary of data collected*
Information exchanged	Bulk of information exchanges are mainly request for quotations, and quotations, followed by purchase orders, call-off, delivery notes and finally invoices. Apart from call-off that is usually made by phone remaining information is exchanged through mail or fax. Little exchange of 'soft' information.
Product, financial exchanges	CAS supply of ready mix concrete and aggregates is project-based and therefore there is a high degree of order uncertainty, and thus on product and financial exchanges. Financial exchanges are considered of medium importance for both firms.
Closeness	There are no permanent adaptations from one firm to the other, regarding production, logistic or administrative processes, only one-off specific changes on some projects.
Co-operation	At the project level there is much co-operation between LCEC's site managers and CAS's liaison personnel. However, LCEC has the traditional reactive attitude regarding invoice processing and payment.
Power/dependence	None of the firms is much dependent on the other, though for CAS's turnover LCEC is an important individual contributor (approximately 1%). There is no coercion or pressure from LCEC on CAS.
Mutual expectations	Long time trading but no formal agreements. For every project, CAS is approached like the first time and jobs are usually commissioned based by price or the ability to cope with specific demands. Expectations were of the eventual development of formal annual agreements and more long-term relationships.

Table 7.36 Data regarding internal features of CAS and LCEC

Variable	*Summary of data collected*
LCEC's business and IT strategy	Current purchasing strategy is to select subcontractors or suppliers based on lowest price, except in special conditions. Pondering the possibility of cutting down the number of suppliers with regular workloads like builders' merchants and concrete suppliers and developing more formal relationships. IT strategy is to slowly integrate internal applications and deploy electronic links with main parties involved in construction projects.
LCEC's IS/IT infrastructure	There is a wide, heterogeneous, internal IT infrastructure with low integration between functional applications, both on offices and on sites. There are electronic links between some sites and offices depending of the size of the project, and between regional offices and central services, using either, dial-up, ISDN or leased lines. Very small IT department, 6 people, for the necessities of the whole firm. Much IT work outsourced to IT consultants. There was no EDI expertise before. Expenditure with pilot EDI considered relevant.
LCEC's organisational infrastructure and processes	Apart from accounting and invoice control, all other major functional and administrative decision-making is decentralised to regional offices or sites. Administrative processes, especially those related with the activities of ordering, goods receivable, invoice checking, payment management, etc. and its interfaces are perceived as poor, with little automation and requiring streamlining.
CAS's business and IT strategy	Foster better relationships with customers, especially with those customers with regular orders like national contractors, both at the project level with the allocation of a liaison manager, at the administrative level, and through the development of long-term agreements. Strategy constrained by low receptivity from customers. Seek full information IT integration, internally, and with customers (eventually with main suppliers too) through EDI. Top management wide support of EDI.
CAS's IS/IT infrastructure	Information flows within and across internal functions, and between regional offices and central offices fully IT integrated, using a sophisticated homogeneous IT infrastructure. Large central IT department which co-ordinates IT systems of all regional offices, no need for IT consultants. A fair internal EDI expertise developed recently for the pilot. Expenditure with EDI considered minimal.
CAS's organisational infrastructure and processes	Some functions and decision-making like price setting, job tender and negotiation, production, logistics, planning, etc., are decentralised to regional offices, while most administrative processes are centralised at main office, like invoicing, credit management, etc. Processes considered as very efficient and best-in-class especially amongst construction firms.

Table 7.37 Data regarding LCEC's and CAS's production network

Variable	*Summary of data collected*
Input-output system	LCEC interact on a project basis with over 3000 subcontractors and suppliers, which have heterogeneous internal characteristics regarding their size, technology, organisational structure and processes, and strategies. Firms also have different types of relationships, from those interacting regularly to those which have only one-off interactions. Only 16 of these subcontractors and suppliers were interested in EDI. CAS interacts with many different types of customers, from the largest contractors to the small-sized local trade contractors, though most important are nation-wide civil engineering contractors like LCEC. Some suppliers were interested in implementing EDI.
Governance structure	LCEC has some hierarchical power over a small number of small subcontractors / suppliers, but in general there is little pressure or coercion influence over the internal operations of those firms, regarding issues like price, quality, logistics, or administrative processes. CAS does not have any significant leadership influence on their customers, though it has over some suppliers.
Territoriality	Both LCEC and CAS have their operations focused across UK, but are also involved on some world-wide projects.
Interconnections	LCEC and CAS are both members of the CITE initiative, which provided the initial trigger for the development of the pilot system, and defined the standards to be used and provided some technical support.

7.3.9.4 - Analysis of the case

Although a pilot EDI system has been implemented which was technically successful, there was no evolution towards the real full implementation of the electronic trading system. The designed EDI system aimed to automate a very specific and narrow part of the information exchange episodes between the two firms: the large volume of invoice exchange. These are not the more intense and frequent information exchanges between the firms. Request for quotation, quotations and orders are. The deployment of the electronic trading system was neither considered crucial nor very important to both firms, but there was a mutual interest in its development.

LCEC spent considerable resources in developing EDI with suppliers, especially with the pilot system. The major costs relate to the time and effort from IT personnel in developing EDI expertise, more than with software, which was considered significant due the reduced size of the IT department and the lack of foreseeable return on investment. The perceived benefits of the designed system were mainly to reduce invoice processing costs and errors. However, for LCEC there would be little benefits from its sole link with CAS, as it represented only 2% of the 150.000 invoices received annually. Cost-benefit analysis indicated that a minimum of 30% of invoice volume would be required to achieve real benefits.

For CAS, the EDI investment was considered low, especially when compared with the overall IT expenditure. The firm was willing and ready to develop a more sophisticated EDI system, with a configuration that would exchange orders and quotations. CAS real benefits would be better cash flow and a more proactive credit management. It is recognised that real operational benefits would only emerge if other large contractors/customers will also adopt EDI systems, though the current design configuration will never bring big benefits to CAS.

As far as LCEC is concerned, the intended development of EDI with CAS was part of its IS/IT strategy of slowly automating information exchanges with subcontractors and suppliers in order to reduce administrative costs. These types of firms were chosen because they are the only ones which the contractor may have some continuous degree of control over the information flows, since with designers, architects, clients, etc. LCEC is very much dependent on the team assembled for each project. The reasons behind primarily choosing a configuration based on invoice exchange are twofold. First, the fact that invoice issuing, processing and receiving is usually done through IT, even on small subcontractors/suppliers, which was perceived would facilitate the linkage with EDI, and therefore, its easy adoption internally and by those firms. Secondly, invoice processing is the only LCEC administrative function done centrally, i.e. not controlled by the regional offices or sites. Without this centralisation it was perceived that it would not be possible to implement a reasonably efficient EDI system.

However, the EDI implementation strategy and the adoption of electronic trading system with CAS was hindered by several internal factors. Firstly, the low internal IT integration and extensive paper-based information flows implied that invoice processing could not be done automatically, as it is not possible to electronically match invoices, orders, and goods receivable notes, and therefore, invoices received electronically bring little tangible benefit to the whole process. Major process changes and IT integration from site to office would be required. Secondly, apart from very few exceptions to very specialised and often used suppliers, the purchasing policy does not seek long-term relationships with subcontractors/suppliers, which are required to implement a permanent EDI system and not a project-based one. The small perceived benefits that EDI would bring did not convince purchasing management either of the necessity to change policy, or of the need to pressure as much as possible their suppliers / subcontractors to adopt EDI. Thirdly, CAS *was perceived as a good firm for the pilot* system by LCEC due its reasonably regular and large invoice volume (2% of total). However, LCEC's IS/IT strategy defined the adoption of individual full EDI systems, and thus that with CAS, was dependent on reaching a critical mass of 30% of invoice volume, which after 18 months of searching was concluded as not possible. Fourthly, an EDI system which would send purchase orders and call-off or request for quotations and quotations would achieve higher benefits both to LCEC, CAS and remaining suppliers / subcontractors, and therefore would be likely to obtain a more enthusiastic response internally and externally. However, it was recognised that the sophisticated configuration of such a system would require very large and expensive internal changes: *i*) a shift of decentralised activities like purchasing, orders, to centralised functions; *ii*) a significant effort to integrate IT applications, automate activities, and link disparate sites with central office; *iii*) completely different approach with suppliers / subcontractors. Finally, it was perceived that because there would be many firms that work one-off and the existence of small projects, there would always be the need for a manual paper-based infrastructure, even if a large number of suppliers / subcontractors adopted EDI systems.

CAS was quite willing to adopt the EDI system with LCEC, though it would prefer a more sophisticated configuration, one that would allow the exchange of requests for quotations or orders. The CAS attitude was enabled by its business and IS/IT strategy, and would be facilitated by its organisational and IT infrastructure. Thus, the sales strategy aimed to develop closer and stable long-term relationships with major customers, like LCEC, which would foster the improvement of interface processes, especially at the administrative level. Following this objective, the IS/IT strategy defined that the development of EDI systems is important and this led to the participation in the

CITE initiative and the development of the pilot system with LCEC. In spite of suggestions by some suppliers to implement EDI, the current IS/IT strategy focus mainly on EDI with customers, as these are perceived as bringing more operational and strategic benefits.

EDI systems, either with a simple configuration like the pilot system, or more sophisticated ones can easily be developed and integrated with internal applications because IS/IT infrastructure is fully integrated and supported by a large central IT department, with a fair EDI expertise. Although some functions have regional decentralised management (like e.g. price setting, negotiation, job tender, production, logistics, planning), these are electronically linked with the main central office, updating central databases, where most administrative functions are processed. The centralised administrative processes and their efficient performance are believed to enable the development of EDI. Finally, CAS was willing to adopt the full EDI system with LCEC regardless of whether other customers would also adopt similar systems. Indeed, only three other customers seemed to be willing to adopt EDI systems in the foreseeable future.

The design and development of the EDI system between LCEC and CAS was highly influenced by the participation of both firms in CITE. LCEC's main objective in participating on CITE was to acquire EDI expertise to support its EDI strategy, and find firms willing to deploy its EDI system and thus obtain the critical mass of users. For CAS, its involvement on CITE derived mainly from the willingness to develop EDI with the largest number of customers possible using the same standards, and thus avoiding the necessity for multiple EDI software and standards. CITE had a crucial role, as it was at one of its meetings that both firms discussed the possibility of developing an EDI system and its piloting, also setting the standards to be used and selecting the suggested VAN.

The full development of the EDI system did not occurred because LCEC constrained its development until its adoption by other suppliers/subcontractors. Thus, there were only sixteen firms that were interested in EDI, mainly large builders merchants and concrete suppliers from CITE, representing 15% of the total number of 150.000 invoices received annually, half of what was considered by the firm as the critical mass for EDI development. Hindering factors for general EDI adoption by other suppliers / subcontractors are: *i*) the great heterogeneity of interactions and relationships of those firms, ranging from rare regular and frequent financial and product exchanges to mostly one-off supplies, and in part due to the nation-wide geographical dispersion of projects and the strategy of using local suppliers; *ii*) firms' internal characteristics regarding size, technology, and IT and organisational infrastructure, ranging from large-size specialised suppliers with highly sophisticated infrastructures and EDI experience to very small-size labour-only trade subcontractors, without even a computer. The lack of willingness by suppliers/subcontractors was not overcome by LCEC's ability to pressure them, due on one hand to the purchasing strategy of lower-price, project-based relationships and no EDI pressure policy; and on the other hand, the low level of leadership or coercion power regarding issues like price, quality, logistics, or administrative processes.

7.3.9.5 - Conclusions

This case analyses the failure of the development of a simple EDI system for invoice exchange in a large contractor - concrete supplier relationship, characterised by low regular, medium/low frequency product and financial exchange episodes, as well as low complexity commercial and management information exchanges. The case demonstrates that the low sophistication of the pilot electronic trading system is very much determined by the contractor's weak IS/IT and organisation and processes infrastructure, and that the supplier is willing and able to develop a more sophisticated system.

However, one of the main points to be made in this case is that the failure of the development of electronic trading systems between LCEC and CAS was influenced by the contractor's IS/IT strategy of constraining its development until reaching a pre-defined critical mass of users, and its inability to convince other suppliers / subcontractors to also adopt EDI invoicing systems. This derives from the contractor's, lack of leadership and capability to exert pressure over its very large, fragmented and heterogeneous network of suppliers/subcontractors, in general and particularly to implement electronic trading systems.

Finally, the case demonstrates the importance for the development process of the pilot between LCEC and CAS of their interconnections to third-party organisation - CITE, which not only contributed to the definition of the standards, but essentially enabled IT people from the two firms to meet and discuss possible linkages. It also stresses the importance that LCEC and CAS gave to adopting universal standards in order to foster EDI adoption by other suppliers and customers respectively, which, however, did not seem to be enough.

7.3.10 - Case study 10: CAS-LCC

7.3.10.1 - Background

This case describes a failed to adopt electronic trading system between LCC - one the ten largest construction contractors in the UK with an annual turnover of £260 million, and CAS - a large UK ready-mix concrete and aggregate supplier with 210 million pounds of annual turnover. LCC operates mainly in the UK but also has world-wide operations, while CAS is a subsidiary of a very large US construction industrial group. Although the firms developed a pilot for an EDI-based system, the full implementation of the system never occurred and this case study addresses the reasons that led to failure.

7.3.10.2 - Designed configuration of the electronic trading system

Table 7.38 summarises the most important characteristics of the designed electronic trading system which was tested on the pilot implementation.

Table 7.38 Configuration of designed/pilot electronic trading system between CAS-LCC

Systems	*Description*
Technology	EDI-based on dial-up connections to VAN mailbox. Both firms used Harbinger, a commercially available translation and communication software.
Standards	Developed by CITE based on EDIFACT 92.1
Information exchanged	'Invoices' issued after deliveries.
Frequency	Depending on the projects, not on a regular basis.
Direction of flow	One-way, invoices are sent from CAS to LCC.
Communication network	GEIS - commercial communications network.
Integration	LCC system was integrated with one of the accounting applications, and CAS integrated with internal applications though for pilot purposes only.

The design and pilot of the electronic trading system between CAS and LCC had a very simple and basic EDI configuration, as it allowed the exchange of just one type of information, one-way only, and it was partially integrated. It is also important to note that there was no aim in the foreseeable future to develop a more sophisticated configuration.

7.3.10.3 - Summary of the case

A summary of the data collected in the case study between CAS and LCC is described in Tables 7.39; 7.40; and 7.41.

Table 7.39 Data regarding relationship between CAS and LCC

Variable	*Summary of data collected*
Information exchanged	Bulk of information exchanges are mainly requests for quotations, quotations, by purchase orders, call-off, delivery notes and invoices. Apart from call-off that is usually made by phone the remaining information is currently exchanged through mail and fax. Little exchange of 'soft' information.
Product, financial exchanges	CAS supply of ready mix concrete and aggregates is project-based and therefore there is a high degree of order uncertainty and thus of product and financial exchanges. Financial exchanges are considered of medium importance by both firms.
Closeness	There are no permanent adaptations from one firm to the other, regarding production, logistic or administrative processes, only one-off specific changes in some projects. There are good personal relations between IT personnel of both firms.
Co-operation	At the project level there is as much co-operation as possible between LCC's site managers and CAS's personnel. However, LCC has the traditional reactive attitude regarding invoice processing and payment.
Power/dependence	None of the firms is dependent on the other. LCC as an individual customer is important but represents less than 1% of CAS turnover, while for LCC there are many ready mix concrete suppliers.
Mutual expectations	Long time trading but no formal agreements. For every project, CAS is approached like the first time and jobs are usually commissioned by price or the ability to cope with specific demands, though there are many situations where personal relations overcome this rule. Expectations of the eventual development of formal annual agreements and more long-term relationships.

Table 7.40 Data regarding internal features of CAS and LCC

Variable	*Summary of data collected*
CAS's business and IT strategy	Foster better relationships with customers, especially with those customers with regular orders like national contractors, both at the project level with the allocation of a liaison manager, at the administrative level, and through the development of long-term agreements. Strategy constrained by low receptivity from customers. Seek full information IT integration, internally, and with customers (eventually with main suppliers too) through EDI. Top management wide support of EDI.
CAS's IS/IT infrastructure	Information flows within and across internal functions, and between regional offices and central offices fully IT integrated, using a sophisticated homogeneous IT infrastructure. Large central IT department which co-ordinates IT systems of all regional offices, no need for IT consultants. A fair internal EDI expertise developed recently for the pilot. EDI expenditure considered minimal.
CAS's organisational infrastructure and processes	Some functions and decision-making like price setting, job tender and negotiation, production, logistics, planning, etc., are decentralised to regional offices, while most administrative processes are centralised at main office, like invoicing, credit management, etc. Processes considered very efficient and best-in-class especially amongst construction firms.
LCC's business and IT strategy	Current purchasing strategy is to select subcontractors or suppliers based on lower price, though there is a degree of freedom to site managers. Analysing the possibility of developing more formal relationships with some (very few) suppliers. IT strategy is to fully integrate internal applications and exchange information electronically with parties involved in construction projects, either through electronic links or through diskette/CD ROM. Involved in some R&D projects which seek to achieve the goal of full IT integration.
LCC's IS/IT infrastructure	There is a high-level of IT use functionally and on-site, supported by a heterogeneous internal IT infrastructure, though with a medium-level of integration. There are electronic links between most sites and offices and central services, using either, dial-up, ISDN or leased lines. IT department able to cope with demand, with 15 fixed employees and a variable number depending on the work load. Some IT work outsourced to IT consultants. A reasonable body of knowledge regarding electronic trading systems has been developed, partially by R&D projects. Expenditure on EDI pilot not relevant.
LCC's organisational infrastructure and processes	Much functional decision-making, e.g. ordering, invoice control, is centralised, while others like operational decision is decentralised to site managers. Administrative processes, especially those related with the activities of ordering, goods receivable, invoice checking, payment management, etc. and its interfaces are considered good - probably best-in-class for contractors, though with scope for streamlining.

Table 7.41 Data regarding CAS's and LCC's production network

Variable	*Summary of data collected*
Input-output system	LCC interacts on a project basis with over 20.000 subcontractors and suppliers, which have very heterogeneous internal characteristics regarding their size, technology, organisational structure and processes, and strategies. Firms also have different types of relationships, from those interacting regularly to those which only have one-off interactions. It was foreseen that only 25 of these subcontractors and suppliers were interested in EDI. CAS interacts with many different types of customers, from the largest contractors to the small-sized local trade contractors. Some suppliers were interested in implementing EDI.
Governance structure	LCC has some hierarchical power over a small number of small subcontractors / suppliers. There is some pressure to influence those firms regarding price, production methods and quality issues but not administrative processes. However, there is little positive reply by suppliers and LCC has little coercion power over them. CAS does not have any significant leadership influence on their customers, though it has some over suppliers.
Territoriality	Both LCC and CAS have their operations focused across UK, but are also involved on some world-wide projects.
Interconnections	LCC and CAS are both members of the CITE initiative, which provided the initial trigger for the development of the pilot system, as well as defining the standards to be used. CAS link with another contractor has also indirectly influenced the configuration of the pilot.

7.3.10.4 - Analysis of the case

LCC and CAS have successfully implemented a pilot EDI system which aimed to automate the invoice exchange, part of the main information exchange episodes between the two firms. Although both firms were also willing to implement a pilot that would test EDI systems for purchase orders, because of the development of CAS's other pilot system with another contractor (LCEC), it was decided to start with the invoice configuration. The development of the electronic trading system was not considered crucial though it was perceived as the future of information exchanges. However, the EDI system development was stalled and has never been fully implemented.

LCC has committed some IT resources (people, time, money) to the development of the EDI system, especially for the pilot implementation. Regarding the other IT R&D initiatives being developed, this was not considered as significant, but still it implied a shift of focus from other IT priorities, like full internal IT integration. There was no formal concern about the return on investment, mainly due to a management perception that the use of electronic trading systems are going to be the future in construction information systems. Because of the percentage of invoices received from CAS is less than 1%, the benefits from EDI invoice receivable would be completely insignificant. It is believed that, in general, the operational benefits achieved by invoice automation through EDI would be minimal when compared with the flexibility enabled by a fully automated system which would link LCC with suppliers and subcontractors exchanging requests for quotations, quotations, orders, call-off, etc.

For CAS, EDI expenditure with the pilot system was considered low when compared with other IT investments, especially due to its use in piloting with another customer. Although CAS was willing to develop a more sophisticated system which would also receive request and quotations, purchase orders, delivery notes, the on-going piloting with another contractor, LCEC, led first to testing the invoice system. The benefits brought by the simple EDI system would mainly be better cash flow and the possibility of having a more proactive credit management. In spite of the perception that the EDI invoice configuration would never bring major cost savings, it was recognised that potential operational benefits would only emerge if many other contractors/customers would also adopt similar systems.

The development by LCC of the pilot EDI system with CAS was embedded in its IS/IT strategy to achieve full IT integration, both internally and externally. LCC is and has been involved in some R&D projects regarding the exchange of information in electronic format either through electronic trading systems or through diskette/CD-ROM exchange, both with customers and suppliers/subcontractors, though it is perceived that it will be far easier with the later type of firms, because there is a higher control over information flows and relationship. LCC was willing to develop a more sophisticated EDI system but because: *i*) CAS was involved in a pilot with another contractor that was based on invoice exchange; and *ii*) internal systems were able to cope more easily with invoices, without requiring many changes, it was decided to develop the simple invoice configuration. However, the EDI development was hindered internally by four main factors.

First, despite LCC having a reasonable good internal IT infrastructure, in most projects it is not yet possible to electronically match invoices, orders, and goods receivable notes. On very large projects the IT infrastructure may be able to cope with such situations with minor changes, but for many projects, information is not automatically processed. Secondly, purchasing strategy defines that there is a mix between centralised and on-site purchases. Site managers sometimes have the freedom to choose the suppliers / subcontractors they feel are the best for the job. The implementation of a permanent EDI system with CAS and other suppliers would need a shift towards centralised purchasing, at least of the items that would have electronic invoices, in order to make the management of orders possible based on formal trading agreements between firms. This would require a change in internal purchasing strategy that is likely to occur. Third, although the development of a more sophisticated system to exchange request and quotations, orders, etc., is perceived as likely to bring more benefits, its development would require considerable effort in time and resources, and therefore a significant investment in fully integrating internal applications and changing some work practices, that could only given a return if a large majority of suppliers/subcontractors would adhere to the system. There is top management awareness of the potential from implementing such a system but it is considered as a very big risk to take especially while other large contractors do not also adopt such systems. For the time being, LCC is developing internal expertise in electronic trading systems and improving internal processes and infrastructure, putting of in a position to be ready to adopt such systems if other firms also implement it. Finally, LCC recognises that the need to dramatically reduce the number of supplier/subcontractors on its purchasing databases, choosing only those that can provide better prices and also those able to cope with different demands, like e.g. EDI (or quality, logistics, etc.). This process is slowly and steadily being carried out in recent years, regardless of the EDI initiatives.

CAS's willingness towards EDI systems in general and to the pilot system with LCC in particular derives from its business and IS/IT strategy, and is facilitated by its organisational and IT infrastructure. CAS strategy stresses that only through developing closer and stable long-term relationships with customers like LCC, can it be possible to improve the efficiency of interdependent processes, both at the production and administrative level. This business strategy provides the framework for the IS/IT strategy, which advocates that administrative processes can be considerably improved through the development of electronic links - e.g. EDI, with customers, which led to the participation in the CITE initiative and the development of the pilot system with LCC and other firms. However, current IS/IT strategy does not consider EDI with suppliers as a priority due to its lack of perceived benefits now and in the future. This is despite suggestions by some of their main suppliers to implement electronic trading systems.

The development of the pilot EDI system by CAS, and the development of an EDI system in general, either sophisticated or simple, is facilitated by: *i*) a fully integrated IS/IT infrastructure, supported by a large central IT department, with a fair EDI expertise; and *ii*) the efficiency, good performance and centralisation of most administrative functions (e.g. invoice issuing and processing), and the electronic linkage of the decentralised functions (e.g. price setting, negotiation, job tendering, production, logistics, planning, etc.) to central databases, where information is updated frequently. Moreover, CAS was willing to adopt the full EDI system with LCC regardless whether other customers would adopt similar systems. In the foreseeable future only three contractors showed some interest.

The participation of both LCC and CAS in the CITE initiative has considerably influenced the design and development of the EDI system. For LCC, the main objective of participating in CITE was primarily to contribute to the development of EDI standards that could be easily accepted by a large spectrum of construction firms, and enhance its EDI expertise. CAS involvement on CITE derived mainly from their willingness to develop EDI with the largest number of customers possible using the same standard, and thus avoiding the necessity for multiple EDI software and standards. Regarding the pilot EDI system, CITE had a twofold crucial enabling role. Firstly, it was at one of its meetings that both firms discussed the possibility of developing an EDI system. Secondly, the pilot EDI system used standards devised by CITE, and also it was implemented on the VAN supporting the CITE initiative.

Although LCC did not constrain, beforehand, the full development of the EDI system with CAS to the adoption of electronic trading by a specific and formal critical mass of suppliers/subcontractors, the very low number of positive responses obtained from initial contacts, twenty five out of twenty thousand, which represent a minimal percentage in terms of product, financial and information exchanges, and the lack of adoption by other large contractors convinced LCC's top management that construction firms were not yet ready for EDI, and decided to stall the EDI initiative until a more enthusiastic response by construction firms emerged (an emergent IT strategy). It was stressed that if it was not possible to convince suppliers / subcontractors to implement a simple system of invoicing, it would be much more difficult to convince them to implement a much more sophisticated configuration, as they wished for and that could really bring tangible benefits. LCC recognises that because their construction products have a wide spectrum of potential different types of supplies and subcontractors, derived mainly by their low control over the design stages (of architects and other designers), it is difficult to develop stable, on-going relationships with firms. This is reinforced by the fact that the geographical location of projects varies considerably, and the strategy of firms is to, as much as possible, use local suppliers/subcontractors, often chosen by site managers personal preferences rather than by central (and co-ordinated) purchasing decision-making. Moreover, because there is great heterogeneity in suppliers/subcontractors internal characteristics - technology, IT organisation, infrastructures, strategies, etc., LCC stresses that it would require a strong coercion power to dictate firms to deploy electronic trading systems. Currently, LCC purchasing strategy is focusing on trying to use its relatively weak power over firms to influence / coerce them on matters like price reduction and quality of products and processes (with low success), and not on EDI, because administrative issues are considered much less important than production.

7.3.10.5 - Conclusions

This case demonstrates that in spite of both the contractor LCC and supplier CAS being initially reasonably willing to develop an electronic trading system, its full implementation was stalled by the contractor's perception of the great heterogeneity of suppliers / subcontractors, and that the overwhelming majority of them were unwilling to adhere to the EDI initiative. The case shows that LCC's weak coercing power over some of the suppliers /subcontractors was being used by the purchasing department to influence production matters, but not administrative issues like EDI, because these later are not considered a priority by the business strategy.

The case demonstrates that, though LCC's internal IT and administrative infrastructure was not ready for the development of a sophisticated EDI system with CAS (contrary to the situation of the supplier), there was initial willingness by the IT department and senior management to make the necessary changes, since only with a fully automated system would benefits accrue. However, because there was not a sufficiently positive reply by other firms, BCC considered that the relationship with CAS in terms of information, financial, and product exchanges was not important enough to justify either the changes necessary or the resources to implement the full simple EDI system.

Finally, this case demonstrates the importance for the development process of the connections of both firms not only with CITE, which served as a facilitator for the two firms to discuss the EDI initiative and for the definition of the standards, but also CAS's connection with another contractor, with whom the supplier was conducting a pilot of a simple invoice exchange EDI system. This contributed to the decision regarding LCC and CAS piloting the same configuration.

7.4 - Summary

This chapter begun with a summary description of the ten cases studies. Descriptions started with the configurations of the electronic trading systems. In order to facilitate pattern-matching, the description of each case had as a framework the variables identified by the CONNET model. Thus, data collected was processed and depicted on tables referring to each type of factor of the model. Following the description, analysis was made of each case, i.e. based on the data the development of the electronic trading system was explained by stressing which variables contributed and how did they constrained or enabled the development of each electronic trading system. Finally, for each analysis, a conclusion was made about the interplay of variables and in determining adoption and configuration of the system.

CHAPTER 8

CROSS - CASE ANALYSIS

8.1 - Introduction

Having in Chapter 7 described, analysed and concluded about each individual case, this chapter makes an horizontal, comparative analysis of the case studies. In order to facilitate pattern matching, analysis structure is based on the CONNET variables, and distinguishes between adoption and sophistication situations, and also between construction and non-construction cases, rather than on separating between theoretical and literal replication cases. At the end of each section, generalised conclusions are made.

8.2 - Comparison of configurations of electronic trading systems

A summary of the main features of the configuration of the electronic trading systems analysed in the cases studies of this work are depicted in Table 8.1. The cases are ordered from left to right according to their decreasing level of sophistication. It is important to note here that the assessment of the degree of sophistication of electronic trading systems and their relative positioning was made on a qualitative basis. Four distinct levels of sophistication were considered: very sophisticated, sophisticated, simple, and pilot only. Ratings within each group can be considered less important.

From the analysis of the different cases it can easily be concluded that the configuration of electronic trading systems may vary considerably in terms of: technology - between EDI or EDI-based and e-mail based applications; information - commercial, managerial, technical, engineering or design; frequency - from every 2 minutes to daily, weekly, monthly; direction of flow - one or two ways; and integration - from fully integrated and automated to stand-alone. Moreover, it is demonstrated that even in cases involving the same leading firm, the configuration of the system can have significant differences. For example, the configuration of the electronic trading systems in the cases between AutoEuropa and SA1 and SA2, or Sonae and SS1 and SS2, vary considerably in terms of information exchanged, frequency, and integration. This reinforces the conclusion

Table 8.1 Configuration and sophistication of electronic trading systems

	Level of sophistication									
	+ Very sophisticated -			+ Sophisticated -			+ Simple -		Pilot only	
	AE-SA1 (1)	Bovis-CB (5)	Bovis-SB (6)	AE-SA2 (2)	Sonae-SS1 (3)	BCC-BRM (8)	Sonae-SS2 (4)	BCC-BBM (7)	CAS- LCEC (9)	CAS- LCC (10)
Technology	Two systems EDI & EDI based	E-mail based	E-mail based	EDI	EDI	EDI	EDI	EDI	EDI	EDI
Information exchanged	Four types of commercial & managerial	Wide range of technical, design & engineering	Design and engineering	Four types of commercial & managerial	Three types of commercial	Two types of commercial	Two types of commercial	One type of commercial	One type of commercial	One type of commercial but envisage other types
Frequency	Ranging from monthly, daily to every 2 min	Several times per day	Usually daily	Ranging from monthly to daily	Twice per week	Twice per week	Once per week	Usually six times per month	Depending on the project, not regular	Depending on the project, not regular
Direction of flow	One way only, AE to SA1	Two ways	Two ways	Two ways	Two ways	Two ways	Two ways	One way, from BCC to BBM	One way, from CAS to LCEC	One way, from CAS to LCC
Integration	Integrated in AE, stand-alone network on SA1	Integrated with project applications	Integrated with project applications	Integrated in AE, stand alone on SA2	Integrated in both firms	Integrated in both firms	Integrated in Sonae, stand alone on SS2	Integrated in both firms	Integrated in both firms but for pilot only	Integrated in both firms but for pilot only
Criticality	Crucial	Crucial	Important	Important	Important	Not important	Not important	Not important	Not important	Not important
Duration	Permanent	Project/3 years	Project/2 years	Permanent	Permanent	Permanent	Permanent	Permanent	-	-
Investment	Mainly by AE, large but insignificant	Mostly by Bovis, large, but paid also by client & SB	Most by Bovis, large, but paid also by client & CB	Mainly by AE, large but insignificant	Both invested but considered not relevant	Both invested but considered not relevant by BCC, but more by BRM	Both invested, considered not relevant by Sonae but for SS2 more sophistication relevant	Both invested but considered not relevant by firms	Both invested similarly, but LCEC considered relevant in face of resource and of lack of return	Both invested similarly, but for LCC more sophistication considered relevant

about the importance of analysing individual links rather than looking to the problem in generic terms, or focusing only on the individual firm.

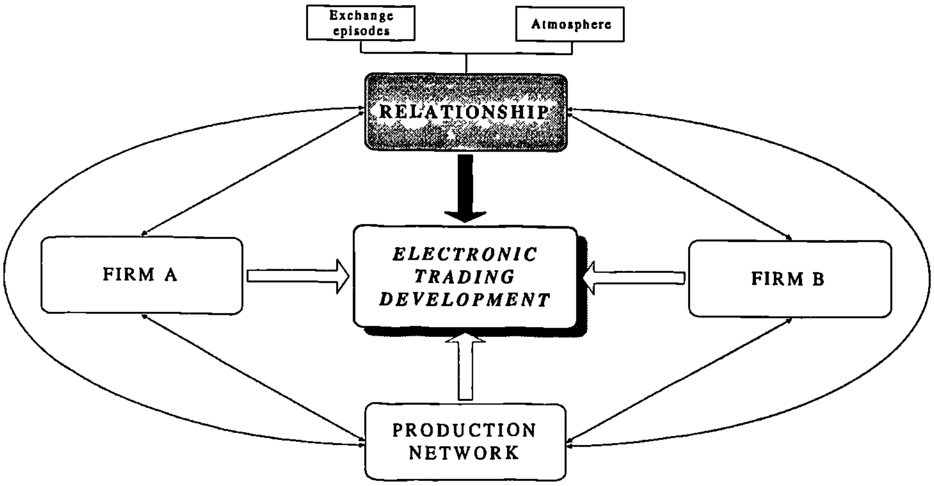
This study avoids discussion of configurations in terms of classes/groups of relationships like assembler-supplier; retailer-supplier; construction manager-consultant and supplier; builders merchant-supplier; contractors-suppliers, etc. as the cases presented here were not intended to be representative and thus a statistical generalisation can not be achieved. However, it can be concluded that within construction and non-construction groups, the configuration and sophistication of electronic trading systems in non-construction cases in *automotive and retailing industries ranges from very* sophisticated to simple configurations, and similarly in construction cases there is a wide variety in the degree of sophistication, ranging from very sophisticated systems like those of Bovis to simple configuration like BCC-BBM, or pilot only like CAS-LCEC. This contrasts with the common perception that electronic trading systems are sophisticated in automotive and retailing industries while in construction these are always simple.

From the cases it can be concluded that, in general, the investment in systems regarding individual links is considered insignificant, though the investment that each firm makes in the aggregated overall electronic trading systems may not be. In all cases, return on investment (i.e. balance between costs and benefits) were always seen in aggregate and not individually. Moreover, for all but one firm, the investment made was considered minimal or small when compared with other internal IT investments. This is not to say that they are not important, rather that it is not the major cause of concern for the adoption, though it might be to the configuration. The higher the level of sophistication of the developed systems the larger the investment needed, especially when the requirements of the systems are far from the existing situations. The element of the configuration that seems to require bigger expenditure is the integration of electronic trading systems applications (especially EDI software) with internal applications. However, the investment in the systems is often asymmetrical. While in the cases involving AutoEuropa and Bovis, the larger investment was done by the leading firms in the development of the overall system which were supplied afterwards to the target firm, in the remaining cases the investments was, in generic terms, symmetrical.

Finally, the cases demonstrate that the development of electronic trading systems is not solely a technological problem. Indeed, they illustrate that there is a set of technological solutions available to cope with different sorts of information exchange requirements, which can provide a high-level of automation and sophistication, even in the construction industry.

8.3 - Cross-case analysis of determinant factors in electronic trading development

8.3.1 - Cross-case analysis of relationship influence



8.3.1.1 - Exchange episodes

Table 8.2 Exchange episodes adoption pattern in construction cases

	Information	*Product*	*Financial*	*Social*
Bovis-CB *(e-mail system)*	High frequency, complex; volume; technical and design type; irregular	Irregular; complex; direct exchanges with the client only	Irregular; large for both firms; direct with client only	
Bovis-SB *(e-mail system)*	Medium / high frequency; complexity; volume; technical and design type; irregular	Irregular; complex; direct exchanges with the client only	Irregular; large for both firms; direct with client only	
BCC-BBM *(EDI system)*	Very high frequency; and volume; regularity; commercial type	High regularity; and volume; simple	Regular; very large volume.	Meetings in MERNET first personal contacts
BCC-BRM *(EDI system)*	High frequency and volume; regularity; commercial type	High / medium regularity; and volume; simple	Regular; large volume	Meetings in CITE first personal contacts
CAS-LCEC *(EDI system)*	Medium frequency; and volume; low regularity; commercial type	Uncertain; medium / low volume; simple	Medium volume; but low regularity	Meetings in CITE first personal contacts
CAS-LCC *(EDI system)*	Medium frequency; and volume; low regularity; commercial type	Uncertain; medium /low volume; simple	Medium volume; but low regularity	Meetings in CITE first personal contacts

Plain: enabling influence Underlined: hindering influence Blank: not relevant

From the analysis of Table 8.2, the frequency, volume, and type of information exchange clearly emerge as an exchange episodes adoption enabling factor, common to all construction cases. Moreover, in all cases it was considered as a major factor to adoption. Information exchanges usually define the main configuration issues of electronic trading systems: information, frequency, direction of flow, and technology - EDI commercial information and e-mail based systems for technical and design information. Low regularity and frequency contribute to hinder the adoption process, mainly reflected in project-based interactions, involving the project manager with consultants and suppliers, and contractors with supplier. Evidence suggests that product and finance episodes are usually interdependent with information exchanges, and thus largely regular, intense product and finance exchanges seem to enable adoption by construction firms, while the opposite is a hindering pattern. Contradictory influence emerges regarding the complexity of information and product exchanges. While for cases of project-based e-mail systems complexity had an enabling influence, for EDI based cases simplicity of information and product exchanges triggered adoption. It is interesting to note the importance and recurrent pattern of social contacts at meetings of third-party EDI standardisation bodies, particularly CITE, for triggering the adoption process.

Table 8.3 Exchange episodes adoption pattern in non-construction cases

	Information	*Product*	*Financial*	*Social*
Automotive				
AutoEuropa-SA1 *(EDI system)*	Very high frequency; high complexity; volume; regular; commercial type	Highly complex; very frequent deliveries; regular	Very large for both firms	
AutoEuropa-SA2 *(EDI system)*	High frequency; medium complexity; volume; regular; commercial type	Medium complexity; frequent deliveries; regular	Large for both firms	
Retailing				
Sonae-SS1 *(EDI system)*	Medium frequency; regular; volume; commercial type	Regular; simple	Medium, specially for SS1	
Sonae-SS2 *(EDI system)*	Medium / low frequency; regular; commercial type	Regular; simple	Medium, specially for SS2	Participation on a Codipor meeting

Plain: enabling influence   Underlined: hindering influence   Blank: not relevant

Case studies depicted in Table 8.3, demonstrate that the high frequency, volume, regularity, and type of information exchanges are a common enabling pattern on the automotive and retailing situations, and like in construction cases, it has a major influence and the characteristics of electronic trading systems derive much from their features. Regular and large product and financial exchanges also have an enabling influence on the adoption decision. While in the automotive cases complexity of information and product exchanges are identified as enablers for adoption, in the retailing cases it is the simplicity of the information and product exchanges that is considered as the enabler for adoption. Social contacts on third-party EDI bodies were only relevant on one of the retailing cases, it was considered with little enabling influence for adoption.

Table 8.4 Exchange episodes sophistication pattern in construction cases

	Information	*Product*	*Financial*	*Social*
Bovis-CB *(e-mail system)*	High frequency; complex; volume; technical and design	Complex; high delivery frequencies	Large for both firms	
Bovis-SB *(e-mail system)*	Medium / high frequency; complexity; volume; technical and design	Medium complexity; high delivery frequencies	Large for both firms	
BCC-BBM *(EDI system)*	Very high frequency; volume; regularity		Very large and regular volume.	
BCC-BRM *(EDI system)*	High frequency; volume; regularity		Large and regular volume	
CAS-LCEC *(EDI system)*	Medium frequency; and volume; low regularity;			
CAS-LCC *(EDI system)*	Medium frequency; volume; low regularity			

Plain: enabling influence   Underlined: hindering influence   Blank: not relevant

Frequency, regularity, and volume of information exchanges, along with large financial exchanges were considered as major enablers for the development of sophisticated electronic trading systems between constructions firms, and from analysis of Table 8.4 it emerges that they emerge as a clear pattern. On the cases of project-based e-mail system, involving project manager with consultant and supplier, the complexity of information and product exchange episodes are also identified as important enablers for the sophisticated configuration of systems.

Table 8.5 Exchange episodes sophistication pattern in non-construction cases

	Information	*Product*	*Financial*	*Social*
Automotive				
AutoEuropa-SA1 *(EDI system)*	Very high frequency; high complexity; volume; regular	Complex; very frequent deliveries; regular	Very large for both firms	
AutoEuropa-SA2 *(EDI system)*	High frequency; medium complexity; regular	Frequent deliveries; regular	Large for both firms	
Retailing				
Sonae-SS1 *(EDI system)*	Medium frequency; regular; volume;		Medium, specially for SS1	
Sonae-SS2 *(EDI system)*	Medium / low frequency regular			

Plain: enabling influence Underlined: hindering influence Blank: not relevant

From Table 8.5 it can be suggested that the frequency and regularity of information and product exchange episodes, along with financial exchanges are the main type of episodes that enable the development of sophisticated electronic trading systems configurations in the automotive and retailing cases. Other identified less relevant enablers for sophistication are the complexity of information and product exchanges in the automotive cases.

8.3.1.2 - Atmosphere

The analysis of Table 8.6 suggests that a co-operative atmosphere between construction firms, like e.g. joint identification of problems or improvements, along with past and mutual expectation of future long-term trading emerge as clear enabling patterns for the adoption of electronic trading systems. Individual cases demonstrate also that these are considered adoption major enabling factors. Where interaction between firms is project-based, the hindrance of deploying a temporary system seems to be overcome by the enabling factor of the long duration of the project, and the expectation of future projects. However, in the two only cases where it occurred, leading firm's (project manager) co-operative attitude by supplying and implementing the core parts of the system, and power pressure from client, project manager and design team was considered as the major adoption enabling factor. Closeness in the form of previous administrative bonding between firms was identified as a minor enabling factor for the adoption process by construction firms.

Table 8.6 Atmosphere adoption pattern in construction cases

	Closeness	*Co-operation*	*Power dependence*	*Expectations*
Bovis-CB *(e-mail system)*		Transparency; work together for improvements; Bovis supply and implementation of system	Client's pressure over CB; Bovis importance in the industry	Long duration of project; other running and future projects involving both firms; temporary system
Bovis-SB *(e-mail system)*		Transparency; work together for improvements; Bovis supply and implementation of system	SB compliance with Bovis requirements; client and design team demand for the system	Long duration of project; for SB, to be selected in future projects by Bovis; temporary system
BCC-BBM *(EDI system)*	Joint information management initiative; good personal relations between IT people	Seek win-win situations; joint resolution of problems		Past and envisaged long-term trading.
BCC-BRM *(EDI system)*		Seek win-win situations; joint resolution of problems and decrease of prices		Past and envisaged long-term trading.
CAS-LCEC *(EDI system)*				Past and envisaged long-term trading; but project-based
CAS-LCC *(EDI system)*				Past and envisaged long-term trading; but project-based

Plain: enabling influence   Underlined: hindering influence   Blank: not relevant

Table 8.7 illustrates that closeness, in the form of administrative, production and logistical bonding, strong co-operation regarding joint improvements, and past and mutual expectations of future long-term trading clearly emerge as enabling patterns of adoption of electronic trading systems in automotive and retailing cases. These were also considered as having a major influence. Moreover, automotive cases demonstrate also the high importance for the adoption decision of the leading firm's power to dictate ways of working, especially regarding the deployment of electronic trading systems, and of supplying and implementing the systems to target firms.

Table 8.7 Atmosphere adoption pattern in non-construction cases

	Closeness	*Co-operation*	*Power dependence*	*Expectations*
Automotive				
AutoEuropa-SA1 *(EDI system)*	Extremely high closeness with major investments; total openness and trust	High co-operation at all levels for improvements; AutoEuropa supply / implementation of systems	AutoEuropa dictates way of working; and implementation of system	Formally set very long-term trading agreement
AutoEuropa-SA2 *(EDI system)*	JIT, quality and production bonds; openness and trust	Joint analysis of improvements; AutoEuropa supply / implementation of system	AutoEuropa dictates way of working; and implementation of system	Informal expectation of future long-term trading
Retailing				
Sonae-SS1 *(EDI system)*	Previous medium administrative and logistical bonding	Common joint innovation and improvements		Past and envisaged long-term trading
Sonae-SS2 *(EDI system)*	Previous small administrative and logistical bonding	SS2 co-operates towards Sonae's requirements		Past and envisaged long-term trading

Plain: enabling influence Underlined: hindering influence Blank: not relevant

Table 8.8 shows that the most significant atmosphere enabling factors for the development of sophisticated systems by construction firms are the power pressure of the leading firms (project manager and client) towards its development combined with its co-operative attitude in supplying and implementing the system for the target firm. The importance of these factors is reinforced by their emergence only in the cases which have the most sophisticated configurations. Past and mutual expectations of future long-term trading emerge also as an important enabling factor for sophistication of electronic trading system by construction firms, whereas the temporary nature of the system is identified as hindering sophistication.

Table 8.8 Atmosphere sophistication pattern in construction cases

	Closeness	*Co-operation*	*Power dependence*	*Expectations*
Bovis-CB *(e-mail system)*		Bovis supply and implement system; partly joint decision on configuration	Bovis and client pressure over CB to implement full system	Use part of the system and know-how for other projects; temporary system
Bovis-SB *(e-mail system)*		Bovis supply and implement system	Bovis and client pre-contract demand to SB implement system	Temporary system
BCC-BBM *(EDI system)*				Past and envisaged long-term trading.
BCC-BRM *(EDI system)*				Past and envisaged long-term trading.
CAS-LCEC *(EDI system)*				Project-based trading
CAS-LCC *(EDI system)*				Project-based trading

Plain: enabling influence Underlined: hindering influence Blank: not relevant

Table 8.9 Atmosphere sophistication pattern in non-construction cases

	Closeness	*Co-operation*	*Power dependence*	*Expectations*
Automotive				
AutoEuropa-SA1 *(EDI system)*	Embedded in other major production and logistical bonding	AutoEuropa fully supply and implement systems	AutoEuropa dictates configuration of systems	Formally set very long-term trading agreement
AutoEuropa-SA2 *(EDI system)*	Embedded in other production and logistical bonding	AutoEuropa fully supply and implement system	AutoEuropa dictates configuration of systems	Envisaged long-term trading
Retailing				
Sonae-SS1 *(EDI system)*		Common joint innovation and improvements		Past and envisaged long-term trading
Sonae-SS2 *(EDI system)*			Lack of Sonae's pressure	

Plain: enabling influence Underlined: hindering influence Blank: not relevant

Table 8.9 illustrates that in automotive cases, the sophistication of electronic trading systems derive essentially from the leading firm's high power to exert pressure in the deployment by suppliers, along with the co-operative attitude of supplying and implementing the core of the system on target firms. However, this co-operative pressure is embedded in the two other enabling atmosphere factors that are the large production, logistical and administrative bonding between firms, and the mutual expectations of long-term trading. Regarding the retailing cases, the emergent enabling factors of sophistication are the co-operative attitude between firms and the past and expected long-term duration of the relationship. The lack of pressuring power by the leading firm was identified as a sophistication hindering factor, though not considered as highly relevant. Still, in non-construction cases, the more sophisticated cases were those where there was a co-operative pressure - automotive cases.

8.3.1.3 - Summary and conclusions on the influence of relationship

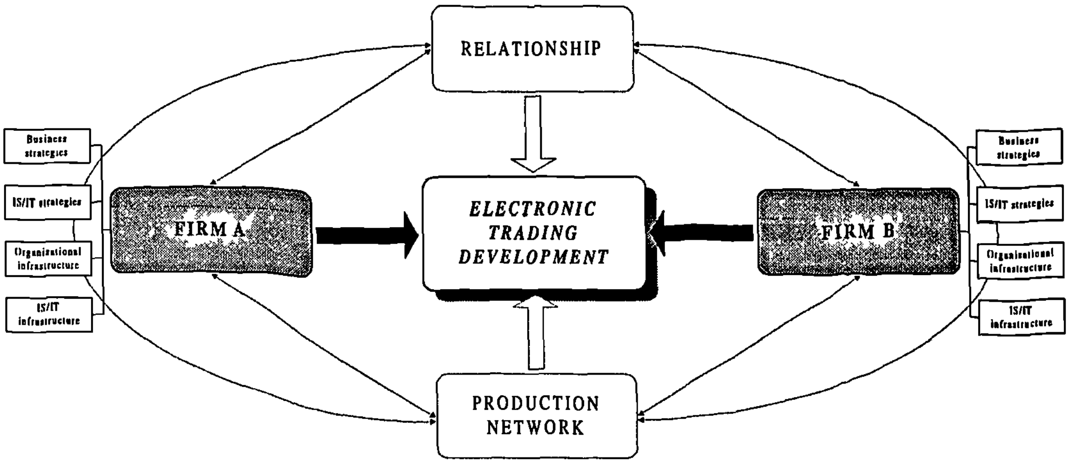
From the comparison of cases studies depicted in Table 8.10, it can be concluded that the major factors enabling adoption are very similar to the major factors enabling sophistication, both within construction and non-construction but also between these groups. Thus, cases studies suggest that with regard to the relationship element of the CONNET model, the main factors influencing adoption and sophistication are: **the frequency, regularity, volume, type, of information exchanges; large and regular financial exchanges; leading firm co-operative attitude through supplying and implementing systems; leading firm power pressure on implementation of systems; strong co-operative attitudes regarding improvements, resolution of problems; past and mutual expectations of long-term trading**. The main difference between construction and non-construction cases regards the importance of **closeness** between firms. This is a factor that is clearly more relevant in the automotive and retailing cases than in construction. The importance for adoption of **social contacts at CITE meetings** for construction firms is also a distinguishing factor.

Table 8.10 Summary of relationship adoption and sophistication enabling factors

	Adoption enabling factors	*Sophistication enabling factors*
Construction	• **Frequency, regularity, volume, type** and complexity/simplicity of **information exchanges;** • **Large and regular product and financial exchanges;** • **Project manager (leading firm) co-operative attitude through supplying and implementing systems;** • **Project manager, client and architect (leading firms) power pressure on implementation of systems;** • **Co-operative attitude regarding improvements, resolution of problems;** • **Past and mutual expectations of long-term trading;** • **Long duration of projects;** • **Social contacts at third-party EDI bodies, particularly on CITE meetings;** • Administrative bonding between firms.	• **Frequency, regularity and volume of information exchanges;** • **Large and regular financial exchanges;** • **Project manager (leading firm) co-operative attitude through supplying and implementing systems;** • **Project manager, client and architect (leading firms) power pressure on implementation of systems;** • **Past and mutual expectations of long-term trading;** • Complexity of technical and design information exchanges.
Non-construction	• **Frequency, regularity, volume, type,** complexity / simplicity **of information exchanges;** • **Large and regular finance exchanges;** • **Leading firm co-operative attitude through supplying and implementing systems;** • **Leading firm power pressure on implementation of systems;** • **Administrative, production and logistical bonding between firms;** • **Strong co-operative attitudes regarding improvements, resolution of problems;** • **Past and mutual expectations of long-term trading;** • Social contacts at third-party EDI bodies	• **Frequency, regularity and volume of information exchanges;** • **Large and regular financial exchanges;** • **Leading firm co-operative attitude through supplying and implementing systems;** • **Leading firm power pressure on implementation of systems;** • **Administrative, production and logistical bonding between firms;** • **Strong co-operative attitudes regarding improvements, resolution of problems;** • **Past and mutual expectations of long-term trading;** • Complexity of information and product exchanges

Bold: major influence Plain: less relevant influence

8.3.2 - Cross-case analysis of the influence of a firm's internal features



8.3.2.1 - Business and IS/IT strategies

Results in Table 8.11 depict that leading and target firms' business strategies of developing more co-operative, closer and longer-term relationships with each other emerge as a clear pattern of enabling adoption of electronic trading systems by construction firms. However, these strategies were not considered *per se* very important. Where the target firm is a customer, purchasing strategies of project-based buying, and of giving priority to closeness and co-operation with customers rather than suppliers have hindered adoption. Business strategy of being in the leading-edge was also identified as an enabling factor though with little relevance and present in only a few cases.

Regarding IS/IT strategies, the pattern of a leading firms' strategy of achieving full internal and external IT integration and automation emerges as being a common major enabler for adoption. Interesting is the project manager's formal IT strategy of suggesting the implementation of project-based e-mail system to client and other parties for large, fast-track or geographically dispersed projects. The target firms' strategy of developing EDI with suppliers (as in the cases that they are customers) enables adoption, though the definition of a critical mass of EDI users emerge as a strong hindering factor, and its relevance highlighted by being present in the two only cases where adoption did not occur. Adoption can also be hindered when leading and target firms have different EDI priorities.

Table 8.11 Business and IS/IT strategies adoption pattern in construction cases

	Leading firm's business strategy	*Target firm's business strategy*	*Leading firm's IS/IT strategy*	*Target firm's IS/IT strategy*
Bovis-CB *(e-mail system)*	Project partnership with client, and others parties; continuous improvement and challenging work	Being on the leading-edge; get large projects; co-operate with client and Bovis	On big or special projects replace paper-based IS for electronic systems; full internal and external IT integration	Develop expertise on electronic links, Internet and Intranets.
Bovis-SB *(e-mail system)*	Project partnership with client, and others parties; continuous improvement and challenging work; preferred suppliers	Obtain large projects; maintain good relationship with Bovis	On big or special projects replace paper-based IS for electronic systems; full internal and external IT integration	Develop expertise on e-mail and Internet
BCC-BBM *(EDI system)*	Leading-edge on production and management; closer relationships with customers	Priority to closeness with customers	Seek full internal and external IT integration (EDI) and automation	EDI primarily with customers;
BCC-BRM *(EDI system)*	Leading-edge on production and management; closer relationships with customers	Improve interface processes with customers and suppliers	Seek full internal and external IT integration (EDI) and automation	EDI with suppliers
CAS-LCEC *(EDI system)*	Sales strategy of closer relationships with customers; improve interface processes	Project-based purchasing policy; reduction of supply base	Seek full internal IT integration; develop EDI with main customers	EDI with suppliers; critical mass of EDI users
CAS-LCC *(EDI system)*	Sales strategy of closer relationships with customers; improve interface processes	Reduce supplier base and develop more co-operation;	Seek full internal IT integration; develop EDI with main customers	EDI with suppliers; critical mass of EDI users

Plain: enabling influence Underlined: hindering influence Blank: not relevant

From analysis of Table 8.12 it emerges that in the automotive cases, the leading firm's business strategy of having world-class logistic and production processes, developing longer-term, closer and more co-operative relationships with suppliers, along with the suppliers' strategy of being involved in such a type of relationship, are identified patterns of major enabling factors of the adoption of electronic trading systems. Similarly, in the retailing cases, the leading firm's strategies of reducing the number of suppliers and developing a more co-operative and closer relationships with selected firms, like e.g. deploying integrated logistics and efficient customer response initiatives, and suppliers willingness to be involved, emerge as important enablers to the adoption of EDI systems.

In both automotive and retailing cases, the leading firms' strategy of developing full internal IT processing and integration, and external EDI with suppliers, is identified as one of the main triggers for adoption of electronic trading systems, and common to all cases. The enabling pattern from target firms varies, from strategies of full internal IT integration and EDI with customers, to strategies of only complying with leading firms' minimum EDI requirements.

Table 8.12 Business and IS/IT strategies adoption pattern in non-construction cases

	Leading firm's business strategy	*Target firm's business strategy*	*Leading firm's IS/IT strategy*	*Target firm's IS/IT strategy*
Automotive				
AutoEuropa-SA1 *(EDI system)*	Long-term, close, co-operative relations with suppliers; world-class processes	Trustful and co-operative relations with AutoEuropa;	Full internal and external IT processing and integration	Full internal and external IT integration
AutoEuropa-SA2 *(EDI system)*	Long-term, close, co-operative relations with suppliers; world-class processes	Evolve towards European-wide dimension	Full internal and external IT processing and integration	Implement IT requirements from AutoEuropa
Retailing				
Sonae-SS1 *(EDI system)*	Reduction of suppliers; integrated logistics and efficient customer response initiatives	Improve processes; develop closer relationships with customers, specially with Sonae	Develop full internal IT integration; EDI with suppliers	Full internal IT integration; EDI with main customers
Sonae-SS2 *(EDI system)*	Reduction of suppliers; integrated logistics and efficient customer response initiatives	Customer satisfaction; leading edge on production and logistics	Develop full internal IT integration; EDI with suppliers	Implement EDI requirements by Sonae

Plain: enabling influence Underlined: hindering influence Blank: not relevant

Table 8.13 Business and IS/IT strategies sophistication pattern in construction cases

	Leading firm's business strategy	*Target firm's business strategy*	*Leading firm's IS/IT strategy*	*Target firm's IS/IT strategy*
Bovis-CB *(e-mail system)*			Full internal and external IT integration	
Bovis-SB *(e-mail system)*			Full internal and external IT integration	
BCC-BBM *(EDI system)*		Purchasing policy of no automation	EDI automation with customers	EDI primarily with customers;
BCC-BRM *(EDI system)*			EDI automation with customers	EDI automation with suppliers; policy of phase implementation
CAS-LCEC *(EDI system)*		Project-based purchasing policy;	Develop EDI automation with main customers	Slow IT integration
CAS-LCC *(EDI system)*		Mix between central and decentralised purchasing	Develop EDI automation with main customers	EDI automation with suppliers

Plain: enabling influence Underlined: *hindering influence* *Blank: not relevant*

Table 8.13 depicts that in the construction cases studied no relevant business strategy that fostered sophistication of electronic trading systems was identified. However, purchasing strategies of having 'manual' purchasing and ordering, project-based buying and negotiation, and having a mix between a centralised and decentralised (to regional offices and sites) purchasing function have clearly emerged as a hindering pattern for the development of sophisticated EDI systems.

The IS/IT strategies of developing full IT integration and of developing EDI automation with customers and suppliers are present as an enabling pattern for sophistication on all construction cases, and its major enabling influence identified in individual cases. However, target firms' IT strategies of phasing implementation, and having a slow IT integration pace hinder efforts towards sophistication in some construction cases.

Table 8.14 Business and IS/IT strategies sophistication pattern in non-construction cases

	Leading firm's business strategy	*Target firm's business strategy*	*Leading firm's IS/IT strategy*	*Target firm's IS/IT strategy*
Automotive				
AutoEuropa-SA1 *(EDI system)*	World-class administrative, production and logistics - ILVS	Low priority to administrative processes	Full internal and external IT integration	External integration has less priority than internal
AutoEuropa-SA2 *(EDI system)*	World-class administrative, production and logistics - JIT	Very low priority to administrative processes	Full internal and external IT integration	External integration not considered in new IT strategy
Retailing				
Sonae-SS1 *(EDI system)*			EDI automation with suppliers	EDI automation with main customers
Sonae-SS2 *(EDI system)*		Comply only with minimum requirements for customer satisfaction	EDI automation with suppliers	EDI with customers is not a priority

Plain: enabling influence
Underlined: hindering influence
Blank: not relevant

Table 8.14 demonstrates that the main business strategy identified as a major enabler of the sophistication of electronic trading systems is, in the automotive cases, the leading firm's strategy of implementing world class administrative, production and logistic processes. Hindering factors identified in both automotive and retailing cases are target firms' strategies of giving low priority to administrative processes and complying only with the minimum requirements by the leading firm regarding administrative processes.

IS/IT strategies of having full internal IT integration, and external through EDI automation with suppliers and customers, particularly by leading firms, seem to emerge as a clear strong enabling pattern for sophistication in automotive and retailing cases. However, it also seems that target firms' strategies of giving low priority to external integration, especially regarding integration of EDI systems with internal applications hinders the sophistication of systems.

8.3.2.2 - Organisational and IS/IT infrastructures and processes

Table 8.15 Organisational and IT infrastructures adoption pattern in construction cases

	Leading firm's organisational infrastructure	*Target firm's organisational infrastructure*	*Leading firm's IS / IT infrastructure*	*Target firm's IS / IT infrastructure*
Bovis-CB *(e-mail system)*	Decentralised site decision-making with close link with central staff	Production processes much IT-based	Integrated IT infrastructure; IT culture; large IT resources and expertise; supply and implementation of system	Large IT expertise and experience; acquire hardware and software
Bovis-SB *(e-mail system)*	Decentralised site decision-making with close link with central staff; careful analysis of suppliers	Disruption of normal activities due firm's small size	Integrated IT infrastructure; IT culture; large IT resources and expertise; supply and implementation of system	Lack of enough IT expertise; acquire hardware and software
BCC-BBM *(EDI system)*	Streamlined, integrated and centralised administrative functions	Streamlined, integrated and centralised administrative functions	Central mainframe, IT integration across functions and regional offices; EDI expertise	Internal IT integration across functions and regional offices; large IT resources
BCC-BRM *(EDI system)*	Streamlined, integrated and centralised administrative functions	Invoice and payment processes streamlined and centralised	Central mainframe, IT integration across functions and regional offices; EDI expertise	Accounting functions fully IT automated; lack of EDI experience and resources
CAS-LCEC *(EDI system)*	Streamlined, integrated and mostly centralised administrative functions	Central invoice processing; lack of integration across regional offices and sites	Internal full IT integration, also with regional offices; large IT expertise	Highly heterogeneous IT platform with little IT integration across functions and sites
CAS-LCC *(EDI system)*	Streamlined, integrated and mostly centralised administrative functions	Central invoice processing; good administrative processes	Internal full IT integration, also with regional offices; large IT expertise	High-level of IT use on office and sites; medium-level of integration; large IT resources

Plain: enabling influence Underlined: hindering influence Blank: not relevant

From the analysis in Table 8.15, it becomes clear that for EDI-based systems, full or partly centralised, streamlined, and integrated administrative functions, especially on leading firms, emerge as a common and important enabling pattern for EDI adoption by construction firms. Contrary situations, particularly by target firms seem to hinder adoption. In the project-based e-mail system cases, it is the existence of efficient decentralised site decision-making management systems, in close interaction with central office staff, that is an important enabler adoption of systems. On one situation the disruption of normal activities on target firm due to implementation and use of the system was identified as hindering adoption.

As far as IS/IT infrastructures are concerned, the cases depict that the existence of a full or partly integrated internal IT infrastructure, across functions and with local offices and sites, along with the availability of large IT resources are common major enablers to the adoption decision, essentially present on leading firms. The opposite situation, lack of IT integration and resources, has a hindering effect, as depicted by some cases. An important enabling pattern, identified in the project-based e-mail system cases, is also when the leading firm has resources so that is able to supply and implement the core of the system to target firms. This is particularly relevant because it occurs on the construction cases with the higher levels of sophistication.

Analysis of both automotive and retailing cases in Table 8.16 illustrates that centralised, streamlined and integrated administrative functions emerge as a clear pattern of a factor with a major enabling influence for adoption of electronic trading systems. An adoption enabling factor identified in the automotive cases is the criticality of electronic trading systems for the production and logistical processes.

The existence of internal IT integration across functions, and also electronic links with local offices, along with the availability of large IT resources, are major enabling factors for the adoption of systems which emerge as a clear pattern. A major enabler on the adoption in the automotive cases is also leading firm's large IT resources that allow to supply and implement the core parts of the electronic trading system to the target firms, especially as suppliers have not available enough IT resources.

Table 8.16 Organisational and IT infrastructures adoption pattern in non-construction cases

	Leading firm's organisational infrastructure	*Target firm's organisational infrastructure*	*Leading firm's IS / IT infrastructure*	*Target firm's IS / IT infrastructure*
Automotive				
AutoEuropa-SA1 *(EDI system)*	Centralised administrative functions; ILVS production and logistics requires systems	Production and logistics need systems	Fully IT integrated and automated; very large IT resources; supply and implementation of systems	
AutoEuropa-SA2 *(EDI system)*	Centralised administrative functions; JIT production and logistics		Fully IT integrated and automated; very large IT resources; supply and implementation of systems	Lack of IT resources
Retailing				
Sonae-SS1 *(EDI system)*	Centralisation; streamline and integration of administrative functions	Streamlined and integration of administrative functions	Full electronic linkage between local stores and centralised applications	IT processing platform full internally integrated; medium IT resources
Sonae-SS2 *(EDI system)*	Centralisation; streamline and integration of administrative functions	Partly streamlined and partly integrated administrative functions	Full electronic linkage between local stores and centralised IT applications	Reasonably degree of IT integration; access to EDI expertise; medium IT resources

Plain: enabling influence   Underlined: hindering influence   Blank: not relevant

The analysis of Table 8.17 demonstrates the importance of having efficient and adequate organisational infrastructures for the development of sophistication of electronic trading systems by construction firms. Thus, for EDI-based cases, there is a clear pattern of the important enabling influence of centralised, streamlined, integrated administrative functions. Conversely, the decentralisation and fragmentation of functions like purchasing (particularly by target firms) emerge as hindering the sophistication of systems. A different situation occurs on project-based e-mail systems, where it is the project manager's efficient decision-making systems, decentralised to site but in close interaction with central staff that is a major enabler of the sophistication of the system. Internal IT integrated infrastructure, across functions and regional offices and sites, along with the availability of large IT resources, which are more common in leading firms, emerge also as a clear and important enabler of sophistication of electronic trading systems by construction firms. Large IT resources become particularly relevant when the leading firm has the ability to supply and implement the core of the system to target firms. In the opposite situation, i.e. low levels of IT processing in administrative functions, low-levels of IT integration across functions, sites, and regional offices, emerge as a clear hindering pattern to sophistication.

Table 8.17 Organisational and IT infrastructures sophistication pattern in construction cases

	Leading firm's organisational infrastructure	*Target firm's organisational infrastructure*	*Leading firm's IS / IT infrastructure*	*Target firm's IS / IT infrastructure*
Bovis-CB *(e-mail system)*	Decentralised site decision-making with close link with central staff		Integrated IT infrastructure; large IT resources and expertise; supply and implementation of system	
Bovis-SB *(e-mail system)*	Decentralised site decision-making with close link with central staff		Integrated IT infrastructure; large IT resources and expertise; supply and implementation	
BCC-BBM *(EDI system)*	Streamlined, integrated and centralised administrative functions	Streamlined, integrated and centralised administrative functions	Central mainframe, IT integration across functions and regional offices; big EDI experience	Internal IT integration across functions and regional offices; IT expertise
BCC-BRM *(EDI system)*	Streamlined, integrated and centralised administrative functions	Purchasing functions partly decentralised and not streamlined	Central mainframe, IT integration across functions and regional offices; EDI expertise	Purchasing low level of automation and IT links with regional offices; EDI experience and resources
CAS-LCEC *(EDI system)*	Streamlined, integrated and mostly centralised administrative functions	Decentralisation of administrative functions to regional offices and sites; and lack of integration across functions	Internal full IT integration, also with regional offices; large IT expertise	Poor IT invoice processing; lack of IT integration across functions, regional offices and sites; low IT resources
CAS-LCC *(EDI system)*	Streamlined, integrated and mostly centralised administrative functions	Mix between central and decentralised purchasing	Internal full IT integration, also with regional offices; large IT expertise	Not full IT integration of invoice processing with sites

Plain: enabling influence   Underlined: hindering influence   Blank: not relevant

Table 8.18 Organisational and IT infrastructures sophistication pattern in non-construction cases

	Leading firm's organisational infrastructure	*Target firm's organisational infrastructure*	*Leading firm's IS / IT infrastructure*	*Target firm's IS / IT infrastructure*
Automotive				
AutoEuropa-SA1 *(EDI system)*	Centralised administrative functions; ILVS production and logistics		Fully IT integrated and automated; very large IT resources; supply and implementation of systems	Lack of enough IT resources to cope with full integration demands
AutoEuropa-SA2 *(EDI system)*	Centralised administrative functions; JIT production and logistics	Poor internal administrative processes	Fully IT integrated and automated; very large IT resources; supply and implementation of systems	Very heterogeneous, stand alone, idiosyncratic IT platform; lack of IT resources; and EDI expertise
Retailing				
Sonae-SS1 *(EDI system)*	Centralisation; streamline and integration of administrative functions	Streamlined and integration of administrative functions	Full electronic linkage between local stores and centralised IT applications; large IT resources	IT processing platform internally full integrated; medium IT resources; lack of EDI experience
Sonae-SS2 *(EDI system)*	Centralisation; streamline and integration of administrative functions	Processing of orders, stock inventory and logistics structure do not support EDI automation	Full electronic linkage between local stores and centralised IT applications	Some administrative applications do not support EDI

Plain: enabling influence Underlined: hindering influence Blank: not relevant

Table 8.18 depicts as a clear pattern on both automotive and retailing cases, leading firms' centralised, streamlined and integrated administrative functions important enabling influence for the development of sophisticated configurations. As hindrances to the sophistication decision process are identified target firms' inefficient or inadequate administrative processes. The automotive cases depict also the importance of leading firm's very demanding production and logistical processes to sophistication.

In both automotive and retailing cases, the existence of integrated IT infrastructures, across functions and linking local office's applications to central IT processing, emerge as a clear and important enabler of sophistication of systems. The availability of large IT resources, especially when the leading firm is able to supply and implement to target firm the core of the electronic trading system is also a very important contributor to the sophistication process. Conversely, the lack of IT resources, low levels of IT integration or inadequacy of internal applications to EDI systems emerge as hindrances.

8.3.2.3 - Summary and conclusions on the influence of a firm's internal features

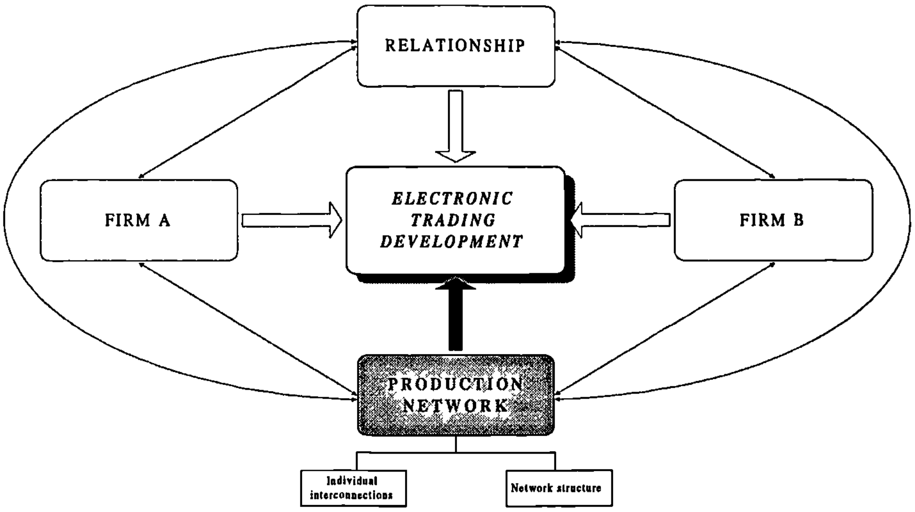
From the comparison of cases studies depicted in Table 8.19, it can be concluded that there are common adoption and sophistication enabling factors to both construction and non-construction situations. Thus, cases studies suggest that the main adoption and sophistication enabling factors of a firm's internal features are: **firms' IS/IT strategy of full internal and external IT integration and automation; centralised, streamlined and integrated administrative functions or efficient decentralised decision-making systems in close interaction with central functions; integrated internal IT infrastructure, across functions, regional offices and sites; large IT resources available, particularly if able to supply systems to target firms**. Some differences within construction and between construction and non-construction cases can also be identified. Thus, **no definition of a critical mass of EDI users for individual EDI adoption**; and **leading firm's formal IT strategy of implementing the project-based e-mail system for projects with specific characteristics**, were identified as important adoption enablers in construction but are neither considered as sophistication enabling factors nor identified in non-construction cases. In non-construction cases, other factor of for adoption and sophistication is **leading firm's business strategy of achieving world-class processes.**

Table 8.19 Summary of firm's internal features adoption and sophistication enabling factors

	Adoption enabling factors	*Sophistication enabling factors*
Construction	• **Leading firms' IS/IT strategy of full internal and external IT integration and automation;** • **Project manager e-mail system strategy for large, fast track or geographically dispersed projects;** • **No definition of a critical mass of EDI users;** • **Centralised, streamlined and integrated administrative functions;** • **Efficient site decision -making system in close interaction with central office staff;** • **Integrated internal IT infrastructure, across functions, regional offices and sites;** • **Large IT resources available, particularly if able to supply systems to target firms;** • Leading and target firms' business strategies of fostering co-operation, closeness and longer-term relationships; to be in the leading-edge • Target firms' strategy of EDI development; • Aligning leading and target firms' EDI priorities;	• **Firms' IS/IT strategies of full IT integration and automation;** • **Centralised, streamlined and integrated administrative functions;** • **Efficient site decision -making system in close interaction with central office staff;** • **Integrated internal IT infrastructure, across functions, regional offices and sites;** • **Large IT resources available, particularly if able to supply systems to target firms;** • Centralised, time-based rather than project based purchasing strategies;
Non-construction	• **Leading firm's business strategy of achieving world-class administrative, production and logistical processes;** • **Leading firms' IS/IT strategy of full internal and external IT integration and automation;** • **Centralised, streamlined and integrated administrative functions;** • **Integrated internal IT infrastructure, across functions, regional offices and sites;** • **Large IT resources available, particularly if able to supply systems to target firms;** • Criticality of IT systems to production and logistics; • Leading and target firms' business strategies of fostering co-operation, closeness and longer-term relationships; • Target firms' strategies of full IT integration, EDI with customers, and EDI compliance;	• **Leading firm's business strategy of achieving world-class administrative, production and logistical processes;** • **Leading and target firms' IS/IT strategies of full internal IT integration and EDI automation;** • **Centralised, streamlined and integrated administrative functions;** • **Integrated internal IT infrastructure, across functions, regional offices and sites;** • **Large IT resources available, particularly if able to supply systems to target firms;** • Target firms' priority to administrative processes; • Demanding production and logistical processes;

Bold: major influence Plain: less relevant influence

8.3.3 - Cross-case analysis of the influence of production network



8.3.3.1 - Individual interconnections and network structure

From Table 8.20 it is possible to identify in EDI-based construction cases an enabling pattern for adoption of systems regarding the importance of firms' connections with third-party EDI bodies, especially the CITE initiative. In the project-based e-mail system cases, the importance to the interactions project manager - consultant and project manager - supplier, the role of the client but also of the remaining design team become evident. In all construction cases the development of electronic trading systems was not isolated from adoption by other firms, and thus, the number and characteristics of firms within the production system effect adoption. For EDI-based cases, the existence of a small number of firms with whom trading represents a high proportion of total financial and information exchanges has emerged as an adoption enabling pattern. Similarly, in project-based e-mail systems, adoption was facilitated by the small number of core users of the system, though in later stages the system would also be used by a large number of suppliers with heterogeneous characteristics. Conversely, the existence of a large number of interacting firms, in a very fragmented structure, with a high-level heterogeneity regarding size, technology, and relationships, emerged as an important factor hindering adoption. This is particularly relevant as its effect was stronger on the two cases where there is no adoption.

Table 8.20 Production network adoption pattern in construction cases

	Individual interconnection	*Input - output structure*	*Governance structure*	*Territoriality*
Bovis-CB *(e-mail system)*	Client; architect and remaining consultants; BAA; IT consultant	Ten core users of the system; large number of suppliers (200); heterogeneity	Client, Bovis, and architect formed a strong leadership but co-operative; project procurement system	Geographical dispersion of part of the project team across UK
Bovis-SB *(e-mail system)*	Client; design team; BAA; IT consultant	Ten core users of the system; large number of suppliers (200); heterogeneity	Client, Bovis, and architect formed a strong leadership but co-operative; project procurement system; Bovis leadership *over suppliers*	Geographical dispersion of part of the project team across UK
BCC-BBM *(EDI system)*	Links with CITE and MERNET	BCC 12 customers with EDI - 50% of invoice exchange; mostly medium / large-size. BBM, EDI with 30 firms - 35% of total invoices exchange		
BCC-BRM *(EDI system)*	Links with CITE	BCC, 12 customers with EDI - 50% of invoice exchange; mostly medium / large-size. BRM, EDI with 5 firms - 10% total invoices		
CAS-LCEC *(EDI system)*	Links with CITE	LCEC's large number and great heterogeneity of suppliers; only 18 potential EDI users, representing low proportion of information and turnover; CAS's main customers represent large proportion of sales	LCEC has little pressuring power over suppliers, mainly due to purchasing strategy	Geographical dispersion of projects increases fragmentation of suppliers
CAS-LCC *(EDI system)*	Links with CITE	LCC's large number and great heterogeneity of suppliers; only 25 potential EDI users, representing low proportion of information and turnover; CAS's main customers represent large proportion of sales	LCC does not exert leading power that has over some suppliers for EDI;	Geographical dispersion of projects increases fragmentation of suppliers

Plain: enabling influence Underlined: hindering influence Blank: not relevant

In the cases having a co-operative leadership that strongly influences the co-ordination of the network, this has emerged as a major enabler for the adoption of the electronic trading systems. In the project-based e-mail cases, this leadership is formed by the client's and project manager's attitude along with the co-operation of the architect. This leadership is also possible partly because of the construction management procurement system. The project manager ability's to influence its preferred suppliers also contributes to the adoption. The absence of leadership on the two EDI contractor-supplier cases seems to hinder adoption, though on the remaining EDI cases this is not seen as a relevant influencing factor. Finally, geographical dispersion of firms seems to contribute to adoption of electronic trading systems, though on the contractor-supplier cases the geographical dispersion of projects was seen as contributing to the large fragmentation of suppliers, and thus, indirectly hindering adoption.

Table 8.21 illustrates that there is some evidence that individual interconnections with IT consultants, third-party EDI organisations, and other EDI linked firms contributes to the adoption of systems in automotive and retailing cases, but no clear pattern is established. In automotive cases, the existence of a small number of firms (ten) that represent 50% of turnover and 90% of information exchanges, is identified as a major enabling factor influencing the adoption process of electronic trading systems. Moreover, in spite of the large number of remaining suppliers their relative homogeneity and previous experience with EDI facilitated adoption. On retailing cases, leading firm's EDI links with other firms enabled adoption, though for target firms the absence of other EDI-customers is seen as hindering adoption.

In the automotive cases, a major enabling factor to adoption that has emerged is the leading firm's strong but co-operative leadership over most suppliers, especially because it convinces all suppliers to adopt electronic trading systems. The geographical dispersion of suppliers across Europe is identified as fostering adoption decision.

Table 8.21 Production network adoption pattern in non-construction cases

	Individual interconnections	*Input - output structure*	*Governance structure*	*Territoriality*
Automotive				
AutoEuropa-SA1 *(EDI system)*		Core group of 10 suppliers represent 50% of turnover and 90% information; other 600 suppliers; homogeneous; medium-size; previous EDI experience	AutoEuropa has a strong leadership capability over most suppliers; combined with co-operation	Geographical dispersion of suppliers across Europe
AutoEuropa-SA2 *(EDI system)*		Core group of 10 suppliers represent 50% of turnover and 90% of information; other 600 suppliers; homogeneous; previous EDI experience	AutoEuropa has a strong leadership capability over most suppliers; combined with co-operation	Geographical dispersion of suppliers across Europe
Retailing				
Sonae-SS1 *(EDI system)*	Common IT consultant			
Sonae-SS2 *(EDI system)*	Sonae EDI link with SS1; both firms link with Codipor	Sonae development of EDI with other firms; lack of SS2's other customers EDI interest		

Plain: enabling influence Underlined: hindering influence Blank: not relevant

Analysis of Table 8.22 demonstrates that in the project-based e-mail system cases the individual interconnections of the project manager, consultant and suppliers with the client, architect and remaining design team enable the development of a sophisticated system configuration, as they were all involved in the configuration decision. The sophisticated configuration of the system was also facilitated by the small number of core users. The most important enabler of the sophistication was, however, the leadership provided by the client's and project manager's attitude along with the co-operation of the architect. This leadership was partly possible due to the type of construction management procurement system. This leadership was combined with a co-operative attitude of supplying and implementing to users the main parts of the system.

On some EDI-based cases, sophisticated automated individual EDI connections of the leading firm with other firms were seen as examples to be followed, and thus enable the development of other sophisticated systems.

Table 8.22 Production network sophistication pattern in construction cases

	Individual interconnections	*Input - output structure*	*Governance structure*	*Territoriality*
Bovis-CB *(e-mail system)*	Client; architect and remaining consultants;	Small number of core users of the system;	Client, Bovis, and architect formed a strong leadership; but co-operative	
Bovis-SB *(e-mail system)*	Client; design team	Small number of core users of the system;	Client, Bovis, and architect formed a strong leadership; but co-operative	
BCC-BBM *(EDI system)*	BCC has full EDI automation with 2 customers			
BCC-BRM *(EDI system)*	BCC has full EDI automation with 2 customers			
CAS-LCEC *(EDI system)*				
CAS-LCC *(EDI system)*				

Plain: enabling influence Underlined: hindering influence Blank: not relevant

Table 8.23 illustrate two different situations regarding the development of sophisticated systems in automotive cases. One case suggests that the implementation of a very sophisticated system was partly fostered by the fact that the core users were only ten firms, representing 90% of total information exchange, and by being geographically concentrated in the industrial park. In the other case, a less sophisticated system was partly enabled by the homogeneity of the large number of suppliers, their previous EDI experience, and by their geographical dispersion across Europe. However, in both cases, the major enabler for sophistication is the leading firm's strong leadership and ability to convince all firms to implement the customised systems. The leadership is associated with the leading firm's co-operation through supplying and implementing the main parts of the sophisticated system to suppliers. On the retailing cases, the low take up of EDI systems by a large number of suppliers which represent a large proportion of information and financial exchanges, along with the leading firm's lack of leadership, mainly due to the purchasing department's lack of interest on EDI, emerge as a hindering factor.

Table 8.23 Production network sophistication pattern in non-construction cases

	Individual interconnections	*Input - output structure*	*Governance structure*	*Territoriality*
Automotive				
AutoEuropa-SA1 *(EDI system)*		Core group of 10 suppliers represent 50% of turnover and 90% of information; all adopted systems	AutoEuropa has a strong leadership capability over most suppliers; combined with co-operation	Core group of 10 suppliers installed in industrial park
AutoEuropa-SA2 *(EDI system)*		Over 600 suppliers; homogeneous; medium-size; previous EDI experience; all adopted system	AutoEuropa has a strong leadership capability over most suppliers; combined with co-operation	Geographical dispersion across Europe
Retailing				
Sonae-SS1 *(EDI system)*		Only 56 firms (2%) adopted EDI with Sonae, representing less 10% of exchanges; most suppliers are SMEs	Sonae's lack of pressuring power over suppliers, mainly due purchasing attitude	
Sonae-SS2 *(EDI system)*		Only 56 firms (2%) adopted EDI with Sonae, representing less 10% of exchanges; most suppliers are SMEs; Lack of SS2's other customers EDI interest	Sonae's lack of pressuring power over suppliers, mainly due purchasing attitude	

Plain: enabling influence   Underlined: hindering influence   Blank: not relevant

8.3.3.2 - Summary and conclusions on the influence of production network

Analysis of Table 8.24 suggests that in both construction and non-construction situations, the most important production network adoption and sophistication enabling factor is the **existence of a strong but co-operative leadership on the production**

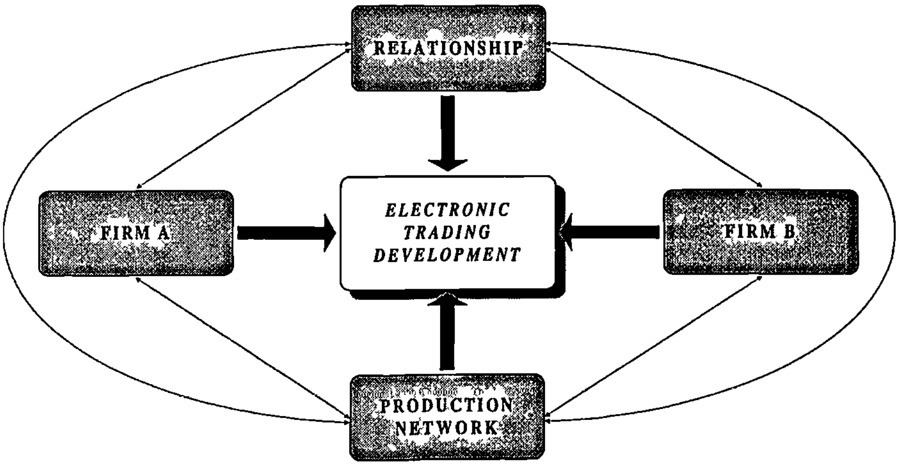
Table 8.24 Summary of production network adoption and sophistication enabling factors

	Adoption enabling factors	*Sophistication enabling factors*
Construction	• **Small number of homogeneous interacting firms in the network represent a large proportion of information and financial exchanges;** • **Existence of a strong co-operative leadership over the co-ordination of network of firms;** • **Project manager and client having a leadership position;** • **Links with EDI bodies, particularly CITE;** • Interconnections of project manager, consultant and supplier with the client and design team; • Construction management procurement system; • Geographical dispersion of firms	• **Existence of a strong co-operative leadership over the co-ordination of network of firms;** • **Project manager and client having a leadership position;** • Interconnections of project manager, consultant and supplier with the client and design team; • Small number of homogeneous interacting firms in the network represent a large proportion of information and financial exchanges; • Leading firm's individual automated EDI links with other customers
Non-construction	• **Existence of a strong co-operative leadership over the co-ordination of network of firms;** • **Leading firm positioned in the leading position;** • Interconnections with IT consultants, EDI bodies, and individual links with other suppliers or customers; • Small number of homogeneous interacting firms in the network representing a large proportion of information and financial exchanges; • Leading and target firms' EDI links with other firms; • Geographical dispersion of suppliers	• **Existence of a strong co-operative leadership over the co-ordination of network of firms;** • **Leading firm positioned in the leading position;** • **Small number of homogeneous interacting firms in the network representing a large proportion of information and financial exchanges;** • Geographical concentration of suppliers on industrial park; • Leading and target firms' EDI links with other firms; • Geographical dispersion across Europe;

Bold: major influence   Plain: less relevant influence

network and that **the electronic trading development leading firm is positioned in the core of that leadership.** In the construction situation, the existence of a **small number of homogeneous interacting firms in the network that represent a large proportion of the total information and financial exchanges** and **interconnections with third-party EDI bodies (especially CITE)** are also considered important enablers for adoption, while in non-construction cases the former factor is identified as a major factor enabling sophistication.

8.3.4 - Cross-case analysis of the influence of the interplay of factors



Data collection was not designed with the purpose of drawing many insights regarding the complexity of the combinations of enabling and hindering factors and variables of adoption and sophistication of electronic trading systems. Moreover, case studies presented in this study exemplify how each case presents an almost unique combination of enabling and hindering factors, with diversified adoption and configuration results. Still, some generic insights can be made regarding the interplay of adoption and sophistication factors. These are presented below.

8.3.4.1 - Interplay of factors regarding adoption

From the analysis of the eight cases where electronic trading systems adoption occurred, i.e. the literal replication adoption cases, depicted from Tables 8.2 to 8.24, it can be easily concluded that there is, in general, a considerably larger presence of more enabling factors than hindering factors. The two case studies selected where there was no adoption, CAS-LCEC and CAS-LCC, depict a low presence of enabling factors and from the 21 relationship, firms' internal features, and production network adoption enabling factors/variables patterns previously identified in this work, only 3 were fully present in the two cases, with 6 only partly present. The absence of the remaining enabling factors has clearly hindered adoption in these cases. Thus it can be concluded **the importance for adoption of the concentration of relationship, internal firms features and production network main enabling factors**.

These two cases also suggest that the **interplay of enabling patterns of information, product; financial; and social exchanges; mutual expectations of continuing the relationship; leading firm's IS/IT strategies; administrative; and IT infrastructures and resources; and interconnections with EDI bodies, is not enough for adoption**. It becomes evident that the hindering influence of the combination of the factors: lack of a co-operative and close atmosphere, lack of pressuring power from leading firm over target firm; target firm's inadequate IT strategies, administrative and IT infrastructures; and the existence of large and heterogeneous input-output structure along with the lack of a strong but co-operative leadership in the production network.

8.3.4.2 - Interplay of factors regarding sophistication

As described in section 8.2, four cases were selected because they had low-levels of sophistication (theoretical replication sophistication cases). These were the cases of the Sonae-SS2, BCC-BBM, and the pilot cases of CAS-LCEC and CAS-LCC. The remaining cases were considered as sophisticated, though it was considered useful to distinguish the degree of sophistication into very sophisticated and sophisticated systems. From the analysis presented in Tables 8.2 to 8.24, it can be suggested that, in general, **higher-levels of sophistication of electronic trading systems, emerge when a larger number of enabling factors of sophistication are present.**

8.4 - Summary

In this chapter a horizontal analysis was made regarding the ten case studies described in chapter seven. The analysis focused on the identification of the more common and determinant enabling factors that influence adoption and sophistication of electronic trading systems. In order to facilitate pattern-matching, the analysis was based on the framework provided by the CONNET model. Conclusions about which variables of the relationship, internal firm's features, and production network factors are more determinant for electronic trading development were drawn.

CHAPTER 9

RESULTS

9.1 - Introduction

Chapter 5 presented the CONNET model as a group of variables that were theoretically identified as being relevant to influence the development of electronic trading, and the expected determining behaviour was described in four sets of theoretical propositions. This provided the framework for the empirical collection of data and analysis. Chapters 7 and 8 have described, analysed, and presented the conclusions from the case study analysis. In this chapter a comparison between the theoretical propositions and the findings of the empirical study is made, and conclusions about the degree of support and therefore of the analytical generalisation of the CONNET model is drawn.

It is important to highlight once again that it is out of the scope of this work to draw conclusions about the extent of use of electronic trading systems between the different types of relationships, e.g. between contractor-suppliers, builders merchants-suppliers, assembler-suppliers, etc. Rather, the objective is to identify and explain the behaviour of variables that are likely to influence electronic trading development.

9.2 - Electronic trading configurations

One of the main selection criteria of the ten case studies was to provide as much as possible a rich picture of the factors and variables determining electronic trading development rather than focusing too much on technology or configuration. Still, analysis of the empirical data in this study shows that the configuration of electronic trading systems, both in construction and non-construction situations, and even in situations involving the same firm, varies considerably. Configuration varied in terms of technology - EDI and e-mail based systems; in terms of information exchanged - commercial to technical and design; frequency of information exchanges - from minutes to monthly; direction of flow - one or two ways; and in terms of internal integration - from fully automated to stand-alone systems. Moreover, the degree of sophistication of systems did also varied, ranging from pilot systems only, to simple, sophisticated and very sophisticated systems.

Three main points should be made here. First, this study reinforces the assumption that despite the technical complexity of linking disparate applications from different companies, there is today enough technological solutions that support a range of electronic inter-firm information flows. Recent technologies like Internet and STEP promise to enhance this portfolio of solutions. Second, cases like Sonae with SS1 and SS2, or BCC with BBM and BRM demonstrate that the enabling factors of each electronic trading system between two firms may be quite different, reinforcing thus the importance of analysing individual connections. Third, contrary to what is often referred in the literature (see e.g. Akintoye and McKellar, 1997; O'Brien and Al-Soufi, 1994; Baldwin *et al.*, 1995), the case studies of Bovis with CB and SB or BCC-BRM demonstrate that there are examples of sophisticated electronic trading systems between construction firms.

9.3 - Adjusting the CONNET model

Based on the empirical results described and analysed in Chapters 7 and 8, it is now possible to review and adjust the CONNET model, operationalised through the four sets of propositions described in Chapter 5. The presentation of propositions distinguishes between the empirically reviewed and modified propositions - Revised Proposition, and propositions that emerged from empirical analysis - Emergent Proposition. The numbering of propositions is also reviewed according to changes.

9.3.1 - Revising the first set of propositions: the relationship influence

Theoretical Proposition 1

Intense, complex, frequent and regular information exchange episodes enable adoption.

Revised Proposition 1.

The frequency, regularity, volume, and type of information exchanged between firms is a major enabler to the adoption and contributor to the configuration of electronic trading systems.

For all case studies on both construction and non-construction situations, the frequency, volume, regularity and type of information exchange episodes was considered as a major adoption enabling factor. Moreover, those cases that adopted electronic trading systems presented high to medium levels of frequency and volume of information exchanges. The regularity of exchanges was considered as an important enabling factor, and though cases like Bovis with CB and SB, and CAS with LCEC and LCC did not present regularity on exchanges, this was seen as a hindrance to adoption. This seems to suggest that regularity is important but not fundamental to adoption. No conclusion could be reached regarding the role of complexity/simplicity of information exchanges on adoption, since different cases presented contradictory conclusions. The empirical evidence provides strong support to the original theoretical proposition but on the regularity aspects.

Theoretical Proposition 2

Intense, complex, frequent and regular information exchange episodes enables sophisticated configurations. The type of information determines the technology.

Revised Proposition 2.

The frequency, regularity, volume, complexity, and type of information exchanged between firms is a major enabler to the sophistication and contributor to the configuration of electronic trading systems. The type of information exchanged is one of the most important determinants regarding the technology to be used: EDI for commercial information, e-mail based systems for technical and design information, at present.

Construction and non-construction case studies having higher levels of systems sophistication, like those involving AutoEuropa with SA1 and SA2, or Bovis with CB and SB, had very high frequencies, volume and complexity in information exchanges. For these cases, and for most remaining cases, these characteristics were also identified as having a major influence on sophistication. Regularity was not present in all sophisticated cases, like those involving Bovis, but its absence was perceived as a hindrance. This seems to suggest that though regularity is important is not a fundamental factor. In generic terms, where there are more intense information exchanges of a commercial type, EDI-based systems were deployed, whereas technical and design information were exchanged through e-mail based systems. The empirical results provide strong support to the original theoretical proposition but on the regularity aspects.

Theoretical Proposition 3

Intensive product/service and financial exchanges facilitate the adoption and sophistication of systems.

Revised Proposition 3.

Large and regular product but essentially financial exchanges are a major enabler of electronic trading systems adoption and sophistication.

For all cases presented in this study the intensity and regularity of product and financial exchanges seem to be very much interdependent with information exchanges. Large product but essentially financial exchanges were seen as major enablers of electronic trading adoption and sophistication. Cases presenting a higher degree of sophistication had also larger financial exchanges. Regarding regularity, sophisticated cases involving Bovis - where there is no regularity of exchanges, seem to suggest that though regularity is important is not a fundamental factor. Empirical analysis provides strong support to the original theoretical proposition but on the regularity aspects.

Emergent Proposition 4.

Social contacts between IT managers of different firms on third-party EDI bodies meetings foster adoption of electronic trading systems.

For constructions cases where EDI was implemented, the social contact between IT managers from the different firms on EDI bodies seem to have been an important enabler for adoption. CITE meetings emerged as a typical example for UK construction firms. On one retailing case an EDI body was also referred, but with little relevance as an enabling factor. Empirical analysis support the proposition that social exchanges between IT managers may be relevant for EDI adoption. This was not explicitly predicted by the theoretical analysis.

Theoretical Proposition 4

Close relationships enable the adoption and sophistication of electronic trading systems.

Revised Proposition 5.

Closeness between firms in the form of administrative, production or logistical bonding enables adoption and sophistication of electronic trading systems.

Bonding between firms was a factor that was a clear and important enabler for adoption and sophistication in non-construction cases, especially on automotive cases involving AutoEuropa, but was identified as having low enabling impact on adoption and sophistication in construction cases. This may occur because construction relationships seem to have a low degree of closeness. Thus, empirical evidence provides little support to the original theoretical proposition.

Theoretical Proposition 5

Co-operation facilitates the adoption of electronic trading systems.

Revised Proposition 6.

Co-operation between firms is a major enabler to adoption of electronic trading systems. The leading firm's co-operative attitude of supplying and implementing the system to the target firm is a clear enabler of adoption but particularly of sophistication.

In cases where there was adoption of electronic trading systems, there was a reasonable degree of co-operation between firms regarding e.g. joint improvement initiatives, or resolution of problems, and these co-operation was recognised as a major enabler of adoption. The two cases where there is no adoption are the only ones with little or no co-operation. Regarding sophistication, co-operation between firms was generally identified as an important enabling factor. However, cases like AutoEuropa with the two suppliers and Bovis with consultant and supplier, show that particularly relevant for sophistication is the co-operative attitude by the leading firm through supplying and implementing the electronic trading system to target firms. The empirical results provide strong support to the original theoretical proposition and have also enhanced its scope.

Theoretical Proposition 6

Power/dependence enables the adoption and sophistication of electronic trading systems.

Revised Proposition 7.

Leading firm's power pressure on the implementation of systems is a major enabling factor for the adoption and sophistication of electronic trading systems.

Despite case studies in both construction and non-construction situations demonstrate that adoption of electronic trading systems can occur without any power pressure, they also demonstrate that in the cases where it occurs it is identified as an important enabling factor for adoption. When power pressure is exerted, the configuration of systems seems to be very much determined by the leading firm, and the construction and non-construction cases with the highest degree of sophistication are also those where power pressure was exerted. Construction cases involving Bovis with CB and SB seem to suggest that together the project manager, client and architect can be positioned in order to exert power pressure on remaining project parties. Empirical evidence provides strong support to the original theoretical proposition and have also enhanced its scope.

Theoretical Proposition 7

Long-term relationships foster the adoption of electronic trading.

Revised Proposition 8.

Past and mutual expectation of long-term trading is a major enabler of adoption and sophistication of electronic trading systems.

For cases in both construction and non-construction situations the importance of the continuity and stability of trading, not only for adoption but also for sophistication of electronic trading systems, has been identified. In project-based relationships like cases involving Bovis, although there is no formal continuity of trading, the long duration of the project, and the expectation of interaction in other projects in the foreseeable future, were considered important enablers of adoption and sophistication. Thus, despite the importance of this factor it can not be considered fundamental for electronic trading development. Empirical results give strong support of the original theoretical proposition.

9.3.2 - Revising the second set of propositions: firms' internal features influence

Theoretical Proposition 8

Business strategies fostering more close, co-operative and long-term relationships are expected to enable adoption and sophisticated electronic trading systems.

Revised Proposition 9.

Leading and target firms' business strategies of developing more co-operative, closer relationship, and longer-term relationships enables adoption of electronic trading systems. Leading firm's business strategies of world-class administrative, production and logistical processes foster adoption and sophistication.

In all case studies in both construction and non-construction situations leading firm's business strategies of enriching business relationships, of having better supply or customer chain management were identified as enabling the adoption of electronic trading systems. The importance of business strategies to the adoption was reinforced by target firms' willingness to be involved in such type of relationships. Particularly relevant seems to be the purchasing and sales strategies. There was no clear indication that business strategies contribute to the sophistication of electronic trading systems, apart from the automotive cases where the leading firm's strategy of developing world-class administrative, production and logistical processes was identified as enabling both adoption and sophistication. Empirical results support part of the original theoretical proposition, but provide little evidence regarding sophistication aspects.

Theoretical Proposition 9

The existence of an IS/IT strategy advocating the use of electronic trading systems and its alignment with the other firm strategy contributes positively to the adoption.

Revised Proposition 10.

Leading and target firms' IS/IT strategy of full internal and external IT integration and automation is a major enabler of adoption and sophistication of electronic trading systems.

For all construction and non-construction cases leading firm's IS/IT strategies of achieving full IT integration, i.e. aiming at low levels of paper-based information systems, both internally and with main customers and suppliers, was considered as a major adoption and sophistication enabler of electronic trading. While evidence suggests that for the adoption process it seems important mainly leading firm's IT integration strategies, for sophistication target's full IT integration strategy is also important. Some case studies suggest that electronic trading development may be conditioned by specific IT strategies. Cases involving Bovis demonstrate that its IT strategy defined that the deployment of the project-based electronic trading system was conditioned by specific characteristics of the project. Also, adoption decision was clearly influenced by the definition of IT strategies that defined a critical mass of EDI users in the cases involving CAS with LCEC and LCC. Empirical results provide support to the original theoretical proposition and enhance its scope.

Theoretical Proposition 10

Large IS/IT infrastructure and resources enable the adoption and sophistication of electronic trading systems.

Revised Proposition 11.

Firms' integrated internal IT infrastructure, across functions, regional offices and sites are a major enabler of adoption and sophistication of electronic trading systems. Large IT resources available, particularly by the leading firm that is able to supply and implement electronic trading system to target firm, is also a major enabler for adoption and sophistication.

For all the construction and non-construction cases studies the existence of leading and target firms' internal IT integrated infrastructure, between applications across functions, and where applicable between these and regional office or site applications, were identified as major enablers of adoption and sophistication of electronic trading systems. Moreover, an IT integrated infrastructure was present in all leading firms, though it was not present in many target firms. While IT integration is usually associated with large IT resources, it has emerged from construction and non-construction cases, that large IT resources are particularly important for adoption and sophistication when the leading firm has resources available to supply and implement systems to target firms. The empirical results provide strong support to the original theoretical proposition and have also enhanced its scope.

Theoretical Proposition 11

Efficient administrative infrastructure enables the adoption of systems and of sophisticated configurations.

Revised Proposition 12.

Centralised, streamlined and integrated administrative functions or efficient decentralised decision-making systems in close interaction with central functions are major enablers of adoption and sophistication of electronic trading systems.

For all cases in both construction and non construction situations an adequate and efficient administrative and decision-making system was identified as of a major importance to the adoption but particularly to sophistication of electronic trading systems. EDI cases highlighted that though centralised, streamlined and integrated administrative functions like purchasing, ordering, sales, accounting, are present in all leading firms, few target firms present similar pattern. This seems to enable adoption and sophistication. In e-mail system cases, like those involving Bovis, demonstrated the importance for adoption and sophistication of client and project manager site decentralised decision-making but in close interaction with central office staff. The empirical results provide strong support to the original theoretical proposition.

9.3.3 - Revising the third set of propositions: the production network influence

Theoretical Proposition 12

Exclusiveness of the relationship gives support to the adoption and configuration decisions.

Revised Proposition 13.

Exclusiveness of the relationship.

Empirical evidence in the case studies did not address this theoretical proposition. However, regarding the interconnection dimension, the following proposition has emerged.

Emergent Proposition 14.

Individual interconnections with third-party organisations may influence the adoption and sophistication of electronic trading systems, particularly EDI bodies.

From the case studies in this work, essentially in the construction situations, it is possible to suggest that some individual interconnections of leading and target firms with other customers, suppliers, IT consultants, and particularly regarding EDI cases with third-party EDI bodies like CITE, may contribute to the adoption process, and configuration of the system on issues like standards, software used, and even sophistication levels. Empirical analysis provide support to the proposition that individual interconnections may enable adoption, though patterns are not clear. This was not explicitly predicted by the theoretical analysis.

Theoretical Proposition 13

The positioning of the leading firm on the core of the production system facilitates the adoption and sophistication of electronic trading systems.

Revised Proposition 15.

The existence of strong but co-operative leadership in the production network, and the leading firm's positioning of its core is a major enabler of the adoption and sophistication of electronic trading systems.

Cases involving AutoEuropa with SA1 and SA2, and Bovis with CB and SB, demonstrate the major importance of the positioning of the leading firm on the core of a production network for adoption but essentially for the development of sophisticated systems, as these cases have the higher degree of systems sophistication. While on the automotive cases AutoEuropa is positioned as the sole and main co-ordinator of the production system, Bovis cases illustrate a different situation as the project manager is part of a co-operative co-ordinating core formed also by the client and architect. The empirical results provide strong support to the original theoretical proposition.

Theoretical Proposition 14

A small and homogeneous input-output structure of the production network contributes positively to the adoption and sophistication of electronic trading systems.

Revised Proposition 16.

The existence of a small number of homogeneous interacting firms in the network, that represent a large proportion of the total information and financial exchanges, enables adoption and sophistication of electronic trading systems.

For construction cases the existence of a small number of firms representing a large proportion of the information and financial exchanges of the input-output system of the production network was clearly identified as a major adoption enabling factor. Moreover, all construction cases but those where adoption did not occur present an input-output structure with these characteristics. Regarding sophistication, this factor was not considered so relevant. Conversely, in the non-construction cases, this factor was identified to be more important to sophistication than to adoption. Still, both construction and non-construction cases with a higher degree of sophistication, presented production networks with a small number of organisations that have a large proportion of the total amount of turnover and information exchanged. The homogeneity regarding the characteristics of the interacting firms and their relationships seems also to facilitated development. The empirical results provide strong support to the original theoretical proposition.

Theoretical Proposition 15

The geographical agglomeration of the production system facilitates the adoption of electronic trading systems.

Revised Proposition 17.

Geographical dispersion of firms stimulates adoption of electronic trading systems.

AutoEuropa cases with SA1 and SA2 depict the importance of the geographical dispersion of firms for the adoption of electronic trading. Although for the specific cases involving Bovis and CB and SB the geographical dispersion was not seen as an importnat factor, Bovis acknowledged that one of the main situations for them to convince the client for the need to the implementation of their electronic trading system is when the project team is geographically dispersed across Europe. This finding is in accordance with a recent EC funded case study research - SCENIC, about best practice of IT use in construction projects, where a similar conclusion regarding the importance of geographical location for the deployment of inter-firm IT systems was reached. Thus, it can be asserted that the geographical dispersion of firms in the production network seems to stimulate the adoption of electronic trading, though there is no clear pattern. This finding clearly contrasts with the theoretical proposition put forwarded before, but the empirical evidence also produces little support to this new found pattern.

9.3.4 - Revising the fourth set of propositions: the interplay of factors influence

The empirical analysis of case studies has not given many clear insights regarding enabling patterns of the interplay of factors. Still, some conclusions can be drawn.

Theoretical Proposition 16

The likelihood of electronic trading adoption and sophistication between two firms increases along with the rising number of enabling conditions.

Revised Proposition 18.

The concentration of relationship, firms' internal features and production network enabling factors clearly enables adoption and sophistication of electronic trading systems.

Construction and non-construction cases demonstrate that adoption and sophistication does not require the presence of all previously referred enabling factors, and in many cases the presence of important enabling adoption or sophistication factors is not enough to strongly determine development. However, the interplay of a larger number of enabling factors contributes to down play the negative influence and problems derived from the interplay of hindrances. Regarding adoption, theoretical replication cases, i.e. those were adoption did not occur but for theoretically predicted reasons, present very few enabling factors when compared the literal replication cases, i.e. those were adoption occurred. A similar situation can be found regarding the theoretical and literal replication cases regarding sophistication. Thus, the empirical results provide strong support to the original theoretical proposition.

There is an obvious need to empirically investigate enabling combinations of factors. The following proposition presents a combination of factors that emerged from this study, though with little empirical support.

Emergent Proposition 19.

The interplay of enabling patterns of information, product, financial, and social exchanges; mutual expectations of continuing the relationship; leading firm's IS/IT strategies; administrative, and IT infrastructures and resources; and interconnections with EDI bodies, is not enough for adoption.

9.4 - Conclusions

In this chapter the theoretical propositions that operationalise the CONNET model described in Chapter 5, have been reviewed, compared, and modified according to empirical data analysis of Chapters 7 and 8. The empirical work illustrates that some variables have a stronger enabling role than others, and that some have a larger influence on adoption, others on sophistication but most have influence on both, as is concluded in Table 9.1. Case studies in this work suggest that CONNET's model factors and variables, identified theoretically from the relationship perspective and network approach, and their influencing pattern, are indeed relevant to understanding the development of electronic trading system between construction firms. Therefore, it is claimed here the analytical generalisation of the CONNET model. The detailed and modified CONNET model is depicted in Figure 9.1.

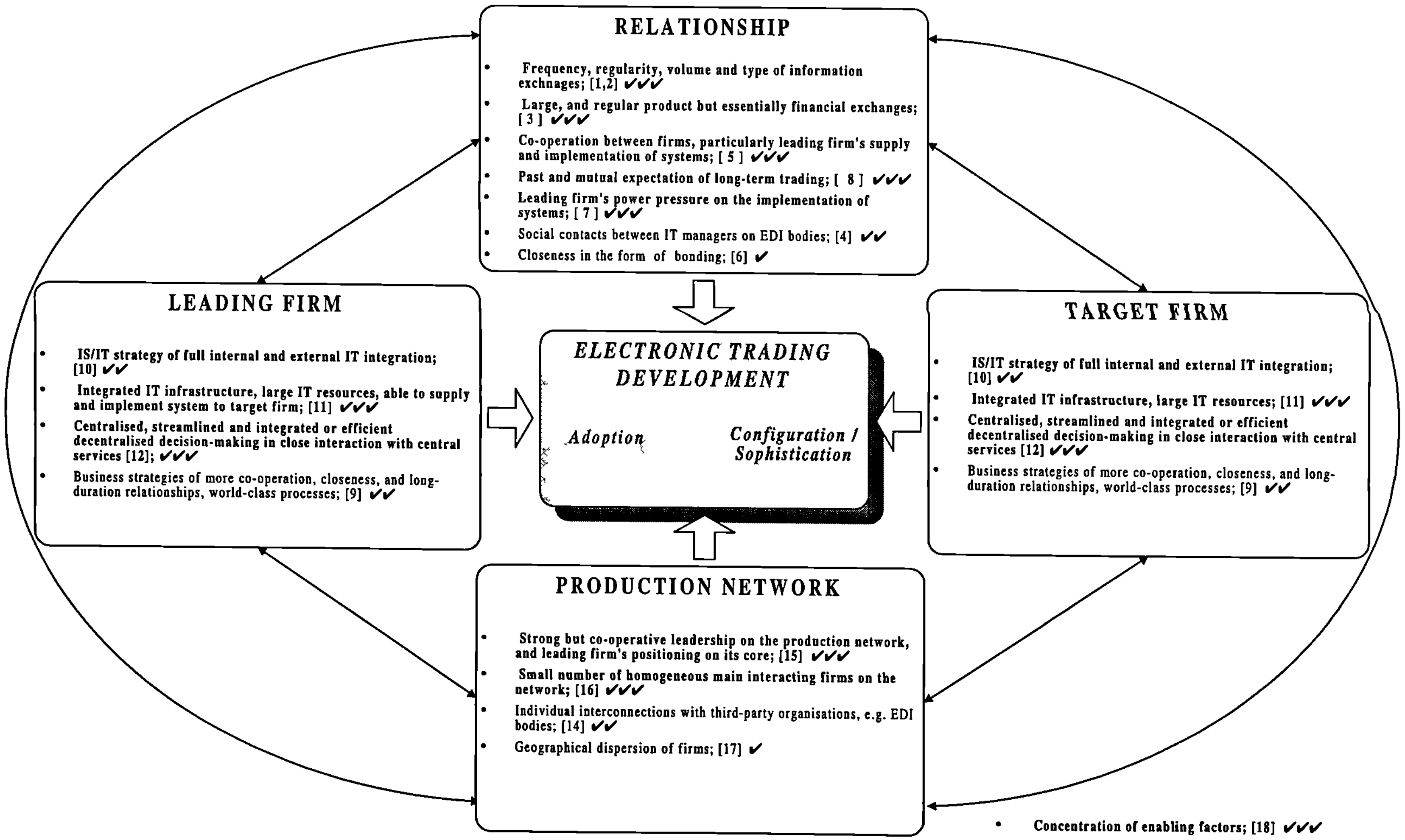
Although it is possible to assert that the CONNET model is sustained by empirical data from case studies, Table 9.1 illustrates that some variables and propositions are more strongly supported by results than others. This implies that some variables need further empirical investigation, especially concerning the interplay of factors.

Table 9.1 Summary of proposition matching

New Prop.	*Orig. Theor.*	*Variable Description*	*Adoption*	*Sophistication*	*Support*
1	1	Frequency, regularity, volume and type of information exchanged	Major Enabler	-	✓✓✓
2	2	Frequency, regularity, volume, complexity of information exchanged	-	Major Enabler	✓✓✓
3	3	Large and regular product but essentially financial exchanges	Major Enabler	Major Enabler	✓✓✓
4	-	Social contacts between IT managers on EDI bodies meetings	Enabler		✓✓ *N*
5	4	Closeness in the form of administrative, production or logistical bonding	Enabler	Enabler	✓
6	5	Co-operation between firms, leading firm's supply of systems	Major Enabler	Major Enabler	✓✓✓ *E*
7	6	Leading firm's power pressure on the implementation of systems	Major Enabler	Major Enabler	✓✓✓ *E*
8	7	Past and mutual expectation of long-term trading	Major Enabler	Major Enabler	✓✓✓
9	8	Business strategies of more co-operation, closeness, and long-duration, world-class processes	Enabler		✓✓
10	9	Firms' IS/IT strategy of full internal and external IT integration	Major Enabler	Major Enabler	✓✓ *E*
11	10	Firms' integrated IT infrastructure, large IT resources, able to supply systems	Major Enabler	Major Enabler	✓✓✓ *E*
12	11	Centralised, streamlined and integrated or efficient decentralised decision-making in close interaction with central services	Major Enabler	Major Enabler	✓✓✓
13	12	Exclusiveness of relationship	No data	No data	
14	-	Individual interconnections with third-party organisations, EDI bodies	Enabler	Enabler	✓✓ *N*
15	13	Strong but co-operative leadership on the production network, and leading firm's positioning on its core	Major Enabler	Major Enabler	✓✓✓
16	14	Small number of homogeneous main interacting firms in the network	Major Enabler	Major Enabler	✓✓✓
17	15	Geographical dispersion of firms	Enabler		✓ •
18	16	Concentration of enabling patterns	Enabler	Enabler	✓✓✓
19	-	Specific interplay of factors	Does not enable		✓ *N*

✓✓✓- Strong support; ✓✓- Support; ✓- Little support • - Contrary to theoretical proposition *E* - Enhanced scope *N* - New

Figure 9.1 - Revised CONNET model



✓✓✓- Strong support; ✓✓- Support; ✓- Little support [ ] - Proposition number **Bold** - Major enabler Plain - Enabler

CHAPTER 10

CONCLUSIONS

10.1 - Introduction

The empirical data, analysis and results have been presented in Chapters 7, 8 and 9. This chapter starts by providing a summarised description of this work. However, the main purpose is to show how the results of the research relate to the original hypotheses and objectives that were set. The chapter ends by providing a description of the potential roles of the CONNET model, the theoretical and practical implications of the work, and recommendations for future work.

10.2 - Contributions of this research work

This research study was an exploratory investigation of the phenomena of electronic trading development between constructions firms. Defined as a relationship between two firms where there is use of computer and telecommunication technologies to exchange information, electronic trading was seen to contribute to an improved co-ordination processes between construction firms which enhances productivity. However, previous research into the subject highlighted that little adoption of electronic trading systems between construction firms seemed to exist, and existing systems were reported to have simple configurations when compared with systems in other industries.

The body of knowledge regarding electronic trading provided little empirical and essentially theoretical insights about the process by which firms decide whether to adopt electronic trading systems and the configuration of the system. Thus, this study sought to identify **the factors determining the development of electronic trading**, and also **how those factors influence the development process**. The aim was to achieve a holistic picture of the electronic trading development phenomena, rather than focusing on just a small part. This contributed to the distinctiveness of this research.

To accomplish this, a theoretical model was developed - **the CONNET model,** grounded in the relationship perspective and network approach (see Chapter 5). To test the theoretical propositions that operationalise the model, and the hypotheses drawn from the theoretical analysis, a case study strategy was adopted which allowed study of the subject embedded in its context, desirable due to the holistic aim of the work (see Chapter 6). Six cases studies involving construction situations were conducted, and in order to obtain a richer content regarding variations in electronic trading development, four cases studies from automotive and retailing industries were also conducted. From these cases, it was possible to draw analytical rather than statistical generalisation about the theoretical propositions.

From the intra-case (Chapter 7) and cross-case analysis (Chapter 8), adjustments were made to the theoretical propositions, resulting in a series of nineteen analytically generalised propositions depicted and discussed on Chapter 9, and summarised on Figure 10.1.

Based on the assumptions that electronic trading development implies the establishment of a business relationship between two firms that are mutually committed to the electronic exchange of information, and that the rationale behind the decision is economic, this research hypothesised that the adoption and configuration of electronic trading systems between construction firms would be influenced by the interplay of:

- The characteristics of the relationship between the two firms, both what is exchanged (information, product, finance, social), and how it is exchanged (based on co-operation, closeness, power/dependence, and mutual expectations);

- The internal features of each of the firms, their business and IS/IT strategies, and also their current organisational and IS/IT infrastructures and processes;

- The characteristics of the production network in which both firms are embedded, i.e. the individual interconnections with other organisations, the power structure, the number and type of firms involved in the network, and their territoriality.

With regard to this hypothesis, and from the results of this study, the analytical generalisations suggest the following main conclusions.

1. For adoption and sophistication of electronic trading systems, it is very important that the relationship between the two firms has a large frequency and volume of information and financial exchanges, with the type information influencing the technology decision: EDI for commercial, and e-mail based systems for technical and design information. Social contacts between IT managers in meetings also contributes to the adoption process.

2. An atmosphere between firms where they generically co-operate with each other for general improvements, and have past and mutual expectation of long-term commercial interaction, is very important to the emergence and sophistication of systems. Particularly relevant for adoption and sophistication is when the leading firm of the development process is able to exert pressure, but at the same co-operate with the target firm by supplying and implementing the system.

3. The development of electronic trading is linked with leading firm's, and also sometimes target firms', IS/IT strategies of achieving internal and external IT integration. However, electronic trading is not just an IT matter, it requires that business strategies promote innovation and depart from traditional price driven strategies.

4. In order to deploy electronic linkages with external applications, it is very important that firms have an internal integrated IT infrastructure, not only between individual applications but also between the different offices and sites with central applications, otherwise the adoption, and particularly the sophistication of systems, is unlikely to succeed. The adoption, and particularly the sophistication, of electronic trading systems demand large finance, people, and time resources and thus it is important that both firms have them available. However, when the target firm does not have large IT resources available then it becomes very important that the leading firm has resources available to supply and implement the system to the former.

5. For adoption and sophistication it is also very important that each firm has adequate and streamlined administrative and decision making functions, that should be either

centralised and integrated, preferably for EDI systems, or decentralised but in close interaction with central functions, preferably for e-mail systems.

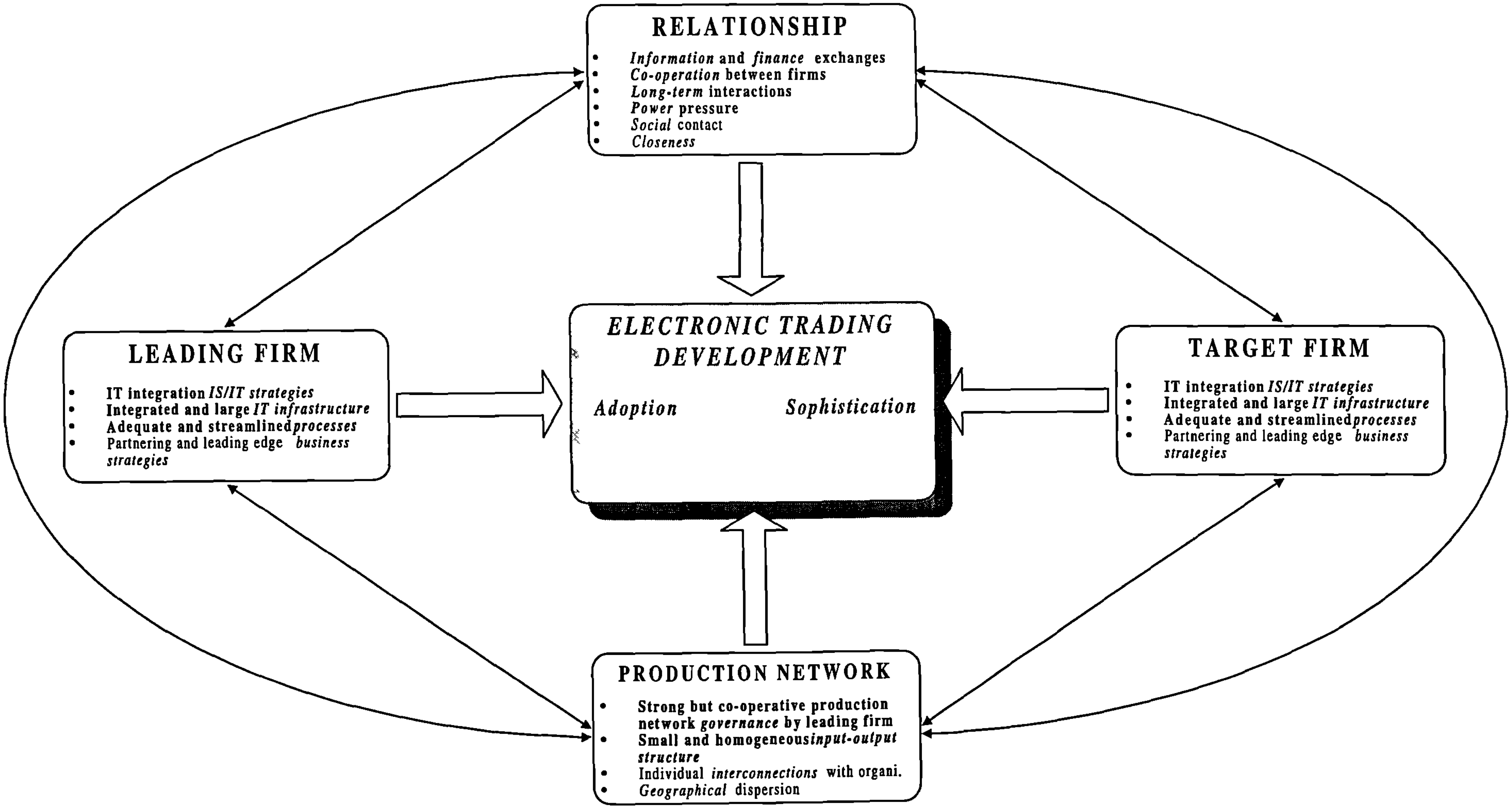
6. Individual interconnections of leading and target firms with other organisations may influence the development of electronic trading. It is most important for adoption and sophistication, that the leading firm is positioned in the core of a strong but co-operative leadership over the network of firms in which both firms are embedded. Also it is very important that a small number of firms with relatively homogeneous characteristics represent a large percentage of the total information and financial exchanges in the input-output system.

7. Finally, geographical dispersion of firms within the network may foster the adoption of electronic trading.

This research also hypothesised that the adoption and configuration of electronic trading systems between two construction firms would emerge when the interplay has a clear enabling pattern, and that this would be similar either in construction or non-construction situations. Regarding this hypothesis, and from the results of this study, analytical generalisation results in the main conclusions that adoption and sophistication of systems occur when there is a concentration of the above described enabling conditions. Some variables have a stronger influence on the adoption process, others on sophistication. Most of them affect both adoption and sophistication. Moreover, in generic terms, it is possible to state that enabling factors in construction are similar to non-construction situations.

Therefore, it is concluded that the hypotheses put forward in this work in Chapter 5 have been supported. These results also lead support to the conclusion that the relationship perspective and network approach provide a solid and comprehensive theoretical framework of reference to explain the electronic trading development phenomena, as argued in the objectives stated in Chapter 1.

Figure 10.1 - The CONNET model



Bold - Major enabling influence Plain - Enabling influence *Italic* - Initial theoretical themes

The remainder of this chapter is concerned with addressing the implications of the study for researchers, and for practitioners, along with pointing towards further potential work in this area.

10.3 - Implications of this work

10.3.1 - Roles of the CONNET model

The value of the model developed in this work can be highlighted by focusing on three different roles: descriptive, empirical, and normative. These generic roles are now briefly discussed. Later in the chapter, more specific roles and functions of the model are put forward.

10.3.1.1 - Role as a descriptive framework

At a first level, the CONNET model can be viewed as a conceptual framework that allows researchers and managers to organise the complex set of factors and variables that could potentially determine the adoption and configuration of electronic trading systems. Thus, as a minimum, the model identifies the set of variables that are likely to influence behaviour, providing researchers with a tool that helps to envisage business, organisational and technological solutions to overcome potential problems in the adoption of certain electronic trading system configurations. This framework can also be used by managers in construction firms, and in others sectors, to discuss the phenomenon of electronic trading development in an inter-organisational co-ordination and IT setting, and therefore, create more adequate and realistic electronic trading strategies.

10.3.1.2 - Role as an empirical framework

Another potential role for the CONNET model is its potential to guide empirical research regarding electronic trading, both in construction and non-construction situations. Because the model builds from diverse research disciplines (that are well known and have proven theoretical and empirical merit) and provides an integrated and holistic view of the phenomenon, this serves as a framework to empirically examine several research issues. Following what has been done in this work, this requires that the relevant variables and factors be operationalised using observable and measurable indicators. In section 10.4 of this chapter this issue is developed further.

10.3.1.3 - Role as a normative framework

Due to the increasing interest in electronic trading/commerce by the construction business community (and others too), and where researchers are concerned with the ability of studies to form and guide management practice, it is important that the CONNET model has the inherent potential to offer normative insights. It is believed that empirical research in construction and non-construction situations, rooted in this framework, could offer important insights into the area of electronic trading strategies, such as: selection of partners for the development of specific configurations of electronic trading systems given possible constraints, and under different conditions; the selection of electronic trading systems configurations under given patterns of factors and variables; business, IT and co-ordination strategy development in the face of electronic trading systems. This has partly started with the empirical work of this study but requires much more in-depth and broader studies.

10.3.2 - Implications for theoretical knowledge

Having described the potential uses of the CONNET model, the contribution that this work has made, directly or indirectly, to several research areas is now reviewed.

10.3.2.1 - Electronic trading studies

The most obvious and direct theoretical contribution of this work regards the electronic trading body of knowledge in general, and in the construction context in particular. Before this study there was scarce research giving a qualitative description and analysis of electronic trading development by constructions firms. The explanations concerning the understanding of the adoption and configuration process were very fragmented and lacked theoretical background. Themes often stressed were related to benefits, costs, legal issues, and industrial structure, but provided no linkages between the factors nor embedded them in any theoretical context. This research work provides a significant step forward, through presenting an empirically validated theoretical model grounded in robust theoretical disciplines, which gives a comprehensive and detailed framework to the understanding of the problem of electronic trading development between construction firms.

The model also enhances the body of knowledge about the development of electronic trading in general. As discussed in the second chapter, in spite of the body of knowledge regarding electronic trading in manufacturing and retailing sectors being richer than in the construction context, there was still a clear gap in the existence of theory-based models that explain the adoption and configuration process, and particularly that could explain the wide range of variations to the sophistication of systems. The CONNET model, has proved to be robust enough to cover this gap in the knowledge.

10.3.2.2 - Computer Integrated Construction (CIC) studies

CIC has emerged as the discipline that aims to develop methods and computer tools to integrate the management, planning, design, construction and operations of construction products (Sanvido, 1990). This discipline has been aiming to achieve computer integration in construction by focusing on technological solutions. Following Betts *et al.* (1995), which has raised the necessity to map current CIC knowledge and research efforts in order to define strategies to pave the way forward, the research work in this study contributes to the move towards CIC by providing a framework that can help to define strategies grounded in business factors. This helps avoid the development of technological solutions that due to business factors would not be implemented.

10.3.2.3 - Construction management research

For researchers concerned specifically with investigating construction project organisations and their management, the findings of this work suggest the importance of broadening the view of the situation when studying the practices of construction management. The contribution of this work to this area of research is that project problems have also to be seen through a broader view than just from the project perspective in order to obtain further insights of the underlying causes rather than the surface symptoms. By advocating that part of the variables determining the development of electronic trading in a construction project are broader than the project dimension, i.e. have to do with overall firms' strategies, infrastructures, business relationships with the other parties beyond the project duration, and the structure of the network of firms which are involved in the project, this work draws the attention of construction researchers to other project specific issues that should be analysed bearing in consideration the context in which they are embedded. This follows similar conclusions by other authors, like e.g. Bresnen (1990). Thus, the emerging research fields of the application of Total Quality Management (Barrett, 1994), or Lean Production (Alarcon, 1997) to construction management, or even research into construction innovation (Nam and Tatum, 1992), procurement systems (McDermott and Jaggar, 1996), etc. should also look beyond the project dimension.

10.3.2.4 - Network and relationship theory and models

Although the relationship perspective and network approach have a reasonably well established body of knowledge, it is recognised that there is the need to enrich its empirical content by studying specific phenomena and applications areas (see e.g. Axelsson, 1992). In this sense, this study has contributed by studying two areas that have been neglected so far by network and relationship researchers: the construction context, and the development of electronic trading. Regarding the former, it is possible to conclude that the network approach and relationship perspective are relevant to describe and analyse events embedded in a construction context, broadening their domain of application and bringing new and useful insights to construction researchers as discussed before.

Despite its importance as far as inter-organisational phenomena are concerned, electronic trading development has gained little attention by network researchers. This study has contributed to bridging this gap, and through its conclusions helps to support one of the fundamental claims of researchers in these disciplines, which is that any form of inter-firm linkage is far better understood and explained using network and relationships concepts. More particularly, the characteristics of the relationships and the structure of the complex web of interconnections in which they are embedded play a very important role in any form of bonding development.

10.3.3 - Implications to practitioners

From the conclusions of this work several implications to practitioners in construction, and managers in general, can be drawn. Hence, there are two main areas where effects of the development of electronic trading systems are important and need to be addressed: IT and organisational management; purchasing and sales management and strategy development.

10.3.3.1 - IT and organisational management

It became evident from this work that the development of electronic trading implies minimum requirements in terms of IS/IT infrastructures and organisational/process infrastructures. In other words, for firms to be able to achieve operational and tangible benefits, and especially be able to deploy systems with a configuration that indeed provides a certain degree of automation and improvements to paper-based systems, it is important that internal administrative processes as well as IT systems are adequate, i.e. streamlined, integrated, and designed bearing in mind the interface with external systems through e.g. EDI or e-mail systems. Thus, before thinking about embarking into external integration, managers in construction firms must carefully analyse the current status of internal systems and processes, as well as available resources, and if necessary make the necessary and possible changes to make them compatible with a desired configuration of electronic trading system.

Another important issue that can by useful to practitioners in construction is the relevance that e-mail based systems may have to the construction situations, particularly when they are project-orientated. Indeed, this technology allows a more flexible and wider range of information exchange through the design and construction phases of projects than traditional and rigid EDI systems. However, commercial information exchange may still be better electronically exchanged through EDI. It can be foreseen that if in functional terms e-mail based type of systems seem to be the most adequate to construction situations, Internet technology is likely to emerge as the most significant support of future electronic trading systems in construction.

Finally, it became quite obvious in this study that, if electronic trading initiatives are often triggered and led by IT people, in order to succeed it is crucial that right from the beginning purchasing / sales people are also involved, so that an alignment between the specific configuration of an electronic trading system and its business requirements (e.g. in terms of relationship or network management) can be achieved. Otherwise, the unpleasant situation may emerge that IT people may spend resources in trying to develop systems that will be hindered by purchasing/sales strategies and practices.

10.3.3.2 - Purchasing and sales management and strategy development

There are two main points to be made here that can be useful to people in construction responsible for purchasing and sales management, and strategy development. Firstly, purchasing and sales managers must be aware that companies can not unilaterally control and decide the development of relationships and therefore of inter-firm processes and systems. Thus, because the new production, logistical and administrative approaches (e.g. lean production, JIT, TQM, electronic trading systems) imply higher level of connections with suppliers, customers, third-parties, etc. it is important that construction purchasing/sales strategies shift accordingly to support the development of such initiatives (e.g. focus more on co-operation, long-term, higher power). This implies that managing relationships is not just about price, but must also accommodate the potential requirements of other company's functions. Although, there seems to be a general slow move towards that goal by construction firms in general, there is still a great gap regarding from practice by automotive, retailing and the leading-edge construction firms.

Secondly, the importance of the positioning of firms within the network structure in which they are embedded becomes obvious from this work. Thus, a firms' capability to positively influence the co-ordination and direction of the production systems to their 'favour' and therefore of the relationships and other firms' internal features, is very much dependent on their position in the governance structure of the production network. People in construction responsible for business strategies must bear in mind that in order to develop inter-firm management systems (like e.g. electronic trading systems) it is not enough to have adequate internal IT and organisational infrastructures and processes, and manage individual relationships effectively. Due to the interdependencies, it is also crucial that construction firms interested in the development of such types of systems attain a favourable positioning of the core of the production system. This may imply a focus on a certain type of procurements systems, like management-orientated, or integrative; the centralisation of often decentralised functions like purchasing or sales to obtain leverage over other firms; or the development of strategic alliances. This is an area where much further research work is urgently needed.

10.4 - Future work

This work has been of an exploratory nature, with a concern to raise a broad range of issues that should be explored and explained in future research work. Like any work addressing a new subject, the number of questions that emerged from the application of the network and relationship approaches to the development of electronic trading systems between construction firms, and of the CONNET model, surpasses the theoretical and empirical conclusions.

Following the contribution of this work in having identified and empirically tested the determining factors, variables and their expected behaviour regarding the development of electronic trading systems by construction firms, it is believed that it would be very interesting and useful to expand the empirical research developed in this work, and uncover naturally occurring dominant patterns of those factors and variables in different construction settings. Thus, through extensive surveys to pre-defined groups of potential developers of electronic trading systems (e.g. client-contractor; contractor-architect; client-construction manager; construction-manager-consultants; builders merchants-suppliers), a cluster analysis based on the variables identified in this work could be conducted in order to define the patterns of adoption and systems configuration. With this it would be possible to obtain a statistically significant and clearer picture of the effects resulting from the combination of enabling and hindering variables. A follow up of such a study could be with non-construction situations, and conclusions drawn from a comparison between the sets of two results. These multivariate empirical analyses could be complemented by bivariate specifications and analysis under *ceteris paribus* conditions (maintaining one variable and varying the pattern of the others) to test the effect on the adoption and configuration of very specific combinations of variables. These could also be reinforced by the conduct of very in-depth case studies, where a broader number of data points would be possible.

These studies would allow a mix between traditional empirical verifications of conceptual typologies. Empirically uncovering sets of taxonomies, and the comparison between group adopters and non-adopters, and inter-group analysis, empirical-based strategies could also be defined for the development of electronic trading by construction firms. This would make a significant contribution and would be practically relevant.

Future work should also address the evolution of electronic commerce. The new technological developments will not eliminate the importance of the business factors for the adoption and configuration of the systems, though other adoption patterns can emerge. Thus the CONNET model will continue to be an extremely useful tool for the description, analysis and explanation of the factors influencing electronic trading development. Particularly interesting will be to study and analyse, based on the CONNET model variables, the impact that the new electronic commerce technologies may have on the companies and people's way of working, on the relationships, and on the structure of the production network. A comparison between the existing pattern and situations where the new technologies have already been deployed can bring interesting insights to the overall impact of electronic commerce. This could help firms preparing for the near future.

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