

The Evaluation, Adoption and Diffusion of Electronic Data Interchange (EDI) by Retail Firms operating in South Africa

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PREFACE

This research paper is not confidential.

I would like to thank my supervisor, Professor M.L. Hart of the University of Cape Town, for his generous assistance throughout this study. I would also like to thank all the academics, consultants and retail firms for their appraisals and comments on the focus and methodology of this study. Furthermore, I wish to convey my gratitude towards the retail firms who responded to the questionnaire and who made this study possible. Finally, I appreciate all the comments received from those who reviewed this document.

I certify, except as noted above, that this research paper is my own work and all references are accurately reported.

Signed by candidate

Gary Stocks (19 August 1996)

SYNOPSIS

Two fundamental elements of the retail industry are customer service and merchandising. Customer service entails meeting customer needs and wants, while merchandising is the art of selecting the combination of goods that meets those needs and wants. One of the strategies open to retailers is to move in the direction of suppliers by creating partnerships with those suppliers. The system of Quick Response (QR) distribution embodies this strategy. QR is analogous to Just-in-Time (JIT) manufacturing, where the objective is to speed up the entire order and replenishment cycle. The potential results are enhanced customer service through greater responsiveness to customer demands and reduced costs through lower inventory holding costs and lower opportunity costs (in terms of lost sales when goods are not in stock). Electronic Data Interchange (EDI) is an Information Technology (IT) that can be used to facilitate a system of QR. EDI can be used as an Interorganisational System (IOS) that spans the retailer and supplier organisations and communicates structured messages, such as orders and invoices, between the trading partners. Apart from creating efficiencies in the flow of information between retailers and suppliers, EDI applications can be integrated with internal systems and the entire order and replenishment cycle can be redesigned to improve customer service. However, despite predictions of a high growth in the use of EDI, these forecasts have not been realised. Consequently, the process of utilisation (initiation/evaluation, adoption and diffusion) of this technology needs to be understood more clearly to better manage this process. There are a number of theoretical frameworks that can be used to help describe this

process and the factors that are associated with it. First, EDI is an IS innovation because it offers retail firms new ways of doing business. Innovation diffusion theory considers the process of evaluation, adoption and diffusion, and hypothesises that the perceptions of using the technology are important determinants of a firm's progress through the stages. Secondly, critical mass theory considers the influence of trading partners (in this case, suppliers) and competitors as external forces. Finally, political and learning forces are also considered important. Therefore, the research hypotheses in this study examine which factors are associated with this process for retailers operating in South Africa. This study used a mailed questionnaire survey that targeted a sample of retail firms which only included those linked to the Johannesburg Stock Exchange (JSE), either directly or through holding companies. Independent, typically smaller retail firms were omitted after discussions with market research firms and consultants revealed that their responses would be inadequate. The questions used in the instrument were drawn from previously validated studies as far as possible, and the entire instrument was reviewed by academics and consultants. In addition, a pilot test was done on a few retail firms in the population under study. A relatively good response rate of 58 percent was achieved after the key respondent was identified through telephonic contact with the organisation. Validity and reliability tests on the final responses indicate that the instrument exhibits reasonably good reliability and validity. Statistical tests of the hypotheses reveal that the factors that are strongly, positively associated with evaluation of EDI are the perception that it is organisationally compatible with the retailer (in terms of supplier relationships, operating practices and work style) and the perception that it is technically compatible with the retailer's existing systems. Organisational compatibility is also strongly,

positively associated with a retailer's adoption and diffusion of the technology, along with the perception that EDI is strategically important to the retailer and the retail industry. However, these relationships could only be tested in terms of associations because the study took place at a particular point in time. Therefore, causation can only be inferred and not proved conclusively. Nevertheless, these findings add support for the importance of innovation diffusion theory and political forces in the evaluation, adoption and diffusion process. However, no support was found for the expected influence of external (critical mass) factors, namely the influence of key suppliers and key competitors. Consequently, the results indicate that retail management needs to be aware of the broader system within which EDI fits in the organisation as well as the compatibility with existing systems. In addition, the strategic importance of EDI for the retail firm needs to be identified and communicated to senior management. In future studies, temporal validation of these findings, such as through a longitudinal study, will add confidence to the results. Furthermore, additional and/or alternative variables may improve the overall model by reducing the unexplained variation.

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1. INTRODUCTION

“At their simplest, EDI systems simply permit the electronic exchange of documents between companies or business units - invoices, specifications, inventory data, and the like. But leaving it at that is rather like calling Mozart a tunesmith. For by wedding one another's data bases and electronic systems, companies are able to form highly intimate partnerships.” (Toffler, 1990, p.120)

Toffler sums up the essential challenge that EDI provides, which is to form close partnerships with trading partners so that information can be shared. In particular, retailers can use EDI to facilitate a system known as Quick Response (QR) distribution with suppliers, whereby retailers order smaller batches and replace fast-selling items more frequently as styles and consumer tastes change. Toffler (1990) quotes an example of one department store chain which was able to sell 25 percent more slacks while carrying 25 percent fewer slacks in its inventory. Consequently, EDI has been described as an innovation since it can change the way that organisations operate (Swanson, 1994). However, despite the potential advantages, the use of EDI has not spread as rapidly as predicted (Bouchard and Markus, 1995).

It is therefore important to understand the process by which retailers utilise this technology in order to manage that process effectively. Theories of innovation diffusion, Information Technology (IT) implementation and organisational change have been used to describe the process of evaluation, adoption and diffusion of an IT

innovation, and to identify which factors influence an organisation's progress through those stages.

Consequently, the objectives of this research study are as follows:

1. To recognise the importance of a technology such as EDI for the retail industry.
2. To describe the configuration of an EDI system and the potential it offers retail firms.
3. To identify the factors that are considered to influence the process of evaluation, adoption and diffusion of EDI through a review of current literature and opinion.
4. To test the importance of these factors empirically in the retail industry in South Africa (SA).
5. To compare the findings to similar and related studies.

The focus of this study is on the organisational factors which influence the process of evaluation, adoption and diffusion. The success of the EDI system(s) will not be defined or tested in any way. However, since the use of an IT system is often used as a surrogate measure of success, any factors which are found to be important in this study may be useful in studies which are measuring success.

The major limitation of this study is that the research methodology incorporates a cross-sectional design as opposed to a longitudinal design. Therefore, responses were collected at a particular point in time and conclusions can only be made regarding the association between the stages of utilisation of EDI and the various factors which are thought to influence an organisation's progression through those stages. In other

words, inferences can only be made about the causation or influence that each factor exerts on the organisation to move to the next stage.

The variables in the research model were identified through a literature review in the areas of IT, retailing and general management. In addition, discussions were held with local researchers and, through the Internet, with foreign researchers. After an initial pilot test, the research model was then tested empirically using a national, mailed questionnaire survey of retail firms from all sectors operating in SA. The questionnaire instrument was constructed, as far as possible, from previously validated studies and it was tested for validity and reliability using the final responses.

This dissertation will start with a review of the literature in order to identify the focus of the study and the variables in the research model. This will cover concepts from the retail supply chain and IT, and will focus on the technology under study, namely EDI. The research methodology will then be described, comprising the selection of a mailed questionnaire survey, the questionnaire development and validation process, and the data collection process. Next, the data analysis procedures and results will be examined, and the limitations of the study will be highlighted. Finally, conclusions will be drawn from the results, including the applicability of the findings to theory and practice, as well as identifying areas for further research.

2. LITERATURE REVIEW

The objective of the literature review is to identify the area under study, to focus on a specific aspect and to explain the importance of researching that aspect. The literature review will start by describing the retail industry and will highlight the importance of managing the supply chain effectively and efficiently. EDI will be then introduced as a tool to enhance the management of the supply chain. Finally, a conceptual framework will be proposed to describe the process by which retail firms utilise this technology, as well as the factors that potentially influence a retailer's progression through the various phases.

The main source of information for the literature review was journals. Naturally, journals targeting Information Systems (IS) were focused on. However, a large amount of information was also gathered from journals in the areas of Marketing, and Organisational and Management Theory. As a consequence, though, the literature review is relatively lengthy.

2.1 The Retail Industry

The bottom line of any business operation is profit, where profit is the difference between revenues and costs. In the retail industry, revenues are simply derived from the sale of goods to customers at a specific price. Retailers decide on a certain mix of goods that they will stock. Some of the important costs in the retail industry comprise

the cost of goods, the cost of holding the inventory, labour costs, and the cost of coordinating the flow of goods from supplier to final consumer. These issues will be discussed in the following section, as will strategies to increase profits. The potential impact of EDI on a retail business can then be identified and placed into context.

2.1.1 Introduction to the Retail Industry

The retailer is closest to the final consumer in the value chain from producer to final consumer. Essentially, a retailer provides a service to its customers by offering a suitable mix of goods at a price that customers are prepared to pay and at a location relatively close to the customer. Therefore, two of the most basic tenets of the retail industry are customer service and merchandising (The Economist, 1995). Management Horizons (cited in Ryan and Furlonger, 1991), an American-based retail consultancy, used the term "sensitivity to the market" to describe these concepts. *Customer service* entails meeting customer needs and wants, while *merchandising* is the art of selecting the best mix of goods for the customer. It is clear that merchandising and customer service are inter-related because customer needs drive the mix of goods that the retailer stocks and the best mix of goods for the customer enhances the service to that customer.

A number of areas in a retailer's operations emerge as important when one considers these fundamentals. First, a unique value formula is important. Management needs a sense of entrepreneurial spirit to search for better ways to satisfy customers while maintaining the efficient operation of stores. Secondly, a highly-motivated, well-trained

workforce is often the most visible aspect of the service that is offered to customers. Thirdly, investment in stores and technology needs to be considered as a possible method to improve customer service and/or operational efficiency. Finally, management of the channel is important to ensure that the replenishment of inventory is as efficient as possible (The Economist, 1995; Ryan and Furlonger, 1991).

At the same time, the main costs that the retailer faces are the variable costs of labour and stock, including the coordination costs of moving the goods from supplier to final consumer, and the fixed costs of the land and buildings (The Economist, 1995). As in any profit-oriented business, the retailer has to try to maximise customer service while minimising the costs. Aloma Jonker (cited in Financial Mail, 1991), a retail analyst at Mathison and Hollidge, identifies working capital management, especially the control of inventory and debtors, as one of the keys to success in the nineties.

The objective for this section is then to identify the supply chain as an area of opportunity for the retailer to increase profits and to improve its competitive position, by creating efficiencies and improving customer service. The broad strategic directions that are available to the retailer will be highlighted first, to place these opportunities into the context of the retail business. Then the supply chain will be discussed in some detail, including the IT opportunities in this area. This will, in turn, place EDI into the context of the retail supply chain.

2.1.2 Retail Strategy

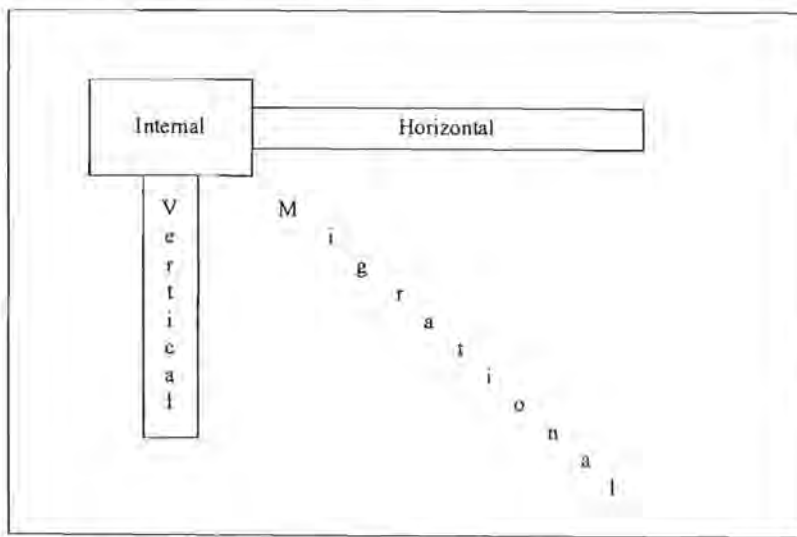
This section describes the broad strategic options that are open to retailers and introduces the supply chain as the focus of this research study.

The strategic planning horizon for a firm is defined by that firm's core competencies and the development of general principles for managing the firm around those competencies. Strategies are actions taken to utilise the firm's resources to take advantage of external opportunities. Furthermore, a strategy is designed to generate competitive advantage and is constrained by the firm's basic policies, and targets for risk and profit. Since the firm has limited resources and there are many opportunities, the firm's management needs to decide on an overall strategy that will most likely generate the greatest competitive advantage for the firm. This corporate strategy then serves as a guideline for strategic decisions taken at the operational level (McDowell Mudambi, 1994).

Ansoff (cited in McDowell Mudambi, 1994) infers that strategic choices need to be mapped out because there are many options which can be interdependent. McDowell Mudambi's (1994) topology of strategic choice for retailers builds on a number of matrices of strategic choice identified in the retail literature and is presented in Figure 2.1. This topology classifies strategic choice into four categories that are defined by the direction of that strategy. These directions are internal, horizontal, vertical and migrational. First, *internal* strategies encompass changes in processes within the organisation's boundaries. These include productivity-led differentiation, service

differentiation, product differentiation and time aspects. Secondly, *horizontal* strategies are expansionary and include choices on the number of outlets, internationalisation, mergers and acquisitions of retailers, and joint ventures. Thirdly, *vertical* strategies take the firm in the direction of its suppliers and incorporate strategies of acquisition of suppliers or distributors, and improved buyer/supplier relations. Finally, *migrational* strategies are extra-territorial and involve a radical change of direction. This can mean a change in outlet size category, outlet location type, or diversification of outlet type. This topology of strategic choices lies in multi-dimensional space and there are synergistic interactions within and between strategic directions.

Figure 2.1: A Topology of Strategic Choice in Retailing



Source: McDowell Mudambi (1994)

The broad focus of this research study is the relationship between retailer and supplier, which is classified as a vertical strategy in terms of this framework. These strategies move the retailer from its established plane of activity into the territory of its suppliers. The first type is vertical integration whereby the retailer acquires a supplier or distributor, or develops physical distribution and warehousing capabilities. In terms of

warehousing and distribution, McDowell Mudambi (1994) states that centralised distribution has been shown to strengthen the retailer's negotiating position with suppliers, improve the efficiency of the retailing operation and improve customer service. This has been cited as a major reason for Wal-Mart's success in America (The Economist, 1995). The second type of vertical strategy involves an attempt to control suppliers and distributors through a directed change in the buyer/supplier relationship. McDowell Mudambi (1994) states that these shifts in the bargaining power of buyers relative to that of suppliers depend first, on the size and concentration of buyers relative to suppliers, secondly, on the quality of information buyers have about suppliers and their products and costs and, thirdly, on the extent of, or credible threat of, vertical integration. Ultimately, according to McDowell Mudambi (1994), investment in the buyer/supplier relationship can pay off for the retailer in terms of improved product quality, shorter lead times, less waste and greater product innovation. These opportunities have led to a concept known as Supply Chain Management (SCM) and it is evident that this area of retailing is becoming increasingly important.

“As the economy changes, as competition becomes more global, it is no longer company versus company but supply chain versus supply chain.” (Harold Sirkin, Vice President of the Boston Consulting Group, cited in Henkoff, 1994, p.36)

The efficiency of the supply chain, in particular, has certainly become an important issue. Due to global competition, faster product development and increasingly flexible manufacturing systems, there are constantly new products and greater variety in

consumer goods (Fisher, Hammond, Obermeyer & Raman, 1994). Consequently, it is becoming more difficult for retailers to forecast customer demand as consumers constantly adapt to greater choice. According to Fisher et al (1994), inaccurate forecasts are increasing as a consequence. In turn, “stock-outs” and markdowns ensue, which result in lost sales and lower margins respectively. Therefore, it is important for the retailer to manage the replenishment of stocks to ensure that out-of-stock situations are avoided while minimising slack inventory. Consequently, price is not the only important variable against which suppliers need to be evaluated.

“Successful cost-driven retailers have adopted a total cost viewpoint that recognises the importance of suppliers’ operational and logistical support and performance.”

(McDowell Mudambi, 1994, p.37)

2.1.3 The Retail Supply Chain

After identifying the supply chain as an important area in the retail industry, the issues and opportunities in the retail supply chain need to be examined in more detail. This section will discuss supply chain management issues and IT opportunities, which will introduce the context within which EDI can be used.

2.1.3.1 Introduction to the Retail Supply Chain

An aspect of the retail supply chain, or value chain, that is becoming increasingly discussed as an area of opportunity is that of closer coordination with suppliers. A report produced by The IT Management Programme at the P-E Centre for

Management Research (1995) concludes that value-chain integration promises to reduce uncertainty through shared information. Consequently, firms will be able to greatly enhance performance through new ways of doing business.

For example, cost savings are possible by increasing the efficiency of the supply chain through faster replenishment of inventory and reduced inventory holding costs (Henkoff, 1994). According to Neil Ross and Associates (cited in Bierbaum, 1994), publishers of the 1993 FMCG (Fast Moving Consumer Goods) Trade Digest, the SA retail environment is set to change with the entrance of new suppliers such as Procter & Gamble (P&G). These firms have been helping retailers to achieve cost savings through partnerships with retailers in the logistics/service area.

The management of the supply chain is strategic because it impacts on customer service. Consequently, the supply chain should be driven by customer needs. Ronnie Herzfeld, Director of Systems at Pick 'n Pay, one of SA's leading supermarket chains (cited in Slabber, 1994), emphasises this customer focus by stating that, ultimately, the stores must stock what the customer wants and when he/she wants it. Therefore, the focus of managing the supply chain is to maximise customer service while minimising costs. Besides the cost of the goods, important cost areas include the cost of holding the inventory, the cost of coordinating the flow of goods from supplier to the stores and the opportunity cost of lost sales when goods are not in stock when the customer demands them.

The objective of this section is to emphasise the potential of EDI in the retail supply chain. Therefore, the supply chain, or logistics function, will first be identified as an important activity in the retail organisation and opportunities in this area will be highlighted. Opportunities facilitated or enabled by IT, in particular EDI, will be emphasised. Then the concept of Quick Response (QR) partnerships, and issues concerning the relationship between retailers (as buyers) and suppliers will be elaborated on. Finally, the concept of an Electronic Market will be discussed briefly.

2.1.3.2 Supply Chain Management

Henkoff (1994) defines SCM, or logistics, as getting the right products to the right place at the right time. It combines the elements of the supply chain into a common environment to evaluate the efficiency and effectiveness of the supply chain as a whole. As a result, SCM integrates the activities that are the responsibility of a variety of departments, including sales and purchasing. The ultimate objective is to determine the implications of meeting various customer service levels (Hayman, 1993). Lester (1992) stresses that this approach is becoming necessary to manage the growing complexity as the number of product lines increase dramatically and demand patterns fluctuate with the greater variety on offer.

The supply chain consists of a number of elements, from the physical goods to the information component. Hayman (1993) describes these elements:

1. *Inventory management* controls the physical storage and distribution of goods to the stores. The major variables of concern in this area are: source of supply; frequency of delivery; delivery constraints; working capital availability; demand

projections; size of storage facilities and locations; and fleet mix and capacity. IT is necessary to assist in the identification of problem areas because of the complex nature of this function. Since a relatively large amount of capital can be invested in inventory, any changes will produce noticeable effects. Higher inventory levels result in increased costs, while lower inventory levels result in an underutilisation of facilities and lost sales. This function is centralised in many companies because of the often conflicting requirements of purchasing and marketing. Purchasing looks for bulk discounts, while marketing would like to increase diversity to meet every level of demand.

2. *Sales forecasting* is important since it drives the volume calculations in the inventory management arena. Under-performance against forecasts usually results in excess capital tied up in stock, while over-performance against forecasts typically results in opportunity costs in the form of lost orders and dissatisfied customers.
3. *Physical depot siting* involves determining the location and function of storage depots. These decisions are essentially a trade-off between optimum delivery schedules and costs. Electronic Point-of-Sale (EPOS) data play an important role in determining schedules that impact on stock levels and customer service.
4. The *information component* of each supply chain function is critical for management. This information needs to incorporate and model the elements that materially affect the performance of the company. In particular, the control points of the supply chain need to be evaluated and exception standards developed. This information needs to be readily available and timeous to enable management to make decisions effectively.

These elements can be combined with the processes that occur along the supply chain to create a model of the entire supply chain. This involves describing what each process is trying to achieve in terms of supply, transformation and demand. Sources of

uncertainty can then be identified and included in the model. Consequently, managing the supply chain involves identifying, measuring and controlling these uncertainties. Any subsequent changes can be planned and studied in terms of their effect on the network. This approach necessitates taking factors other than price into account when selecting suppliers. The delivery performance of suppliers, including their responsiveness and delivery accuracy, becomes important as well. Their performance can be measured with metrics such as average lateness and degree of inconsistency. However, the difficulty with attempting to measure these uncertainties along the chain is the availability of data, unless there is a close relationship with suppliers (Matthyssens and Van den Bulte, 1994; Davis, 1993).

This raises the issue of the relationship with suppliers. There are a number of strategies for dealing with suppliers. Matthyssens and Van den Bulte (1994) describe three, where the focus progressively moves towards greater attention on factors other than price, such as the speed and flexibility of delivery, quality, and innovativeness. The first is the *power strategy*, where buyers and suppliers see each other as opponents. There is a rigid boundary between the firms and negotiations are restricted to price and other conditions. The second strategy is the *tuning strategy* which includes negotiations concerning packaging, logistics, application, and other aspects as part of how the total offer can be adapted to the requirements of the buying organisation. Here the boundaries between the firms become more flexible. The third strategy is called the *cooperation strategy* since it involves both supplier and buyer in the design of the product, resulting in an overlapping of activities between firms and vague boundaries.

There seems to be considerable potential benefits from closer relationships with suppliers. Horst Helleman (cited in Lester, 1992), Procter & Gamble's European Director of Materials Management, claims that certain United States' (US) customers have increased inventory turnover by 400 percent on P&G's product lines, reduced the number of people involved in the direct supplier relationship by 50 percent, and moved from an average of 30 percent error-free invoices and deliveries to a 90 percent level. Henkoff (1994) provides a number of examples of suppliers who have also benefited from closer relationships. National Semiconductor in the US has managed to cut its standard delivery time by 47 percent, reduce distribution costs by 2.5 percent, and increase sales by 34 percent. National Semiconductor used an approach known as *activity-based costing* to measure the expense of everything done to a part as it moves along the supply chain. A number of products were identified as not making a profit at all, and were therefore removed from production. The distribution system was simplified for the remaining products by centralising distribution at a facility in Asia. The company "outsourced" the storage, sorting and shipping facilities to Federal Express. Another example is Laura Ashley, a British supplier of clothing and home furnishings, which now turns inventory roughly five times a year, after overhauling its information systems and consolidating warehouses.

However, not all firms, including retail organisations, have adopted this approach. Stephen Colman (cited in Lester, 1992), operations director of Kraft General Foods, expressed the opinion at the 1991 annual convention of the Institute of Grocery Distribution that companies have recognised the need for supply chain management but have failed to apply it to the whole supply chain, both within the company and

externally with suppliers and customers. The results of a survey conducted in 1991 were quoted at the convention. In particular, 135 United Kingdom (UK) retailers and suppliers in a range of industries were surveyed, with half the logistics relationships considered to be partnerships, and that proportion was expected to increase substantially over the following five years. However, in the grocery trade, only a quarter considered their logistics relationships to be partnerships and most of these retailers admitted to dominating this relationship with suppliers. The researchers, P-E Consultants, characterised the relationships between grocery retailers and their suppliers as antagonistic, with each side attempting to dominate the other. This illustrates the difficulty of changing the culture of the relationship with suppliers.

2.1.3.3 Buyer/Supplier Relationships

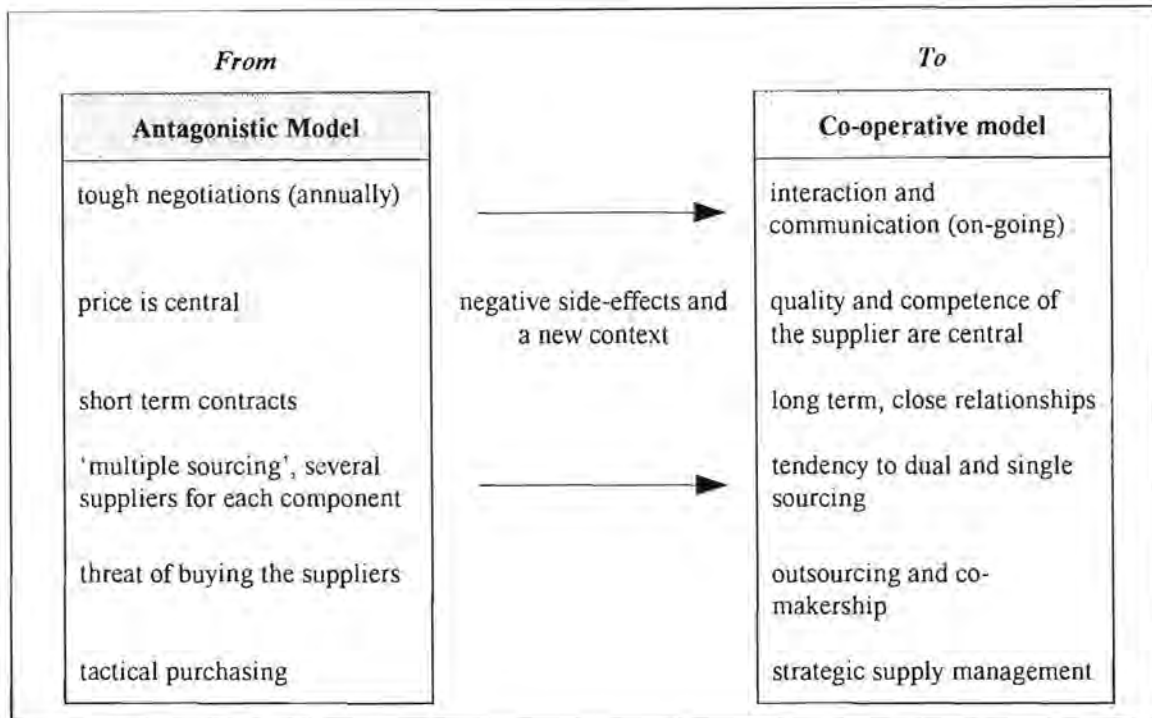
Traditionally, suppliers have tended to dominate the relationship with retailers. However, this situation appears to be changing. According to a survey of relatively large American and European retailers by The Economist (1995), in the past few decades these retailers have surpassed manufacturers in the relative power relationship, becoming some of the largest companies in the world. A number of reasons were cited for this trend. The growth in disposable incomes since the Second World War and the change in the way that goods and services reach the consumer, from a manufacturer "push" to a customer "pull", have been thought to have fuelled this trend. In addition, retail companies have become bigger and more efficient. They have become able to buy in bulk and to generate economies of scale because of improvements in transport and IT.

Although some retailers may be able to dominate suppliers, the concept of SCM highlights the potential for closer relationships between retailer and supplier. Applying price pressure to suppliers may only have negative long-term effects, such as reduced support, and limits the opportunity to focus on other areas of supplier management, such as delivery efficiency and quality. The commitment and support of suppliers is, therefore, required to remove potential process inefficiencies in the supply and replenishment cycle (Shepherd, 1994).

There have been numerous studies and commentaries on buyer/supplier relationships in the American automobile industry, which can be used to parallel the relationship between retailer and supplier to a certain degree. Matthyssens and Van den Bulte (1994) characterise these relationships as antagonistic up until the middle 1980s. Purchasers typically employed tactics characteristic of tough negotiators. These included playing different suppliers off against each other, continuously threatening *backward integration*, using shadow cost calculations and refusing to sign contracts that extended over more than one year. In addition to low prices, they also demanded service, total consistency and high production flexibility. However, this type of relationship had serious disadvantages. First, the exploited suppliers were not prepared to invest in new machines or products and the purchasing companies realised that antagonism led to short-term savings only. In the meantime competitive pressures in the automotive industry forced them to innovate more quickly and to provide a higher quality and more reliable product, requiring the support of their suppliers. Secondly, working with a large number of suppliers led to inconsistencies in input, congestion in production and cumbersome administrative procedures. New insights into inventory

(particularly the JIT philosophy), production and quality helped push buyers in the direction of the cooperative model (Figure 2.2) where buyers and suppliers develop close ties with a shared strategic perspective.

Figure 2.2: The Change in Buying Attitudes and Behaviour



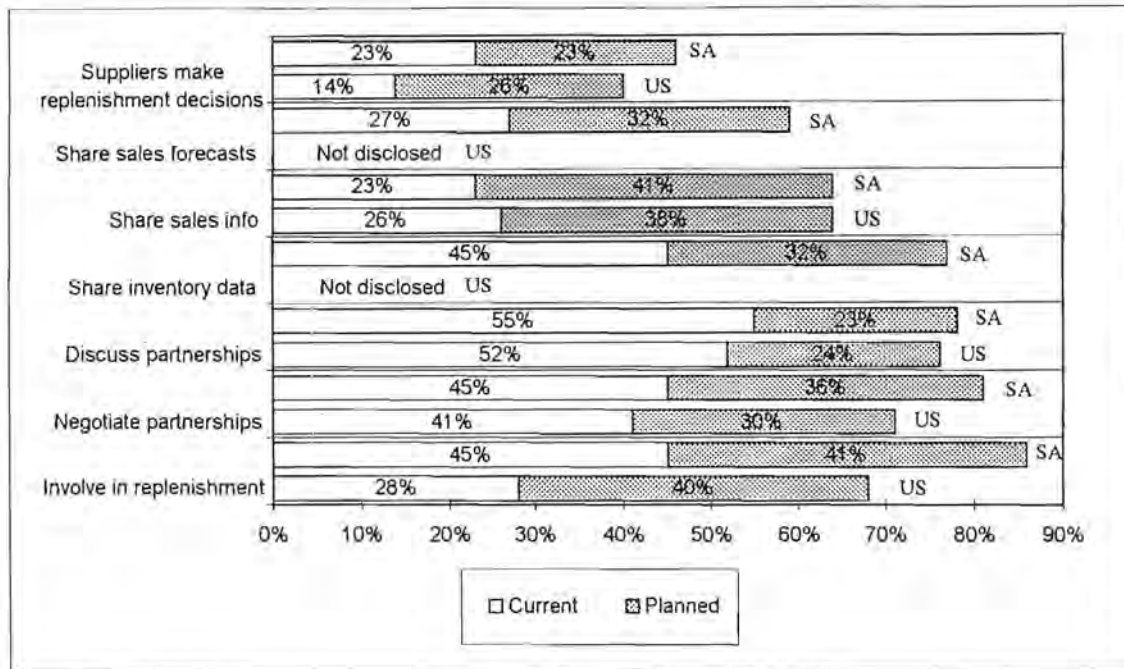
Source: Matthyssens and Van den Bulte (1994)

However, these potentially radical changes introduce risks for both buyers and suppliers. The dependence of buyers on suppliers will most likely increase and there may be less supplier competition as a result of fewer suppliers. Consequently, there is a risk that suppliers may become less efficient and may be able to pass on cost increases to buyers more easily. Another risk to buyers is that the purchasing staff may find it difficult to adapt to a more collaborative bargaining style. From the supplier's perspective, dependence on the buyer will most likely increase as well and there is always the risk that the buyer may revert to the traditional *win-lose* style bargaining. In

addition, sharing information with buyers is a challenge, and becomes a threat to the supplier if the buyer reverts to *win-lose* style bargaining and plays suppliers off against each other (Lyons et al, 1990).

The retail industry has also started to move in the direction of closer relationships with suppliers, which McKinnon (cited in Hart, Gillham and McGlynn, 1994) identifies as the most promising advent for retailers. Hart et al (1994) carried out a questionnaire and interview survey of SA's major retailers. The sample was relatively small, consisting of 26 retailers, and biased towards larger retailers and retailers in the supermarket/grocery and clothing sectors. The retailers in the sample constituted 42 percent of the total turnover generated by the SA retail sector in 1992, with more than 60 percent of the respondents operating in the supermarket/grocery and clothing sectors. The study results were compared with a similar study completed in the US which revealed that SA retailers can be compared with their US counterparts. Figure 2.3 shows the extent that retailers were prepared to involve suppliers in partnerships. A large proportion of the sample of SA retailers were prepared to involve suppliers in replenishment decisions, discuss and negotiate partnerships, and even to share inventory data. However, far fewer were prepared to share sales information with suppliers or to allow suppliers to make replenishment decisions.

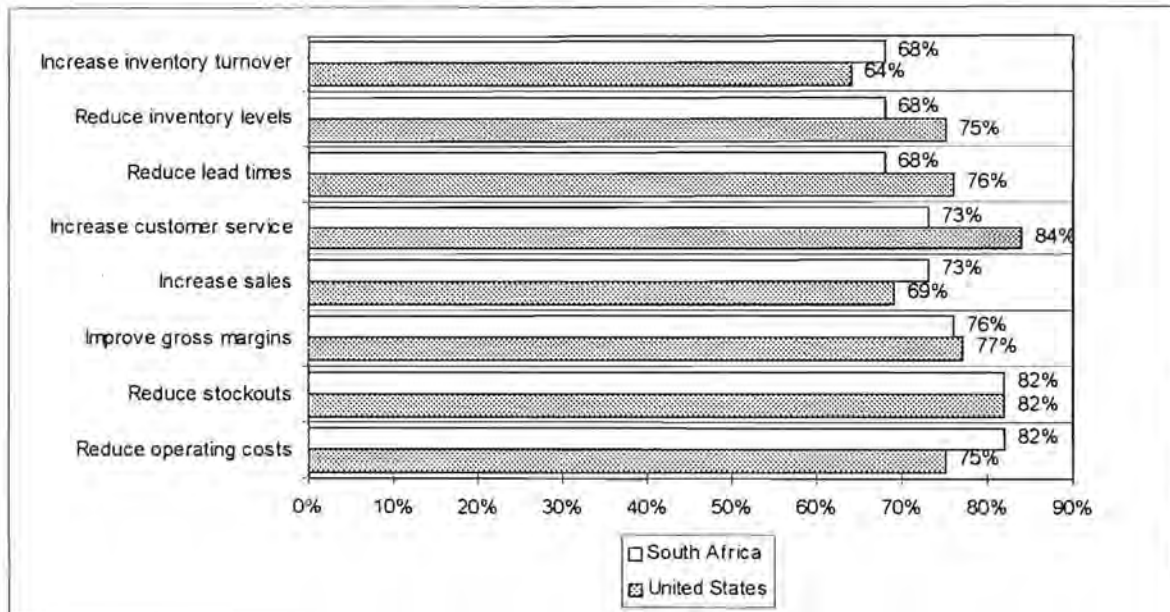
Figure 2.3: The Extent of Supplier Partnerships



Source: Hart et al (1994)

Figure 2.4 illustrates this trend. Reasons given include objectives to increase efficiency as well as to increase revenues. Retailers aim to increase the efficiency of the replenishment cycle by reducing lead times, inventory levels, stockouts and operating costs and increasing inventory turnover. These reasons are inter-related to some extent. For example, reducing lead times will help to improve inventory turnover because less slack stock would need to be ordered, while reducing inventory levels and, therefore, the cost of holding that inventory would help to reduce operating costs. Other reasons were directed at increasing revenues and include the desire to increase sales and customer service. The final objective, to improve gross margins, addresses both the revenue and cost aspects. In particular, discussions with the retailers in the sample indicated that the need to reduce lead times is vital if SA retailers hope to compete in international markets.

Figure 2.4: The Reasons why Retailers are involved with Supplier Partnerships



Source: Hart et al (1994)

2.1.3.4 Information Technology in the Retail Supply Chain

IT facilitates closer relationships between suppliers and retailers because of telecommunications capabilities. A few broad areas of opportunity will be highlighted before the system of QR is discussed. QR is analogous to JIT manufacturing and is made possible by advancements in IT.

The efficiency of the supply chain is important to maintain high customer service levels. Ody and Newman (1991) cite Tesco and Sainsbury as examples of retailers in the UK that have invested heavily in supply chain systems to improve performance. According to Ody and Newman (1991) these investments have paid off. Both companies increased profits following these investments, and Tesco attributed much of its increase in profits to continued investment in high-tech systems.

Lester (1992) envisions the supply chain of the future as one where customer data is scanned and aggregated from the checkout, triggering deliveries from the retailer's depots, with further aggregation of data transmitted to suppliers to prepare for the next delivery. Lester (1992) believes that the necessary computing power and communications technology have been available for some years.

Technologies have been developed that assist in most areas of the supply chain. First, demand details can be recorded at the store through hand-held computer terminals. For example, Tesco's staff use hand-held terminals to record details of empty spaces on the bread display. This technology is particularly useful for items with a short shelflife (like bread) and the staff do not need to wait for data from the EPOS terminals that are totalled nightly. EPOS systems are being developed that can cope with multiple barcodes relating to the same product. This demand data is then used for reordering via EDI. EDI can be used to communicate directly with suppliers' computers to place orders. These do not necessarily have to be large suppliers. Tesco has an EDI link with a Welsh goat farmer's personal computer (PC) for ordering. When the goods arrive at the store, technologies that track goods inward at the store have also been developed. Hand-held terminals with radio frequency capabilities can be used to record barcodes on the outer cases of goods as they are delivered. This information can then be used to reconcile deliveries with orders. However, development of these systems in Europe has been delayed by the lack of agreement on the wavelengths to use (Ody and Newman, 1991). At the supplier's end of the chain, automated picking systems and direct transfer from supplier's to retailer's trucks are available for warehouse automation. Computerised planning systems have been developed to help improve distribution

networks, which are also being linked to Geographic Information Systems (GIS). These systems can include the loading order for merchandise and fixed time slots for delivery and it may also be possible to link these systems to on-line GIS databases produced by the Automobile Association (AA) to avoid traffic congestion.

Possibly the best known example of a successful application of IT by a retailer is the American retail chain, Wal-Mart. When Wal-Mart first started it created a centralised distribution network so that the company could buy goods in volume from powerful manufacturers. A system called *cross docking* divided the warehouse into a receiving area for incoming orders and an area for grouping the products for an individual store. By the early 1980s each store was linked to one of a number of distribution centres. The suppliers were also linked through EDI. Barcodes on incoming goods were read and directed to the appropriate truck. IT therefore facilitated just-in-time replenishment at the stores, as well as cost reductions. In 1992, Wal-Mart's distribution costs were under 3 percent of sales compared with 4.5 to 5 percent for the firm's competitors. Computer modelling programmes have enhanced the distribution system by forecasting customer demand. The next step was a partnership with Procter & Gamble, one of Wal-Mart's major suppliers. This involved data sharing through EDI as well as joint management of the entire relationship between the trading partners. The result has been a faster and more predictable stock turnover, and both firms have said that they have benefited, since Procter & Gamble can tailor production to meet Wal-Mart's demand. However, while Wal-Mart's system has given it great competitive advantage, with sales growing rapidly, Procter & Gamble have been struggling with plant closures. Therefore, the relationship appears to have benefited the retailer more and this may

make it difficult to involve suppliers in similar relationships again (The Economist, 1995).

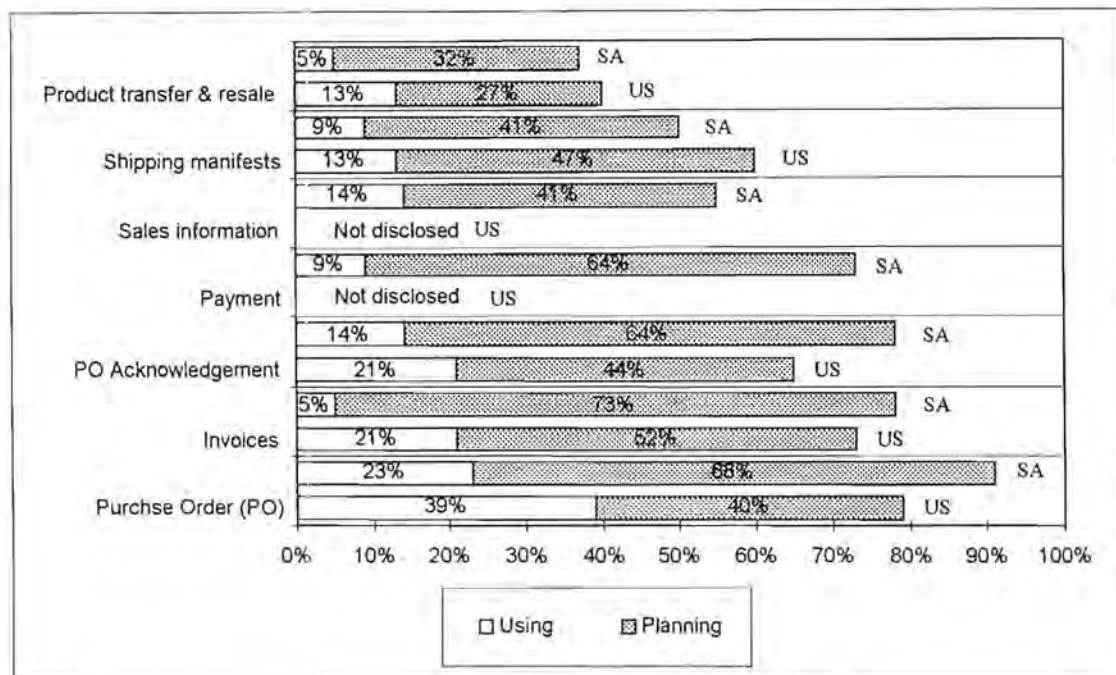
However, many retailers are catching up with Wal-Mart on technology. This raises doubt over the sustainability of a competitive advantage created through IT, such as EDI. According to Bruce Watson of The Gap (cited in The Economist, 1995), a clothing retailer based in San Francisco, competitive advantage is derived from the application of the technology rather than the system itself. Clothing retailers, with more variable demand patterns than supermarkets such as Wal-Mart, are also using IT in the distribution channel. The Limited, a fashion chain based in Ohio, set up EDI links with clothes' makers based in Hong Kong. Using computer-aided design and air freight, it has cut the lag between order and delivery from nine months to between three and five weeks. The consulting firm McKinsey notes that IT has made a difference, with a significant, sustained gap between the front-runners and the average for the particular retail format (The Economist, 1995).

It is apparent that the use of EDI, in particular, by SA retailers is still in its early implementation stage. Figure 2.5 shows the usage of EDI in various areas. The current use of EDI is low, especially considering that the SA sample is biased towards larger retailers with typically greater resources. The most popular current use of EDI is to process purchase orders and eliminate clerical errors. Other areas of interest include using EDI to obtain product quantity and price information from the supplier.

Although SA retailers appear to be lagging behind their US counterparts, they expect

to increase their usage substantially in the future, thereby attaining similar levels to US retailers (Hart et al, 1994).

Figure 2.5: The Use of EDI by Retailers

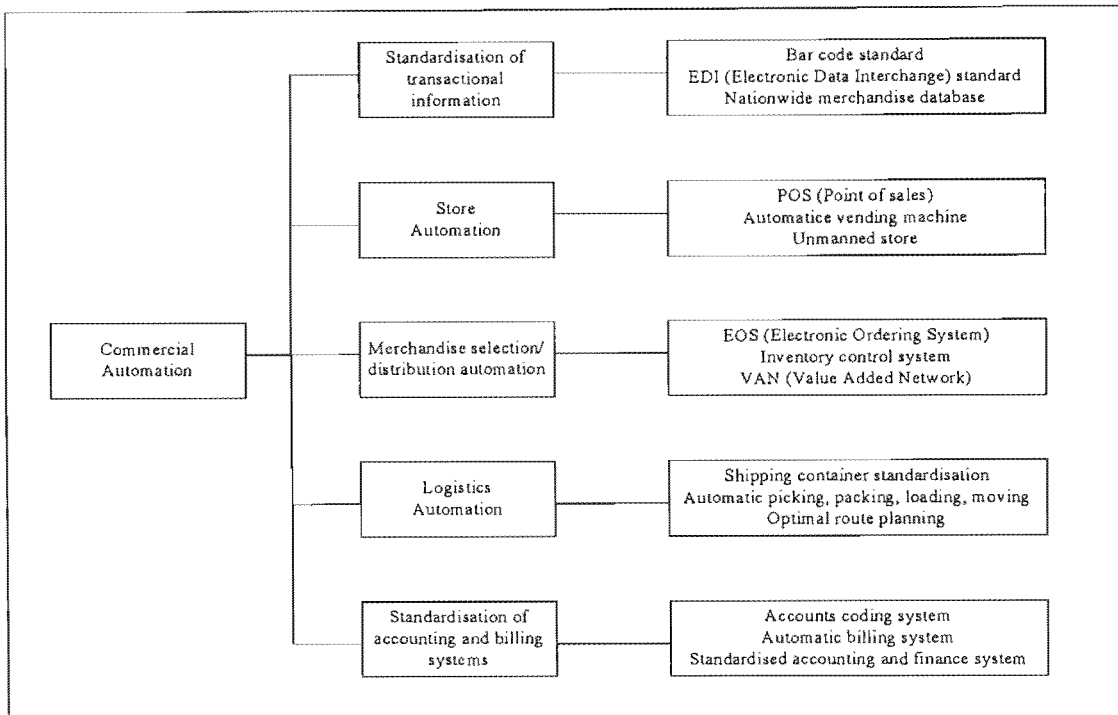


Source: Hart et al (1994)

An interesting application of these supply chain technologies is the Taiwanese government's commercial automation plan, which helps to outline the scope of opportunities. Tan and Lung (1994) report on the Taiwanese government's plan to manage technology from a central government level. Since the commercial sector in Taiwan is characterised by numerous small to medium sized firms, it is a challenge for the government to manage the strategic development for the country as a whole. The government's macro-level objectives include the aim to increase distribution efficiency and enhance competitiveness.

The commerce automation plan views the commercial system as a flow of goods and services from producers, through wholesalers and then retailers, to consumers. The financial and distribution centres are viewed as enablers for the system; although they are not primary components, they contribute to the efficient operation of the system. As a result, any technology or operational process that can enhance the efficiency and effectiveness of the flows and functions will improve the entire system. The scope of the plan is presented in Figure 2.6. Tan and Lung (1994) believe that the true potential of these technologies will only be realised if connectivity is viewed from the perspective of the commercial sector as a whole. Connections between the subsections of the system can be carried out through electronic ordering systems (EOS) and EDI, either through direct dial-up or through a value-added network (VAN) provider. However, essential requirements are the establishment of standards and training.

Figure 2.6: Scope of Taiwan's Commerce Automation Plan



Source: Tan and Lung (1994)

Tan and Lung (1994) surveyed the current levels of automation and found that they are relatively low. In particular, none of the firms surveyed were using EDI. A number of reasons were given for this situation. In many cases, the investment required was too great or could not be justified. The manual operation was often considered sufficient and/or the automation technology was not suitable for operations, including the lack of established standards. In certain cases, a lack of knowledge of the automation benefits was also cited as a reason. Sufficient technical skills were not available in numerous cases as well.

One of the difficulties with implementing new technology is that it can require a substantial investment, which was included as a reason against technology adoption above. The 1994 DATAMATION Information Technology Outlook survey took place

in November 1993, and 202 responses were received. According to the results, IS managers felt that the need to improve company productivity, quality and general competitiveness would be the key driving forces of change in 1994. At the same time, IT budgets were expected to be tightened, with almost a quarter of the survey respondents placing the need to reduce IT costs on the list of critical activities for 1994. Fifty-four percent of the respondents indicated that the most important contribution that IT could make to the organisation would be to improve productivity. Using IT to improve quality, and creating competitive advantage through IT were considered the next most important applications. Ray Lane, the head of consulting at Oracle Corporation in North America, states that the focus is on lowering the cost of doing business, improving customer service and reducing the time to market of new products (Moad, 1994).

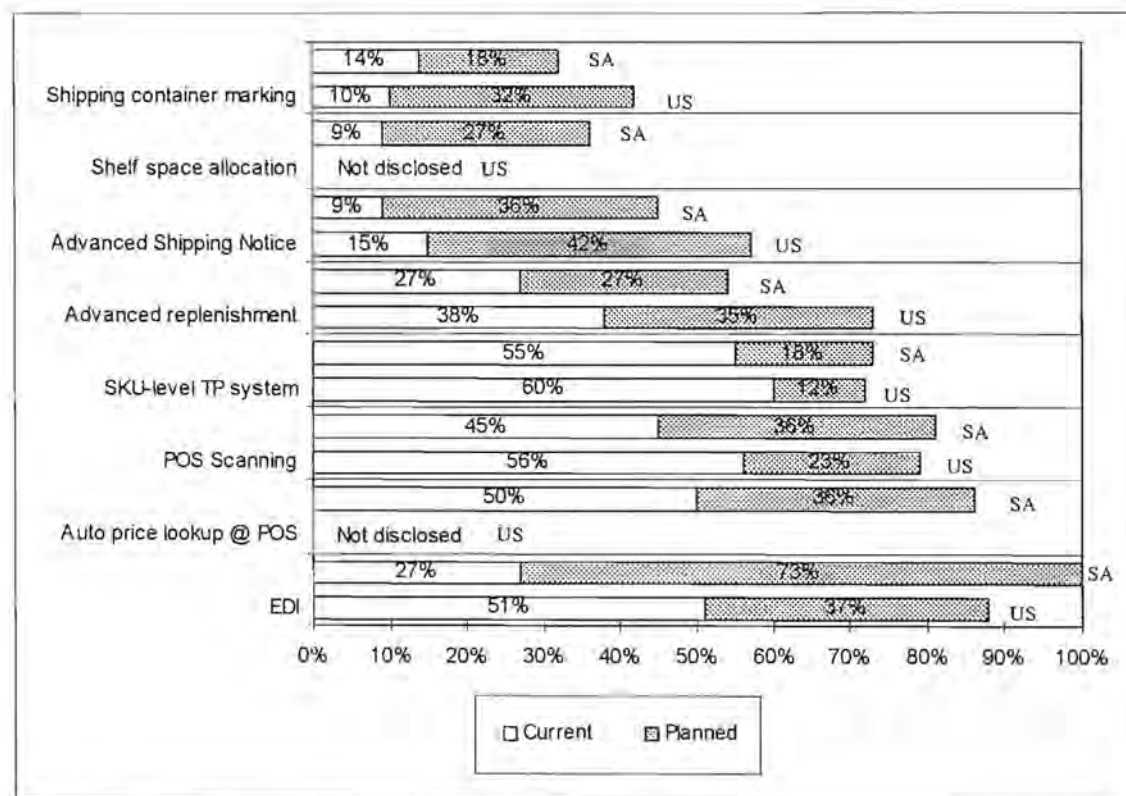
2.1.3.5 Quick Response Partnerships

According to Johnson (cited in Hart et al, 1994), QR is an inventory management strategy in which merchandise planning, forecasting and purchasing is based on an analysis of every item's rate of sale and profit distribution. The merchandising function, supplier, distribution centre, and point of sale are all linked in a closed loop that aims to speed up the flow of merchandise through the supply channel, and, therefore, to reduce safety stocks and the time that inventory spends in the pipeline. Partnerships with suppliers and new IT systems facilitate QR, with EDI, in particular, supporting the communication link between retailers and suppliers. Other enabling technologies

are shipping container marking, universal product code technology, electronic funds transfer and point-of-sale systems.

Hart et al (1994) found that SA retailers are trailing US retailers in their use of EDI for QR but have definite plans to implement a formalised EDI strategy for QR. Figure 2.7 shows the extent of use of EDI by samples of SA and US retailers.

Figure 2.7: The Extent of Use of Quick Response Technologies



Source: Hart et al (1994)

QR is a philosophy that entails a change in the way that a company views its supply chain and its customers, and the manner in which it addresses the demands levied by customer service. The underlying objective of a QR partnership is to maximise availability for sale in store at minimised cost and administrative effort. This is

essentially the main goal for retail management and, therefore, this system can be seen as a means to achieve the strategic goals of a retail firm. The idea behind QR is to work together on a long-term basis so that the two trading partners may harmonise their order management and inventory replenishment approaches, and their physical handling and transport methods. Moreover, the trading partners should exchange information on a routine, but totally open, basis to drive the efficiency of their respective operations. Consequently, the whole supply process should become a single, common, shared process. The potential results are an elimination of unnecessary stock, improvements in handling and efficiency in all elements of the supply chain by eliminating unnecessary tasks, simplifying and automating where possible, and benefiting from integration between partners and the economies of scale that may result (Whiteoak, 1993; Hayman, 1995).

In particular, Whiteoak (1993) highlights the basic objectives of the information exchange in this partnership process as an attempt to improve joint knowledge of future customer demand and behaviour, to increase the predictability of sales fluctuations and to better manage that sales variability.

Hayman (1995) identifies a number of requirements of such a partnership:

- *Demand data from the stores:* This is the order placed by the store to the Regional Distribution Centre (RDC) for the following day's deliveries. This can be distorted by manufacturers demanding minimum order sizes or multiples thereof; the stock control clerk increasing the order "just in case"; errors in forecasting; and the manufacturer increasing inventory to meet the retailer's demands, while the retailer increases inventory because the manufacturer is unreliable.

- *Decision support systems (DSS)*: Data from transaction processing systems needs to be transmitted in real time to make the supply chain system responsive enough to changing demands. The objective is to flatten the demand curve by evaluating the impact of influences such as promotions' effects and price increases on changes in demand.
- *Flexible manufacturing process*: The manufacturer needs to deliver the amount required to satisfy retailers' safety stocks, and not minimum order quantities. Hayman (1995) believes that manufacturers will have to increase stocks to meet retailers' demands for service levels. These stocks can be reduced only once the business has been reengineered and the DSS has been put in place. The closing stock should be a target as a result of the required production rather than as a result of minimum production runs.
- *Eliminating forecasting and understanding the causes of "noise" in demand*: The aim is the standard order. Hayman (1995) believes that demand is fairly stable, but forecasting errors and promotions introduce "noise".
- *The retailers ordering just what they have sold*: Hayman (1995) believes that demand history rather than purchase order history will facilitate the standard order because purchase orders have been distorted by "noise". Anticipated market impacts, such as new product launches, can then be taken into account after the standard order has been calculated.
- *The manufacturers delivering what has been sold within 24 hours*.

The potential benefits include both efficiency benefits and increased revenues. Both manufacturers and retailers ought to reduce stock and costs in the total pipeline.

Retailers, in partnership with suppliers, should be able to eliminate out-of-stock situations and improve product availability, as well as increasing quality and service to customers, with a resulting increase in revenue. In addition, the improvement in

information on supply issues should enable retailers and manufacturers to manage the supply chain better by anticipating problems (Whiteoak, 1993).

However, one of the more important concerns is the apparent contradiction between retailers' and suppliers' stock policies. Partnerships between retailers and suppliers attempt to reduce pipeline stocks and safety buffers while maintaining or increasing responsiveness to customer demands. The concept of QR implies more frequent order reviews and orders comprising a lower quantity of goods. At the same time, sales forecasts and delivery errors are inevitable. Therefore, the manufacturer's ability to meet these demands becomes more difficult, unless the accuracy of sales forecasts and/or delivery accuracy can be improved. The reason is that the efficiency of the manufacturing process increases with the length of the production run. Hence, manufacturers need to try to make the production process more flexible without reducing its efficiency. Otherwise, they need to keep buffer stocks because of demand variability. In other words, there is a trade off between increasing plant responsiveness and inventory - as a plant becomes more responsive, inventory costs tend to fall, but manufacturing costs tend to rise (Whiteoak, 1993).

2.1.3.6 Electronic Markets

Before focusing on EDI, the concept of electronic markets needs to be discussed to highlight the difference this concept and that of supplier partnerships. According to Benjamin and Wigand (1995), economies have two basic mechanisms for coordinating the flow of materials through adjacent steps in the value chain, namely markets and hierarchies. *Market transactions* support coordination between multiple buyers and

sellers, while *hierarchy transactions* support coordination within the firm, as well as throughout the industry value chain. The price a product is sold for consists of three elements: production costs, coordination costs and profit margin. *Production costs* include the physical or other primary processes necessary to create and distribute the goods or service being produced. *Coordination costs* include the transaction (or governance) costs of all the information processing necessary to coordinate the work of people and machines that perform the primary processes. For example, coordination costs incorporate determining the design, price, quantity, delivery schedule, and similar factors for products transferred between adjacent steps along a value chain. Benjamin and Wigand (1995) conclude that as IT continues its rapid cost/performance improvement, the unit cost of coordination transactions will approach zero.

Benjamin and Wigand (1995) argue that, with cheap coordinative transactions, interconnected networks, and easily accessible databases, there will be a shift of economic activity from single-source sales channels to electronic markets for the following reasons:

- Lower coordination costs favour electronic markets. Electronic markets are characterised by low production costs and high coordination costs, whereas the opposite is true for hierarchies. Since IT has been lowering coordination costs, markets should be favoured. Low computing costs can expand products that favour market transactions. These include products that are easy to describe and whose asset specificity is low. For example, a computer's asset specificity can be lowered by making it compatible with many manufacturers' components, such as printers.

- Electronic single-source markets should evolve from separate databases within the firm, to linked databases between firms (EDI), to shared databases between firms.
- There should be trade-offs in market participation. Essentially, the returns from entering the market (for example, a larger customer base) must outweigh the costs, such as lower prices.

Benjamin and Wigand (1995) argue that the expansion of electronic markets has been hampered by a number of factors. Interorganisational value chains are well-established in a number of industries, for example between automobile manufacturers and suppliers. These systems provide opportunities to focus on higher-quality products, increased customer satisfaction, and business reengineering. Electronic supply chain integration in the retail industry has produced inventory and coordination savings for large purchasers (for example, Wal-Mart) and suppliers are forced to comply. These processes are highly coordinated between firms, typically resulting in a reduction in the number of suppliers and the establishment of “partnerlike” arrangements. Firms also fear profit margin deterioration that will probably result as search costs are reduced in electronic markets. However, Bakos (cited in Benjamin and Wigand, 1995) believes that the introduction of a market system providing price information can dramatically reduce seller profits and increase buyer welfare.

2.2 Electronic Data Interchange

In the context of the retail industry, EDI can be used to transmit information electronically between retailer and supplier. This technology will now be examined in more detail.

2.2.1 Introduction to Electronic Data Interchange

Harrington (1994) reports that EDI can realise considerable benefits when viewed as a new approach to doing business. In particular, a reduction in time delays and greater information sharing as a result of using EDI can improve internal operations, supply chain management can be enhanced, and a company's ability to compete in both local and international markets can be improved.

EDI is defined by the UN/EDIFACT standard (1984) (United Nations EDI standard For Administration, Commerce and Transport) as:

“The electronic transfer from computer to computer of commercial or administrative transactions using an agreed standard to structure the transaction or message data.”

(cited in Bamfield, 1994, p.3)

The distinguishing characteristics of EDI are that it involves electronic communication between firms through a telecommunications network and that the data is structured in a standard format (Picard and Leschiutta, 1994; Harrington, 1994; Hansen and Hill,

1989). Alternatively, electronic mail is an example of a system that involves the transfer of unstructured data. Since EDI is a standard technology, the most common documents that are candidates for exchange contain similarly structured data across different firms. Therefore, documents such as purchase orders, invoices, and remittance advices are typical documents that are exchanged (Dearing, 1990).

There have been predictions for the rapid growth and spread of EDI throughout the world. Bamfield (1994) reports on a study that estimated a growth rate of over 70 percent in the number of European firms using EDI. There has also been a growth in the number of trading partners connected by EDI, as well as in EDI transaction volumes. In a survey of American firms, Hansen and Hill (1989) established that, in 1988, 67 percent of firms using EDI were planning to add trading partners, while in 1989 that figure rose above 83 percent. They also found an increase in document volume, with almost 67 percent of firms in the 1989 survey expecting a growth in document volume of more than 30 percent. In the retail industry in SA, Hart et al (1994) found that, although SA retailers are lagging behind their US counterparts, most are planning to increase their use of EDI in the future.

However, Bouchard and Markus (1995) indicate that many predictions appear to have been too optimistic. Although EDI initially spread quickly in America, only 31 000 companies were using EDI by October 1992 compared with an estimated 5 million companies in the US that could use the technology. Bouchard and Markus (1995) quote Thomas Colberg, a partner in Price Waterhouse's EDI Consulting Group:

“EDI should be growing faster than it is [...] Frankly, it’s embarrassing to be an expert on EDI and to forecast explosive growth year after year after year.”

This implies that there are issues that are preventing the rapid spread of EDI as originally forecast. Therefore, EDI needs to be described and these issues need to be exposed.

The objectives of this section are to define EDI and to classify it as an example of an Interorganisational System (IOS), and to understand the benefits and the reasons for implementing such a system. This will lead to a discussion of the implementation issues.

2.2.2 Interorganisational Systems

EDI is a specific example of an IOS. Therefore, most of the issues relevant to an IOS should be relevant to EDI. An IOS will be defined and the benefits and implementation issues will be discussed in this section. Thereafter, the specifics of EDI will be examined in detail.

2.2.2.1 Definition of an Interorganisational System

An IOS is a specific IT category which has become possible because of advances in telecommunications technologies. Cash and Konsynski (1985) coined the term IOS and defined it as an automated information system that is shared by two or more companies. An IOS consists of a computer and communications infrastructure that

permits the sharing of an application, for example an order and purchase system. Therefore, an IOS is a system that enables the movement of information across organisational boundaries. An IOS must provide incentives for all intended participants to become involved in the network. In addition, since the participating organisations may well have different goals, the system needs to make provisions for reliability, data security, user privacy, and system integrity. An IOS also needs to provide some positive return to its sponsor and not merely benefit an industry, since companies are typically not self-sacrificing (Johnston and Vitale, 1988). Typically, participants and facilitators are involved in these systems. A *participant* is an organisation that develops, operates or uses an IOS to exchange information that supports a primary business process. A *facilitator* is an organisation that aids in the development, operation or use of such a network for the exchange of information among participants (Cash et al, 1992).

Cash et al (1992) argue that the potential for IOS growth and impact in a broad range of industries is great, given the rapid diffusion of computer and communications technology into most organisations. They believe that the reasons for this growth are the various technological, economic, and organisational changes, including:

1. The need for fast, reliable information exchange in response to rapidly changing markets, products and services. This is based on increasing international competition, shrinking geographic separation, and deregulation with more open competition.
2. The evolution of guidelines, standards and protocols, such as the universal product code (UPC) is an example in the retail grocery industry.

3. Penetration of information systems into internal business processes. This prevents redundant encoding of data and makes information readily available.
4. Technical quality and capabilities of IT. IT can be used in more business sensitive areas as the reliability increases, as in Automatic Teller Machines (ATMs).
5. The use of IT to distinguish product and/or company. The provision of management information to customers through an IOS, such as order status, can add value to the product and differentiate it from competitors' offerings in terms of service.

2.2.2.2 The Development of an Interorganisational System

There are a number of different configurations of an IOS that will be discussed in this section.

Cash, McFarlan, McKenney and Applegate (1992) stipulate that an IOS is necessarily an integrated system. It is integrated with internal systems in all organisations that are part of the network so that an employee can directly allocate resources and initiate business processes in another company. Since an EDI system does not have to be integrated in this manner, it is not strictly an IOS as defined above. However, Johnston and Vitale (1988) define an IOS more broadly and do not restrict their definition to an integrated system.

Johnston and Vitale (1988) distinguish between three levels of complexity, where the simplest level does not necessarily require the system to be integrated with internal systems in the organisation. They state that the most common type of IOS involves a relationship between a company and its customers and emphasise that the system

should provide benefits to each participating organisation in proportion to their use of the system. There are three levels of functions that an IOS can perform. The simplest level is the transmission of boundary transactions, for example order-entry systems. The second level IOS allows participants to retrieve and analyse data as well as execute boundary transactions. For example, the system would allow a retailer to check on the progress of an order at a supplier. The most complex level allows participants to enter, store and manipulate information that is not transmitted to the sponsor. The system could perform *back office* processing in addition to the transmission of orders. This additional capability may be crucial for increasing the acceptance of the system. Johnston and Vitale (1988) believe that the logical development of an IOS is from the simplest to the most complex level. This allows the trading partners to develop an understanding of each other's processes and to increase the trust needed to foster a closer relationship.

Besides the classification by system configuration outlined above, there are also different roles and responsibilities which the different parties can assume. Cash and Konsynski (1985) state that an organisation needs to consider the extent of investment in the IOS and the extent of management of the IT. Participation falls into three categories based on technological considerations:

1. *Information entry and receipt*: The organisation performs no application processing and merely acts as an information entry-receipt node. Higher-level participants determine the standards and procedures, and maintain control of the system. There are few compatibility problems, but the participant can become increasingly dependent on the higher-level participant as processes require more coordination across organisational boundaries.

2. *Software development and maintenance*: The organisation has control over decisions on access, price and design of the application and the network. However, administrative overheads increase as coordination across organisational boundaries becomes necessary.
3. *Network processing and management*: This involves ownership of all the network facilities as well as the computer processing resources. In addition to network development and maintenance costs, there is considerable internal control responsibility for the integrity of the information exchanged.

There is a second differentiation among the participants as well. Riggins et al (1994) distinguish between initiators and followers. *Initiators* propose the network to their trading partners and plan how to get the most benefit from the technology, while *followers* usually adopt the technology in order to meet a trading partner's requirement. Since followers often lack long-term plans on how to use the technology to their advantage, they may not reap many of the benefits possible. According to Hwang (cited in Riggins et al, 1994), initiators of EDI systems tend to be larger companies who are more experienced with technology, willing to invest more capital in the technology, and achieve a higher level of internal integration with other applications. Riggins et al (1994) identify a trend towards buyer-initiated IOSs by dominant firms in certain industries, for example retailing. The reason why is that buyers are realising that they can dictate more of the network characteristics, thus achieving greater cost savings than when the system is supplier-driven. In the retail industry, these systems are often accompanied by barcoding and shipping label scanner systems to improve efficiency on the receiving dock. Retailers are trying to move

toward JIT inventory programmes to reduce labour costs in material receiving and data entry, while improving the visibility and timeliness of incoming materials.

2.2.2.3 The Benefits of an Interorganisational System

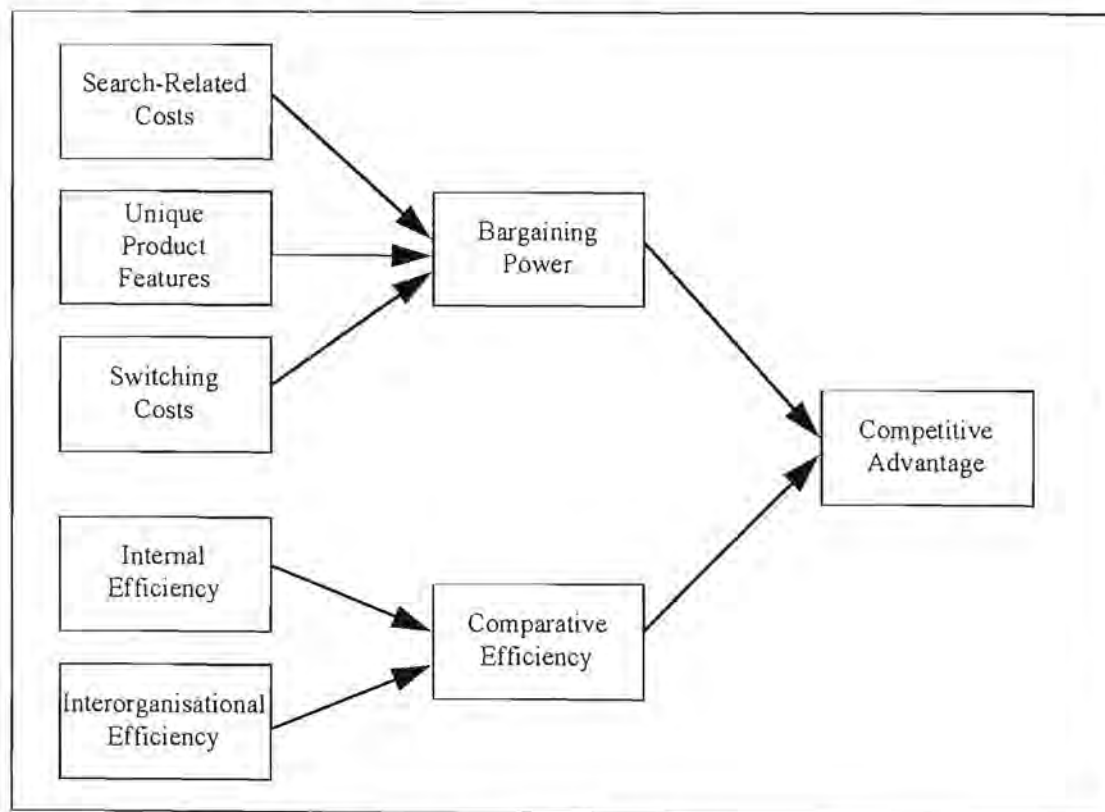
The benefits of an IOS emanate from the ability to use the speed and power of IT to communicate between organisations and between systems in each participating organisation. The most obvious benefits from these systems are efficiency gains. These can arise from the speed and accuracy of the information exchange. As a result, the time required to generate and transmit documentation can be reduced, the integrity of the information can be improved and errors can be reconciled more easily. Furthermore, transmission costs are typically lower (Riggins et al, 1994).

However, there are broader, more strategic implications from these systems as well. Cash and Konsynski (1985) argue that companies can ignore these implications and delegate the decision to implement an IOS to the production clerk level. Under such circumstances, despite the advantages of faster information flow and improved data integrity, the new system may shift inventory holding costs and business risk to the supplier. The costs would probably outweigh the benefits for the supplier and, therefore, the supplier may be reluctant to participate in the system.

Therefore, these authors are suggesting that decisions regarding an IOS should be taken with a broad view of the business in mind and not just from one department's perspective. Johnston and Vitale (1988) applied a model of competitive advantage developed by Bakos and Treacy to the analysis of IOSs. According to Bakos and

Treacy, competitive advantage is based on *comparative efficiency*, which allows an organisation to produce its goods or services more cheaply than competitors, and *bargaining power*, which relates to the relative influence a company has with its customers and suppliers. The strength of these factors is determined by more fundamental issues: comparative efficiency by both internal efficiency and interorganisational efficiency, and bargaining power by unique product features, switching costs, and search-related costs. Figure 2.8 represents these concepts in terms of a simple framework.

Figure 2.8: A Model of Competitive Advantage



Source: Bakos and Treacy (included in Johnston and Vitale, 1988)

Johnston and Vitale (1988) describe how an IOS can provide competitive advantage by influencing each of these factors. For example, an IOS can be used to provide a buying

organisation with supplier information, thereby facilitating just-in-time delivery of inventory. According to the model, this will provide a source of competitive advantage by improving internal efficiency and, in turn, comparative efficiency. However, nothing can be said about the sustainability of any advantage.

2.2.2.4 IOS Implementation Issues

There are a number of important considerations that need to be borne in mind when implementing an IOS. These arise from the peculiarity of such a system, namely that it is an IS shared by more than one organisation, and because it is a relatively new type of IS. In addition, the costs of any new system are always a concern.

These systems are dependent on parties external to the organisation. Factors resulting from the dependence on other parties are known as externalities. According to Riggins et al (1994), network externalities exist when an individual's demand for the network depends on the consumption of others. They studied the case of a buyer-initiated IOS and theorise that, as more suppliers join the network, the relative benefits will decrease. In other words, it becomes more difficult for each additional supplier to reap the economic benefits by demonstrating that they are more responsive to customer needs. As a result, subsidies may need to be offered to additional suppliers to ensure that they join.

Organisational impacts also need to be considered by each participating organisation. Cash and Konsynski (1985) divide the organisational impacts into three levels: first order impacts on business processes, second order impacts on skills and staff

requirements, and third order impacts on organisation structure and business strategy. First, changes in business processes are required to conform to the standards of the IOS or to take into account various procedures in internal control, report formats, planning systems and communication patterns. Secondly, changes in the underlying business processes and communication patterns often lead to changes in skill requirements. Thirdly, when an IOS is used for a key business function such as market access systems (for example, shared ATMs in retail banking), the IOS may force changes in business strategy. Cash and Konsynski (1985) argue that an initiator of an IOS will typically experience third order impacts (organisation structure and strategy) first and first order impacts (business processes) last because of more effective planning. This order should be reversed for a company that joins such a system proposed by another organisation because they are typically not involved in the decision process.

The costs of implementing and using such a system cannot be ignored. Costs include those required to build the necessary applications infrastructure and the development of telecommunications expertise. Another important cost area involves contracting for the telecommunications medium, either through investment in private telecommunications lines or through the use of a third-party network provider (VAN). In addition, users need to be trained to use the applications.

Factors that are considered important for the successful management of an IOS include: high-level involvement of both technical and business people, and strong linkages between the IS planning processes and organisation-wide business planning

processes of participating organisations. High-level management involvement is important when strategic decisions are required. However, potential problems arise when a balanced and widespread exchange of resources, including information, is not possible. The reason is that larger organisations may take advantage of their influence by dictating standards and implementation of a specific IOS to smaller participants. This difficulty is also of concern when there is an unequal balance of power between participants of different countries. The steering committee is a possible management structure for an IOS, comprising representatives from participating organisations. This structure facilitates high-level involvement of both technical and business people (Levinson, 1994).

2.2.3 Configuration of an EDI System

The theory of Interorganisational Systems provides a framework to examine EDI. These systems will first be defined in more detail by describing the various components that make up an EDI system, as well as the process involved in an EDI transaction. Thereafter, potential benefits from these systems and implementation issues will be considered.

The messages from an EDI system are communicated through a telecommunications infrastructure. Therefore, the EDI system needs to interface with the telecommunications infrastructure, in terms of the protocol and bandwidths. The source of the messages from the EDI system may or may not be internal applications in the organisation. Consequently, an EDI system is not necessarily an IOS in the strictest

sense, as defined by Cash and Konsynski (1985). However, the principle of an EDI system is essentially that of an IOS.

The components of an EDI system comprise the hardware platform, software and the telecommunications infrastructure. However, before describing these components, it is noteworthy that EDI is essentially a standard rather than a specific technology or application. It is the standard for sending structured messages, such as orders and invoices, between two or more companies. However, there are many different standards, each with their own structure for the various transactions. The standards are the rules of format and syntax that govern EDI communications. In other words, they provide a common language that enables one application to understand the information passed to it from another application. Proprietary or industry standards exist, such as ODETTE in the automotive industry, as do national standards, such as ANSI X12 in America, and international standards, such as the United Nations' EDI standard for Administration, Commerce and Transportation (UN/EDIFACT) (Harrington, 1994). In SA, the South African Article Numbering Association (SAANA) controls EDI standards, which are based on the UN/EDIFACT standards (Pearcy, 1991). A working group of retailers, manufacturers and wholesalers developed the standards for syntax rules, product coding, location coding and message formats. These standards covered the following transactions in 1990: orders, invoices, statements, remittance advices, delivery notifications, credit/debit notes, pricing confirmation, and product information.

The hardware platform for EDI should not be conditional on the platforms used by the organisation's trading partners because of the standards (Tsay, 1988). The first option is to install the entire set of EDI software on a mainframe or mid-range computer. Although this facilitates high volume processing, the EDI software is typically more expensive than microcomputer software. At the opposite end of the scale, a stand-alone microcomputer (PC) can be used. This configuration is relatively inexpensive, easy to set up and use. However, it does not represent EDI as an IOS in the truest sense since data received by the microcomputer application will need to be rekeyed into related applications. A compromise between these alternatives is to use a microcomputer as a front-end processor to a mainframe or mid-range computer. The microcomputer performs the EDI translation and transmission functions after receiving data that has been extracted from the mainframe. This configuration represents a compromise between the speed of the mainframe and the cost of a stand-alone microcomputer (Harrington, 1994).

The level of integration with internal systems dictates the requirements of the EDI software. Picard and Leschiutta (1994) distinguish between three levels of implementation, relating to the level of integration with existing computer applications:

1. *Standalone EDI*: A standalone computer, typically a PC, receives the documents from the trading partner. Also referred to as "door-to-door" EDI.
2. *Application seamless integration*: Documents are received, validated and serve as input to other computer applications.
3. *Fully engineered business processes and a paperless environment*: The business makes it policy only to deal with trading partners through EDI. Business processes

are designed to maximise the benefits of a paperless environment by eliminating intermediate processes and steps. Examples are JIT manufacturing and QR distribution.

Three main functions are required, namely data conversion, data formatting, and message communication. Integration software allows data to be extracted from internal applications in the organisation, while translation software converts the data into the standard format required by the EDI application. Integration and translation software are obviously not required when the EDI system is not integrated with internal applications. However, translation software may still be used when the data is transferred manually between the EDI application and the internal application by means of diskettes. The application software holds the business form templates for documents such as invoices, purchase orders, bills of lading and disbursements, while the communications software controls the transmission and receipt of EDI messages (McNurlin and Rochester, 1989; Harrington, 1994).

The final component of an EDI system is the telecommunications (network) structure.

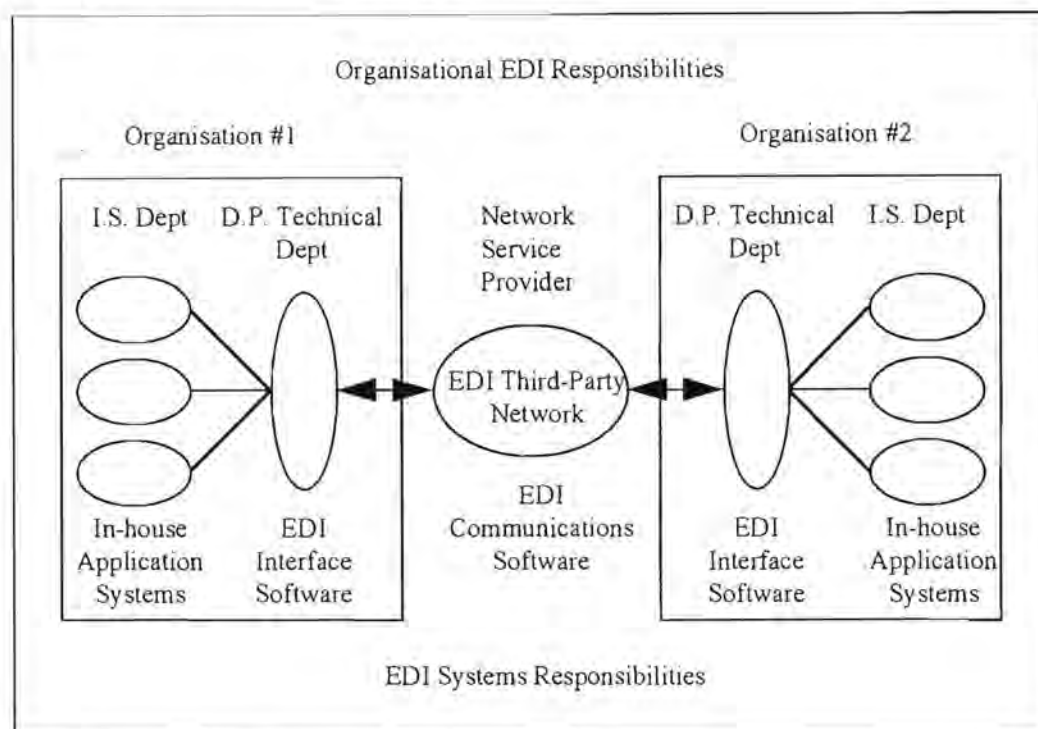
Silber (cited in Tsay, 1988) defines three types of EDI network structure:

1. *Single hub*: The major firm initiates and coordinates the network, with the network extending both upstream to suppliers and downstream to customers. However, maintenance and coordination jobs may be assigned to a third party.
2. *Clearinghouse*: This structure allows a large number of small firms to be connected to a network set up by a communication services' organisation.
3. *Distributed*: There is no central organisation that controls the network. Electronic transactions take place directly between two or more members of the network.

Value-added network providers (VANs) can be involved in all of the above network structures. Two companies can initiate a direct link that is supported by a VAN. A third-party VAN supplier can provide the appropriate protocols and translation into EDI standards, ensure data security and permit electronic messages to accompany orders. A VAN supplier may also offer training in its range of services (Harrington, 1994; McNurlin and Rochester, 1989). In the opinion of McNurlin and Rochester (1989), VAN suppliers are cost-effective since they facilitate EDI with a broader experience base. The alternative is a direct connection via dial-up modems. However, Harrington (1994) notes that difficulties arise with this approach when the number of trading partners increase, particularly with respect to maintaining open lines, coordinating the timing of transactions, assuring communications compatibility, and maintaining security.

Swatman and Swatman (1991) provide a graphic representation of the components of an integrated EDI system, depicted in Figure 2.9.

Figure 2.9: EDI Software Categories

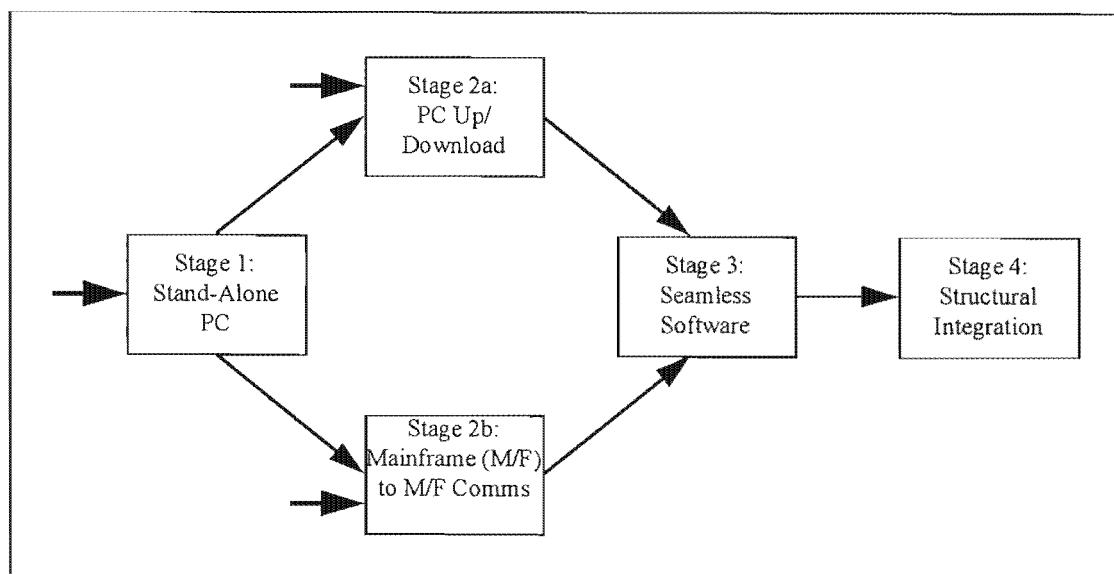


Source: Swatman & Swatman (1991)

The various configurations described above, particularly the integration of EDI with internal business applications, can change over time. There seems to be some evidence that there is a series of comparatively standard and recurring stages that organisations go through to integrate EDI with internal applications. Swatman and Swatman (1991) hypothesised a three-stage model of organisational integration of EDI (Figure 2.10). They tested this model using a multiple case study research method involving major Australian organisations which had been involved with EDI for between one and three years. These organisations were all medium to large in terms of both staff numbers and annual expenditure on IT, and were all considered to have relatively sophisticated technological infrastructures. Swatman and Swatman (1991) found general support for their model but modified it in retrospect due to significant differences between those organisations who were developing their first IOS and those building on prior

experience. This led to the inclusion of a fourth stage in the modified model, namely “Structural Integration”, where EDI influences the functional structure of the organisation and the structure of the supportive information systems. Those organisations with greater experience of an IOS were typically found to enter the model at a higher stage than less experienced organisations. A further finding was that organisations who initiated the EDI system progressed through the stages quicker. These organisations typically viewed EDI from an organisation-wide perspective. Therefore, not surprisingly, the greatest influence on progress through the stages of the model was established as an organisational perspective of EDI.

Figure 2.10: Model of the Stages of Integration
 (with points of entry indicated by heavy arrows)

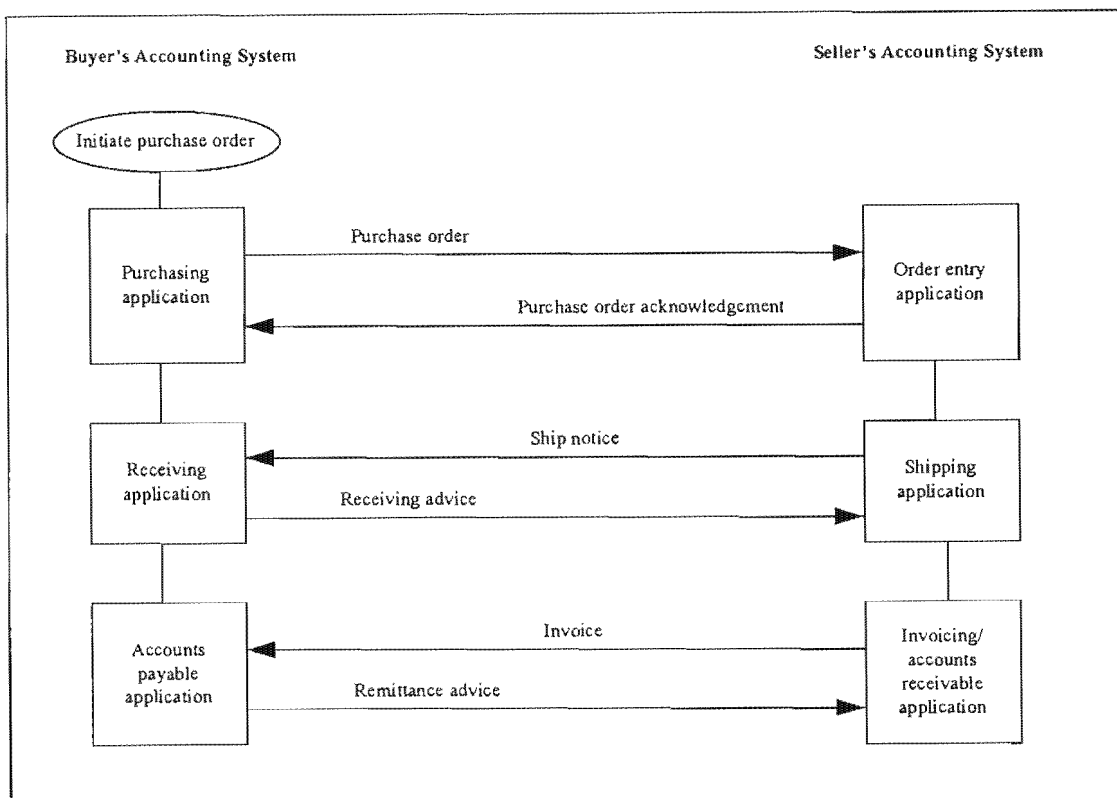


Source: Swatman & Swatman (1991)

The next step towards describing an EDI system is to examine the process of an EDI transaction. Borthick and Roth (1993) highlight the components of a typical EDI transaction (illustrated in Figure 2.11):

- *Initiating an EDI transaction:* The buyer performs transaction processing for an application and initiates a purchase order. The buyer's system then translates the purchase order into the required format for EDI. The coded transaction is known as a transaction set. A header precedes the transaction set and a trailer follows. A functional group is a collection of a number of transaction sets of the same type, for example a functional group of purchase orders. Multiple functional groups can be sent in the same EDI message. The complete set of headers, transaction sets, and trailers is called an EDI envelope.
- *Responding to an EDI transaction:* The seller performs the reverse, by verifying the format of the transaction set as well as the control totals. The seller then sends an electronic acknowledgement of the transaction and converts it to its own internal processing format.
- *Marking with headers/trailers:* There are three kinds of headers/trailers. The first is the header/trailer for the transaction set that defines individual transactions. The second type covers a functional group, where multiple transactions of the same kind are sent as a group. The third is the interchange header/trailer that envelopes multiple functional groups and identifies the envelope to the communications network. Headers/trailers provide control information in the form of numbers identifying the portion of the envelope and control totals based on line counts and sums of data values.
- *Labelling interchanges:* A data field in an EDI transaction set is termed a data element, and a prespecified sequence of data elements is termed a data segment.

Figure 2.11: Transaction Set Sequence for Purchasing/Selling



Source: Borthick and Roth (1993)

2.2.4 The Benefits of Electronic Data Interchange

This section describes the major benefits of EDI that have been cited in the literature. At a simple level, EDI can merely automate existing processes for a retailer, such as ordering. However, more strategic benefits may be possible if EDI is viewed as a method to enable a system of QR distribution.

When EDI is considered simply as a technology that automates existing processes, then there are potential efficiency benefits in the coordination or administration of suppliers. EDI can replace paper documents with electronic ones. This can reduce both the costs of processing paper and the postage costs of sending paper documents between

companies. The productivity of clerical workers can be improved for several reasons. First, provided that the EDI system is integrated with internal systems, errors from transcribing information from paper to computer format can be eliminated. Secondly, the time spent processing paper documents and the chance of mismatching orders with invoices can be reduced. In other words, the accuracy and speed of the information exchange can be improved (Bamfield, 1994; Premkumar, Ramamurthy and Nilakanta, 1994; Harrington, 1994; Itoh, 1994; Snow, 1994; Picard and Leschiutta, 1994).

McNurlin and Rochester (1989) cite a number of examples of companies reporting these benefits (cited in a senior management briefing published by The International Center for Information Technologies). A large grocery wholesaler in the US that uses EDI with over 700 trading partners estimated that it saves \$1.30 on each of the 300 daily purchase orders. The US automobile industry estimated savings of about \$12 per document using EDI rather than paper. These benefits are also being achieved in SA. For example, Mike van den Bergh (cited in Slabber, 1994), managing director of VAN supplier FirstNet, states that one company has reduced the number of credit notes from 600 per month to approximately 10 per month. This efficiency benefit has resulted from a paperless trading environment with EDI that only requires data to be captured once.

EDI can also be used to generate more strategic benefits for organisations. When EDI is viewed as a component of an integrated supply chain, it can be used to facilitate a faster trading cycle. With the cooperation of suppliers, the speed of data transmission in an EDI system can be used to enable a just-in-time replenishment process with more

frequent orders. Hence, inventory holding costs can be reduced. In addition, using the EDI system to communicate demand information from retailer to supplier and order status information from supplier to retailer can reduce out-of-stock situations and thereby improve customer service. Improved customer service translates into increased sales or, alternatively, reduced opportunity costs that result when an item is out of stock. Furthermore, improved customer service can also provide a competitive advantage in terms of enhanced service differentiation relative to other firms. However, it is evident that these improvements will not occur in isolation. In other words, the relationship between retailers and suppliers is important and the supply chain from supplier to retailer to customer needs to be viewed as a whole. EDI is merely a component that is used to speed up the flow of paper documents and information between the trading partners (Itoh, 1994; Bamfield, 1994; Harrington, 1994).

A number of studies have tried to determine whether these benefits are being achieved. Hansen and Hill (1989) report on a survey conducted by EDI Research, Inc. in 1988 on the perceived benefits of EDI among the business community. Respondents who were currently using, or planning to use, EDI were asked why in an open-ended question format (Table 2.1). The most frequently mentioned benefit, "quick response and access to information", was mentioned by 47.1 percent of respondents, nearly twice as often as any other reason. The second most frequently cited benefit was "cost efficiency", mentioned by 20.4 percent of respondents, and the third was "customer request", mentioned by 19.2 percent of respondents. The "effect of EDI on paperwork" was noted by 12.4 percent of the respondents and "accuracy" by 9.8 percent.

Table 2.1: Reasons for Using EDI

Advantages	Percentage of Respondents
Quick response and access to information	47.1
Cost efficiency	20.4
Customer's request	19.2
Effect of EDI on paperwork	12.4
Accuracy	9.8
Better communications	5.7
Ease processing for order entry	5.5
Aids in accounting, billing, etc.	5.5
Better customer service	5.5
Tracing shipments	4.9
Remain competitive	4.9
Industry standards	4.0
Increase productivity	4.0
Convenience	4.0
Reduce manpower	3.7
Inventory control	3.2

Source: Hansen and Hill, 1989

In the above survey, a similar but more structured question revealed a slightly different perspective (Table 2.2). Respondents were asked to rate various possible EDI benefits on a 5-point scale, with "5" being the most important and "1" being the least important. The benefit rated the highest was "improved customer service" which was not mentioned in the previous question at all. However, Hansen and Hill (1989) conjecture that the benefits in Table 2.1 are either directly or indirectly related to customer service, including rapid processing of information, cost efficiency, response to customer request and accuracy.

Table 2.2: Rating Factors Important to EDI

Benefit Factor	Average Rating
Improved customer service	4.29
Improved control of data	4.14
Reduced clerical error	3.97
Decreased administrative cost	3.71
Decreased inventory cost	3.35
Increased sales	3.25
Decreased manufacturing cost	2.75

Source: Hansen and Hill, 1989

Harrington (1994) carried out a questionnaire survey concerning the benefits of EDI in SA. Respondents were asked to rate each potential benefit on a 4-point scale, where “1” indicated a benefit that had not been realised and “4” indicated a benefit that had been realised. Table 2.3 below provides the results of the survey. The benefits that received an average rating of above 2.5 were: “closer trading partnerships”, “improved data integrity”, “improved customer satisfaction”, “reduced clerical errors”, “payment delays avoided”, and “more accurate and timeous information”. However, there were only 29 respondents to the survey and 14 of these were in the manufacturing sector. In addition, the results were not proven to be statistically significant. Consequently, the results of the study cannot be considered conclusive. Furthermore, possible intervening variables that may impact on the benefits realised were not taken into account. These include the number of years trading with EDI, the number of EDI trading partners, the number of different messages, the number of daily EDI transactions, and the percentage of all transactions that are affected by EDI.

Table 2.3: Analysis of Benefits Realised per Benefit Category

Benefit Category	Average Benefit
1. Inventory holdings reduced	1.57
2. JIT ordering enabled	2.05
3. Customer satisfaction increased	2.96
4. Supplier responsiveness improved	2.30
5. Closer trading partner relations	3.00
6. Data integrity improved	3.39
7. Payment delays avoided	2.62
8. Clerical errors reduced	2.93
9. Mailing costs decreased	2.04
10. Forms and stationery expenses reduced	1.84
11. More accurate and timeous information	2.52
12. Staff more optimally utilised	2.35
Overall average	2.46

Source: Harrington, 1994

Benefits increase with the number of transactions, due to economies of scale. Benefits are greatest when all transactions, at least of a certain type, are transmitted through EDI. When some transactions are processed through EDI and others are handled manually, EDI benefits are reduced by the cost of maintaining additional, less efficient processing systems. As a result, three conditions exist. First, larger retailers stand to gain more from EDI than smaller retailers because of the larger transaction volumes they process. Secondly, larger retailers stand to gain most when all of their suppliers, regardless of size, also use EDI. Thirdly, smaller suppliers may not be willing to participate in EDI given their lower potential benefits (Bouchard and Markus, 1995).

McNurlin and Rochester (1989) present the case of Levi Strauss & Company, a US apparel manufacturer, which illustrates the benefits of EDI. A separate department was

established to provide strategic benefits for EDI. The department, called Electronic Data Interchange Services, was positioned between the Information Systems department and user organisations. This department identified six major potential benefits: improved customer service, increased sales, reduced order lead times, more rapid and accurate merchandise replenishment, more efficient merchandise turnover, and lower inventory costs. LeviLink was created as an integrated set of business services for retailers to realise these benefits. According to McNurlin and Rochester (1989), LeviLink has computerised the entire apparel manufacturing and marketing cycle, including replenishing inventory, managing and reconciling purchase orders, receiving goods, processing and paying invoices, capturing point-of-sale information, and analysing market trends. The initial service provided a standard vendor marking ticket, coded with electronically readable information. This ticket carries the size information, a scannable Uniform Product Code (UPC) and Levi's product identification numbers. Consequently, retailers do not need to put identification tags on merchandise when it arrives. This service has been extended to include:

- Model stock management to chart sales and prepare orders;
- Electronic purchase orders that eliminate rekeying as well as mail delays;
- Bar-coded carton tags;
- Electronic packing slips identifying the carton contents, the barcode, the purchase order number and invoice number;
- Electronic invoicing that may also be used as an advanced shipping notice (ASN);
- Sell through analysis and reporting system (STARS) that analyses point-of-purchase data for profitability and identifies best-selling items; and

- Retailer EDI software for PCs, designed to interface with LeviLink.

Designs Inc. is a chain of over 60 retail stores in the Eastern US that sells Levi Strauss clothing exclusively. Designs has used vendor marking to reduce the time required to replenish shelf stock from between 3 and 14 days. The UPC is scanned at the EPOS terminals, and this data is then analysed and sent to the Levi Strauss computers to run in the retail stock management service and to replenish stock. When Levi Strauss delivers an order, the barcode attached to each carton can be scanned and verified against each packing slip that identifies a carton, its contents, the purchase order number and the invoice number. Designs has managed to reduce turnaround times from 9 days to between 3 and 5 days and inventories are replenished almost daily as a result of the automated ordering and receiving of shipments. The data is also used by Levi Strauss to improve inventory management as the data is sent to the manufacturing systems.

Despite the advantages, it is debatable whether EDI can generate competitive advantage and, more importantly, sustainable competitive advantage. Bergeron and Raymond (1992) reason that EDI can reinforce a company's competitive position by creating entry barriers for new competitors through tight relationships with suppliers. Furthermore, EDI can create exit barriers for trading partners. It also increases the difficulty for competitors to offer similar services. However, there is debate over whether EDI can generate sustained competitive advantage, since it is essentially a standard technology (Swatman and Swatman, 1991). Therefore, it is easier and less expensive for competitors to start using the system. McNurlin (cited in Swatman and

Swatman, 1991) concludes that EDI is a definitive example of a cooperative IOS and, therefore, organisations view EDI as a factor in their industry's survival rather than as a competitive weapon. Hence, EDI has been adopted by highly competitive industries in the US, such as the pharmaceuticals and automotive industries.

This sentiment is echoed by Benjamin, De Long and Scott Morton (1990). They examined three case studies of EDI in detail and drew on other insights from MIT's Management in the 1990s research programme. They conclude that EDI is increasingly becoming a necessary way of doing business rather than a source of strategic or competitive advantage. Hence, firms need to justify the investment by means of cost savings which can only come through the painful process of redesigning basic organisational structures and work processes. However, this is difficult in the early stages of EDI when only a small part of an organisation's primary transaction volume is affected. Consequently, they believe that there is logic in keeping EDI systems small at first. Ultimately, the challenge will be to move EDI applications into high volume processing by creating new organisational structures and work processes that make the investment in this technology cost-effective.

In summary, the potential benefits from an EDI system are not assured. There appear to be factors that need to be managed to achieve the benefits in practice. Premkumar et al (1994) report that the implementation and management of EDI systems has become a key management issue, as reflected in a recent survey of top Information Systems executives conducted by Niederman, Brancheau and Wetherbe. Moreover, Swatman

and Swatman (1991, p.143) state that EDI is generally accepted as “90 percent business and 10 percent technology”.

Although EDI can have an impact on the organisation, organisational factors can influence the utilisation of EDI. In terms of IT research, the technological imperative looks at the impact of a technology on organisational factors, whereas the organisational perspective examines which contextual factors facilitate the utilisation of a technology. The objective of these two streams of research is to better manage both deliberate and emergent change due to technology. Research on EDI, in particular, has primarily been exploratory and little is known about the adoption process itself (Premkumar, Ramamurthy and Nilakanta, 1994; Grover and Goslar, 1993; O’Callaghan, Kaufmann and Konsynski, 1992). It seems logical to suggest that an understanding of this process is important before the process can be managed effectively. Therefore, the following section will focus on the organisational factors which potentially influence a retail firm’s utilisation of EDI.

2.3 Understanding the Adoption and Diffusion of EDI

This research study focuses on the adoption and implementation process from an organisational perspective. In the literature, theories of innovation, technological diffusion and organisational change have been applied to the study of the adoption and implementation of a new IT. A theoretical framework is developed in the following sections to study the process of adoption and implementation and thereby to provide direction to the research effort. According to Cooper and Zmud (1990, p.136), “it is only by adopting a comprehensive research framework and then examining sets of constructs from this framework in a systematic manner that substantial progress can be made in prescribing which issues should dominate for each of the IT implementation stages”.

2.3.1 Introduction

The theory of innovations has been applied to organisational innovations, including technological innovations. An innovation has been described as an idea, a product, a technology, or a programme that is new to the adopting unit (Grover and Goslar, 1993). Consequently, Swanson (1994) defines an IS innovation as an innovation in the organisational application of digital computer and communications technologies.

Swanson (1994) states that IS innovation and its diffusion at any organisational level has until recently been relatively little researched.

Swanson's (1994) analysis of innovation literature revealed that distinctions are made among adopters of innovations, among innovation types, and among an innovation's process phases. Swanson (1994) cites a three phase (or stage) model that consists of initiation, adoption and implementation. Innovators may be distinguished from later adopters based on internal organisational characteristics, such as size. However, such characteristics may not be predictive among later adopters as an innovation becomes institutionalised and is taken as good management practice.

Swanson (1994) developed a typology of IS innovations based on their business impact:

- *Type I* innovations are process innovations restricted to the functional IS core, for example a new software development methodology.
- *Type II* innovations apply IS products and services to the administrative core of the organisation, and include, for example, the introduction of automated accounting systems in the 1950s.
- *Type III* innovations integrate IS products and services with core business technology, and typically impact on general business administration as well. The whole business is potentially affected, and the innovation may be strategic, in terms of offering competitive advantage to those who are among the early adopters. EDI is classified as a sub-type of this category, *Type III(c)*, defined as an innovation that provides for the integration or effective coordination of the business with its suppliers, distributors or customers.

The objectives of this section are to characterise the process of utilisation of an IT such as EDI, and to describe the factors that appear to facilitate or influence an

organisation's progress through this process. First, the stages of initiation, adoption and diffusion will be explained in terms of innovation diffusion theory. Secondly, factors identified as important to this process will be explained and categorised.

2.3.2 Innovation Diffusion Theory

Rogers developed a stage model for the study of the diffusion of an innovation that consists of the following stages: awareness, interest, evaluation, trial and adoption.

This model has been applied to the study of organisational innovations, including IT innovations (Huff and Munro, 1985).

Swanson (1994) reports that Thompson's three-phase model of initiation, adoption and implementation is considered the most representative for the study of IS innovations.

Initiation includes pressure to change, and the gathering and evaluation of information, culminating in the *adoption* stage. This stage involves the decision to commit resources to the innovation. The *implementation* stage includes development and installation activities to ensure that the expected benefits of the innovation are realised. Grover and Goslar (1993) used this model but recommend that more refined measures than simple binary ("yes/no") responses for the breadth and depth of implementation constructs may yield greater insights into business assimilation.

Huff and Munro (1985) suggest that diffusion be distinguished from implementation.

Implementation occurs when the trial is extended to the first full use of the technology, usually involving one or a few sub-units of the organisation. *Diffusion* occurs when the

innovation is extended, together with possible modifications, to additional organisational units. Alternatively, Swanson (1994) describes the diffusion of an innovation as its pattern of adoption by an organisational population over time. From a technological diffusion perspective, Cooper and Zmud (1990) define IT implementation as an organisational effort directed toward diffusing appropriate IT within a user community.

The stage model of diffusion is based on theories of organisational change, innovation, and technological diffusion. The stage model includes not only the initiation and adoption stages but also the various stages of diffusion within an organisation, namely adaptation, acceptance, routinization, and infusion. The rationale is that, while adoption is a single event, diffusion of the innovation occurs over a longer time period, starting from an initial *adaptation* stage, adapting to the new technology and procedures initiated by the innovation, to a final *infusion* stage, where the concern shifts to using the innovation for improving organisational effectiveness and measuring its impact on the firm (Premkumar et al, 1994; Cooper and Zmud, 1990).

Therefore, adoption can be considered as a distinct process from diffusion. Studies that have used the adoption perspective have evaluated the characteristics of an organisation that make it receptive to innovation and change. On the other hand, studies using the diffusion perspective have focused on why and how an innovation spreads within an organisation and what characteristics of an innovation lead to widespread acceptance. Most IS studies have only focused on the adoption process. However, diffusion is often necessary to achieve the full benefits (Premkumar et al,

1994). Consequently, Premkumar et al (1994) primarily considered the diffusion of EDI. The adaptation stage and the final stage of infusion were included in their model. The “adaptation” phase referred to the initial use of the innovation, that is the use of EDI in the first application. The “infusion” stage characterised use of the technology in a comprehensive and integrated manner to support higher-level aspects of organisational work and widespread transfer of the technology to other system applications within the organisation. This “infusion” stage was sub-divided into “internal diffusion” and “external diffusion”. “Internal diffusion” was measured by the degree to which the EDI applications are integrated with other internal applications, while “external diffusion” was also included as part of infusion since EDI is an IOS. Therefore, trading links need to be extended with more partners and documents to gain economies of scale and to be cost-effective.

Swanson (1994) also identified the need to distinguish between adopters and non-adopters. In addition, Robertson and Gatignon (1989), for example, distinguished between adoption and rejection.

Innovation diffusion theory also identifies various factors which may influence an organisation’s progress through the process of initiation, adoption and diffusion. Kwon and Zmud (1987) developed an IT implementation research model based on the organisational change, innovation and technological diffusion literatures. According to Kwon and Zmud (1987) there are five categories of factors in innovation literature. These are individual, task-related, innovation-related, structural and environmental. *Individual* factors are related to adoption by an individual and include education and

job tenure. *Task* factors deal with the adoption of an innovation in a specific task context rather than in a general organisational context. These factors include task autonomy and task variety. *Innovation-related* factors are specific to the innovation's characteristics, such as its complexity, compatibility and relative advantage. Finally, *structural* and *environmental* factors are concerned with the context for organisational adoption of innovations.

Studies of IT innovations and EDI, in particular, have focused on the innovation-related factors. Moore and Benbasat (1991) followed a rigorous process to develop a questionnaire instrument to measure the perceptions of an innovation. This involved an in-depth analysis of studies that have used these concepts, as well as thorough analysis and testing for the validity and reliability of the instrument. They came to the conclusion that it is the potential adopter's perceptions of *using* the innovation rather than their perceptions of the innovation that are key to whether the innovation diffuses. Consequently, the characteristics were defined in terms of the potential adopter's use, trial or observation of the innovation, and were labelled the "Perceived Characteristics of Innovating" (PCI). The final constructs included were: relative advantage, compatibility, ease of use, image, result demonstrability, visibility, trialability, and voluntariness. The definitions of these terms are as follows:

- *Relative Advantage*: the degree to which using an innovation is perceived as being better than using its precursor;
- *Compatibility*: the degree to which using an innovation is perceived as being consistent with the existing values, needs, and past experiences of potential adopters;

- *Ease of Use*: the degree to which an innovation is perceived as being difficult to use;
- *Image*: the degree to which use of an innovation is perceived to enhance one's image or status in one's social system;
- *Result Demonstrability*: the degree to which the tangible results of using the innovation are observable and can be communicated easily to others;
- *Visibility*: the degree to which use of an innovation is visible to others;
- *Trialability*: the degree to which an innovation may be experimented with before adoption; and
- *Voluntariness*: the degree to which use of an innovation is perceived as being voluntary, or of free will.

Moore and Benbasat (1991) developed the instrument to study the initial adoption and eventual diffusion of IT innovations within organisations. It measures users' perceptions of adopting an IT innovation. The instrument was tested in the context of the adoption of personal workstations in an organisation. However, the instrument excludes items only applicable to one type of IT, with the result that it is general enough to be used in most diffusion studies. Moore and Benbasat (1991) state that, while some researchers are investigating organisational-level innovations and individual responses to them, the intent of their instrument was to measure respondents' reactions in an "initial adoption" environment where the individual adoption decision is voluntary.

There are a few studies that have examined the implementation of EDI from an innovation theory perspective. These studies all examined the perceived characteristics of the innovation (innovation-related). First, O'Callaghan, Kaufmann and Konsynski (1992) included the perceived characteristics of relative advantage and compatibility in a study of EDI adoption. They found that firms that perceived EDI to offer a relative advantage were more likely to adopt, while firms that expected EDI to be incompatible with existing systems were less likely to adopt. However, they found no support for the influence of expected organisational compatibility on the adoption decision.

Secondly, Neo, Khoo and Ang (1994) studied the adoption of TradeNet by the trading community in Singapore. TradeNet is an EDI system that deals with electronic document transfer for trade clearance and is sponsored by the Singapore government. It has widely been regarded as very successful. The study examined the influence of the system's perceived relative advantage and trialability on the adoption decision, but only found support for the hypothesis that firms that had experimented with the system (trialability) were more likely to adopt the system earlier.

Thirdly, Premkumar et al (1994) included four characteristics of the innovation derived from innovation theory, namely compatibility, relative advantage, complexity, and communicability (similar to result demonstrability). Organisational compatibility was distinguished from technical compatibility and a further factor was considered in the context of EDI, namely cost. This was measured in the same way as the innovation-related factors, namely as a perception. This study examined the diffusion process, rather than the initial adoption decision. The perceptions of EDI's relative advantage, technical compatibility and costs were found to significantly influence at least one stage in the diffusion process. In addition, the success of EDI was measured, and organisational compatibility was one

of the factors that was found to significantly influence implementation success. Finally, Bamfield (1994) carried out a longitudinal study of the adoption of EDI by retailers. This was a descriptive study and didn't involve statistical analysis of data. Two innovation characteristics, namely relative advantage and compatibility, were considered important for the initial adoption stage.

A study that examined structural factors was undertaken by Grover and Goslar (1993). They studied the factors influencing the adoption and implementation of telecommunications technologies in US organisations. Interorganisational links, within which EDI can be classified, was included as one of the technologies. The study dealt with multiple technologies collectively and therefore only considered contextual factors. These were structural and environmental variables (environmental uncertainty, organisational size, centralisation, and formalisation). The results of the study were as follows: greater environmental uncertainty was found to be positively related to initiation, adoption and implementation; negative relationships between centralisation of decision-making and initiation, adoption and implementation were found; and both size and formalisation of decision-making were not found to be related to any stage. However, Swatman and Swatman (1991) report on a survey in Australia that found that larger organisations were more likely to be involved in EDI than small to medium ones. Therefore, the influence of size, in particular, is not clear. Damanpour (1991) conducted a meta-analysis of organisational innovations and listed the following structural and environmental variables that have been studied in innovation studies: specialisation, functional differentiation, professionalism, centralisation, managerial

attitude towards change, technical knowledge resources, administrative intensity, slack resources, and external and internal communication.

Although innovation theory has been recognised as useful in the study of IT implementation, some researchers argue that it is not sufficient by itself. The low explanatory power of some of the models in the study by Premkumar et al (1994) prompted the authors to suggest that additional or alternative variables may be important as well. Bamfield (1994) also noted the importance of other factors, such as peer networks, complementary assets and management learning, when explaining diffusion of the technology. This has been the case with diffusion studies that have focused on other technologies as well. Cooper and Zmud (1990) examined the effect of task and technology characteristics on the adoption and infusion of MRP systems. They found support for the hypothesised relationships with MRP adoption, but not infusion. They conclude that rational decision models may be useful in explaining IT adoption, whereas political and learning models may be more useful when examining infusion. Manross and Rice (1986) also support the contention that political and other factors are important.

2.3.3 Political and Learning Models

Political and learning models have been identified as potential sources of factors that influence an organisation's progress through the stages of IT initiation, adoption and diffusion. Cooper and Zmud (1990) reason that political and learning factors such as champions, top management commitment and coordination, and education and training

efforts may be more influential in later (higher/more complex) stages of infusion. Manross and Rice (1986) note that the innovation diffusion model takes a “system rationalist” perspective, which assumes that consensus around rational criteria for adoption and evaluation of innovations is possible. It therefore does not take into account organisational forces such as power, politics and symbolic use of an innovation. In a study, Manross and Rice (1986) confirmed their conjectures and found that traditional innovation attributes did not explain the difference between adoption success and failure. Training, political and organisational role aspects were found to be more important. However, since these were not measured, no statistical conclusions could be made. Nevertheless, they infer that traditional diffusion theory must be augmented by implementation research which focuses on the political and subjective forces that come into play after an organisation has decided to adopt an information system.

There are a number of other studies that have examined these factors. Swatman and Swatman (1991) developed their own model of the stages of integration of EDI and found that the factor that had the greatest impact on an organisation’s progress through the phases was an organisational perspective of EDI. Firms that instituted an organisational perspective of EDI suggested that a strategic perception of EDI as a natural extension of internal operations should drive implementation of the technology. Furthermore, they found that EDI systems were initiated by organisations that viewed the interorganisational communication involved as central to their way of business and, therefore, were naturally inclined to integrate EDI with their existing internal systems. The importance of an organisational approach is supported by Mike van den Bergh

(cited in Slabber, 1994), managing director of VAN provider FirstNet, who believes that a “top-down” approach is essential whereby management are committed to the success of the project.

Jelassi and Figon (1994) carried out an in-depth case study of EDI at Brun Passot, a small French office supplies firm. Brun Passot established links with its customers, which were primarily other organisations. The implementation of EDI introduced some organisational changes, including creating a new marketing unit exclusively for EDI applications, establishing a new financial bonus scheme to reward employees who convinced a customer to adopt the EDI system, and offering some of the software and training free of charge to attract new customers.

EDI was driven by a strong business pull as opposed to a technology push, as well as the availability of new technologies that made the investment feasible for the company. Jelassi and Figon (1994) consider these factors as the two most important facilitators of EDI at Brun Passot. Other facilitators were the perception of EDI as a core business strategy, the long-term commitment and involvement of top management, a “motivated” organisational environment, the adoption of an evolutionary approach to allow for future enhancement and growth of the interorganisational relationships, the close interaction with customers to agree on the supply chain configuration (what, where, when, how, etc.), and competitors’ late development of similar IOSs. Benjamin et al (1990) also emphasise the importance of senior management support when redesigning work processes to support EDI.

On the other hand important barriers were the relatively weak bargaining power of the organisation relative to its customers, the relatively heavy investment needed on the customer side and the rapid success of previous telepurchasing systems, in particular a videotex system that used proprietary standards. However, since the IT cost/performance ratio is improving, the investment required for EDI is expected to decrease in the future (Jelassi and Figon, 1994).

A number of studies have been completed on Singapore's implementation of EDI at its port facilities. Teo, Tan, Wei and Woo (1994) studied the adoption of the Portnet system. Portnet is an EDI system which links the Port of Singapore Authority (PSA), shipping agents, freight forwarders, haulers and traders to facilitate electronic communication between these parties. Portnet has resulted in a number of advantages. It eliminates the need to make physical trips to apply for services or execute transactions. It eliminates the time consuming process of handling paper documents, reduces the need to raise multiple documents and obtain multiple signatures, and enables a faster flow of information. This permits PSA and Portnet participants to deploy their equipment and manpower more effectively and results in faster cargo clearance at the port. Portnet is considered a successful EDI system because the number of participants and transactions have both grown substantially.

Neo (1994) carried out a case study of this implementation and believes that studies using an innovation theory perspective have ignored issues relating to how the decision to implement is made. These issues include motivation, vision, interorganisational strategic partnerships, infrastructure, and vendor policies. Alternative IT delivery

structures have also not been considered. Neo (1994) provides some insight as to why the implementation process has been successful. First, the trigger was a specific business problem and there was a strategic vision that extended beyond the scope of the original problem. Furthermore, the idea was approved as a conceptual solution before committing to a specific technology. Secondly, a partnership between all relevant people was undertaken, including authorities, business people and IT people, and a separate organisational unit was created to focus the effort. Overseas visits were also used to gain exposure to new information and new ways of doing business. Thirdly, influential champions were involved and the new IT solution was marketed through a publicity and education effort. The adoption of the new IT was facilitated because it could be applied immediately and inexpensively to a business problem. Finally, vendors were carefully managed with specific criteria.

Teo et al (1994) attempted to evaluate the benefits of this system by measuring the influence of four factors on productivity. Productivity was subdivided into organisational and interorganisational productivity. Two aspects of organisational productivity were studied, namely staff productivity and decision quality. The aspect of interorganisational productivity that was studied was enhanced business relationships. The four factors considered important in gaining these productivity benefits were: chief executive officer (CEO) support, adoption time, organisational proactiveness, and information need. These factors were defined as follows. CEO support may take the form of guidance in planning, design, development, and implementation activities. Lucas (cited in Teo et al, 1994) asserts that top management ability to secure resources and their role as change agents are critical aspects of their support. Rogers (cited in

Teo et al, 1994) states that there are early adopters that implement the innovation based on its qualities and there are late adopters that focus on and learn from the experience of the early adopters. The early adopters can attain and sustain competitive advantage through organisational learning and by leveraging their unique resource strengths to make it difficult for competitors to duplicate their innovation. Teo et al (1994) therefore make the distinction between pioneers and followers. Chan (cited in Teo et al, 1994) suggests that planning for EDI adoption, streamlining workflow, and preparing for change are critical success factors for organisations using EDI. Therefore, Teo et al (1994) also make the distinction between initiators who plan their involvement and reactors who participate due to external pressures. The final factor, information need, was deemed important because the chance of successfully using a technology is raised if a specific problem or need exists (Zmud, cited in Teo et al, 1994).

A survey was carried out on a sample of participants in the Portnet EDI system. Overall, Portnet participants appeared to benefit from the system. However, certain groups benefited more than others. Chief Executive Officer (CEO) support and information need emerged as the key factors that appear to have influenced the realisation of Portnet benefits, both from an organisational and interorganisational perspective. However, contrary to expectation, adoption time did not affect organisational or interorganisational productivity.

An example of an EDI implementation in SA can be found at Reckitt & Colman SA.

Mike Lawrence, EDI Project Manager, considered the following issues to be crucial to the success of EDI (Lawrence, 1994):

- top management commitment;
- a “total business” approach;
- a multi-disciplined approach to EDI within the company;
- training of staff in EDI within the company;
- special attention to detail in all EDI transactions;
- special attention to comparison of database records with those of trading partners;
and
- open communications and discussions with trading partners.

Lawrence (1994) states that it was important to establish that the company should embark on an EDI project for sound commercial reasons. This was critical for ensuring the full commitment from all levels of management within the organisation.

Communication with trading partners was initially conducted on a personal basis and an environment for “win-win” negotiations was created. Consequently, the first documents that could be converted to EDI were identified quickly. Lawrence (1994) also highlights the importance of becoming involved in standards’ organisations, such as SAANA in SA. Since representatives from trade organisations that were involved in EDI were also involved with SAANA, this facilitated discussions with trading partners.

The project at Reckitt & Colman was well-planned and initial problems were identified and rectified in the pilot phase before moving into full implementation.

Bergeron and Raymond (1992) surveyed the most commonly cited benefits of EDI and tried to determine the success factors of EDI implementation. These were identified as the factors associated with achieving the advantages. The advantages were identified through the literature and were categorised as being either at the operational level (administrative costs and transaction speed factors), the managerial level (information quality and operations management factors) or the strategic level (strategic advantage factor). The factors tested include organisational context factors (organisational support, the implementation process, and control procedures), the level of integration (internal and external), and the imposition by partner(s).

The first organisational context construct, organisational support, includes training, the degree of involvement and support of top management, the presence of an organisational structure to support EDI, and the level of cooperation of the personnel and trading partners involved. The second organisational context construct, implementation process, refers to the planning of EDI implementation (e.g. impacts of EDI, use of standards), the implementation approach (i.e. the development of a prototype or pilot project), and the evaluation of the initial data interchanges (e.g. in-house tests, response time, error rate, transactions costs). The third and final organisational context construct, control procedures, includes data integrity (through the quality of the procedures set up to protect data, e.g. transaction recording before transmission, responsibility attribution to users, backup copies) and security of

operations (e.g. access codes, passwords, access periods, authorised users, documentation identification through user and date stamps). These factors affected the attainment of operational benefits the most, especially in terms of administrative costs. This implies that greater cost reductions have been achieved by firms that concentrate on planning, organising and controlling EDI. An effect on transaction speed was also found, but was not as significant. A surprising result was the significant but negative relationship with strategic advantages, particularly the implementation process variable. A possible explanation given by Bergeron and Raymond (1992) is that a more rigorous process increases the time taken to start up EDI operations. Competitors with a less rigorous approach may develop the systems quicker and achieve early advantages.

The second category of variables, the level of integration, comprises internal and external integration. The level of internal integration reflects the variety of applications (financial, order-entry, shipping, etc.) interconnected through EDI within the organisation. The level of external integration illustrates the various types of trading partners (e.g. suppliers, clients, retailers) with which the organisation transacts business through EDI. Both these factors were found to be significantly related to operational benefits, particularly administration costs. Internal and external integration were found to be the determining factor in achieving strategic benefits from EDI. Therefore, while an efficient implementation leads to operational advantages, a strategic or competitive advantage appears to be only obtainable through the effective application of EDI.

The imposition variable refers to the obligation for a firm to implement EDI to keep a client or supplier. It was found that organisations which implement EDI because they have to, not because they want to, obtain significantly less advantages overall. This is the case specifically for administrative costs and operations management benefits. It was also found that these firms provide a significantly worse implementation and usage context for EDI in terms of organisational support, implementation process and control procedures. Bergeron and Raymond (1992) conclude that this would probably be due to the lack of proper motivation and preparation, and the inadequacy of available resources when EDI must be implemented without sufficient advance warning, simply because a major partner or partners require it. The effect of imposition as a moderating variable was also tested. It was found that imposition not only has a direct effect on the achievement of benefits, it also has an indirect effect through the organisational context variables.

Learning factors, such as training, have been mentioned already. Premkumar et al (1994) used the organisation's length of experience with EDI as a surrogate measure of this construct and found a significant, positive relationship with some of the stages of diffusion.

2.3.4 External Influences on the Initiation, Adoption and Diffusion

Process

The fact that EDI is an IOS and that the benefits are dependent on trading partner support to a certain degree have been stressed. Therefore, the social and relational context should be considered. This is emphasised in a report by the IT Management Programme (1995) on inter-business collaboration that concludes that there are benefits to be gained from value-chain integration, provided that the alliance is managed appropriately. The report describes three levels of integration: loose, close and tight. In a loose relationship there is no change to interorganisational or value-chain processes, and the focus of improvement is process efficiency through “door-to-door” EDI. In a close relationship, these processes are adjusted to focus on process effectiveness, and inventory and service levels are co-managed through exchange of sales information and forecasts. In a tight relationship, processes are reengineered to focus on process innovation, and plans are harmonised, for example for new products, sales campaigns or product changes. The net result is reduced uncertainty in the value chain that enables the firms to work together in new ways. The tighter the relationship, the greater the benefits, such as reduced inventory, faster response to market changes and improved service levels. At the same time, the tighter the integration, the greater the risks and management resistance because it means extending reengineering beyond internal business processes. Alliances entail sacrificing confidentiality and freedom, with accompanying risks. Naturally, management is inclined to resist these changes, while IT facilitates these relationships. Simple “door-to-door” EDI is the first step, but tight integration through a shared database is the ultimate objective. This requires trust

by both parties and poses all the challenges for IS of in-house applications, compounded by the multi-business environment. Despite the difficulties, the report established, through a number of case studies, that the benefits can exceed the costs when managed correctly.

Retailers may consequently be influenced by the social context in which they operate, consisting of, among others, suppliers and competitors. This is supported by critical mass theory, which argues that actors' decisions to participate in a collective action is based on their perception of what the group is doing. In other words, their decisions are influenced by how many others have already participated, by how much others have contributed, and/or who has participated (Bouchard, 1993). It can be argued that there have been good examples of integration through EDI, especially Wal-Mart's relationship with Procter & Gamble. As a result, retailers who are reluctant to use EDI may be influenced by competitors' actions such as this, as well as the influence of suppliers.

Numerous studies emphasise the importance of these factors. Bouchard (1993) focused on the other side of the relationship between retailers and suppliers, in other words, the influence of retailers on suppliers' decisions to use EDI. In that study, the decision to use EDI was primarily based on two characteristics associated with critical mass theory, namely the likelihood of key business partners using or soon to be using EDI, and a business partner's requirement that the firm use EDI. Neo, Khoo and Ang (1994) analysed the adoption of an EDI application, TradeNet, by the trading community in Singapore. TradeNet is a nationwide electronic transfer system for trade

clearance in Singapore. This EDI system electronically links the trading community to the relevant government authorities. The adoption of TradeNet by the trading community was mandated by the government. In addition to innovation-related factors, they included two broad classes of environmental pressures in their analysis: pressures arising from competitors, and pressures from coercive influence. Peer influence was found to be an important factor affecting the timing of adoption of TradeNet. However, the effect of coercive influence was not significant. Nevertheless, Neo et al (1994) still believe that a high coercive influence is important for ensuring adoption of a nationwide innovation. O'Callaghan et al (1992) analysed the influence of previous adopters, trading partners, and industry representatives. However, they did not find any significant statistical relationship between these factors and EDI adoption.

Bamfield (1994) specifically examined the relationship from the viewpoint of the retailer and performed a study of EDI adoption and diffusion in the UK retail industry. Peer networks were deemed to be influential in the adoption and diffusion process. These include professional bodies (such as computer user groups), trade organisations (in this case, the Institute of Grocery Distribution), intermediaries (such as consultancies), and contacts established through overseas visits.

Despite these influences, retailers may still be reluctant to change the relationship with suppliers because it may result in a change in the relative bargaining power with suppliers. Clemons and Row (1993) support the view that IT can have dramatic, positive effects on overall channel efficiency but emphasise the risks to retailers. Retailers traditionally have exploited the *prisoners' dilemma* facing manufacturers

through *investment buying* during promotions' periods. This consists of, firstly, *forward buying* where a retailer buys products from a supplier at the promotional price and sells them outside the promotional period at normal price. Secondly, *diverting* occurs when a retailer buys products at the promotional price and sells them in an area where the promotion is not in effect. Manufacturers face the dilemma that, if all manufacturers were to reduce the level of promotions, then they would be better off, but then a single manufacturer's motivation for promoting would be higher. Information on product movement would enable manufacturers to reduce or eliminate this arbitrage activity. Hence, Clemons and Row (1993), in a series of case studies in the US consumer packaged goods industry, found some resistance from retailers to closer relationships and greater information sharing.

3. A CONCEPTUAL MODEL FOR UNDERSTANDING THE ADOPTION AND DIFFUSION OF EDI

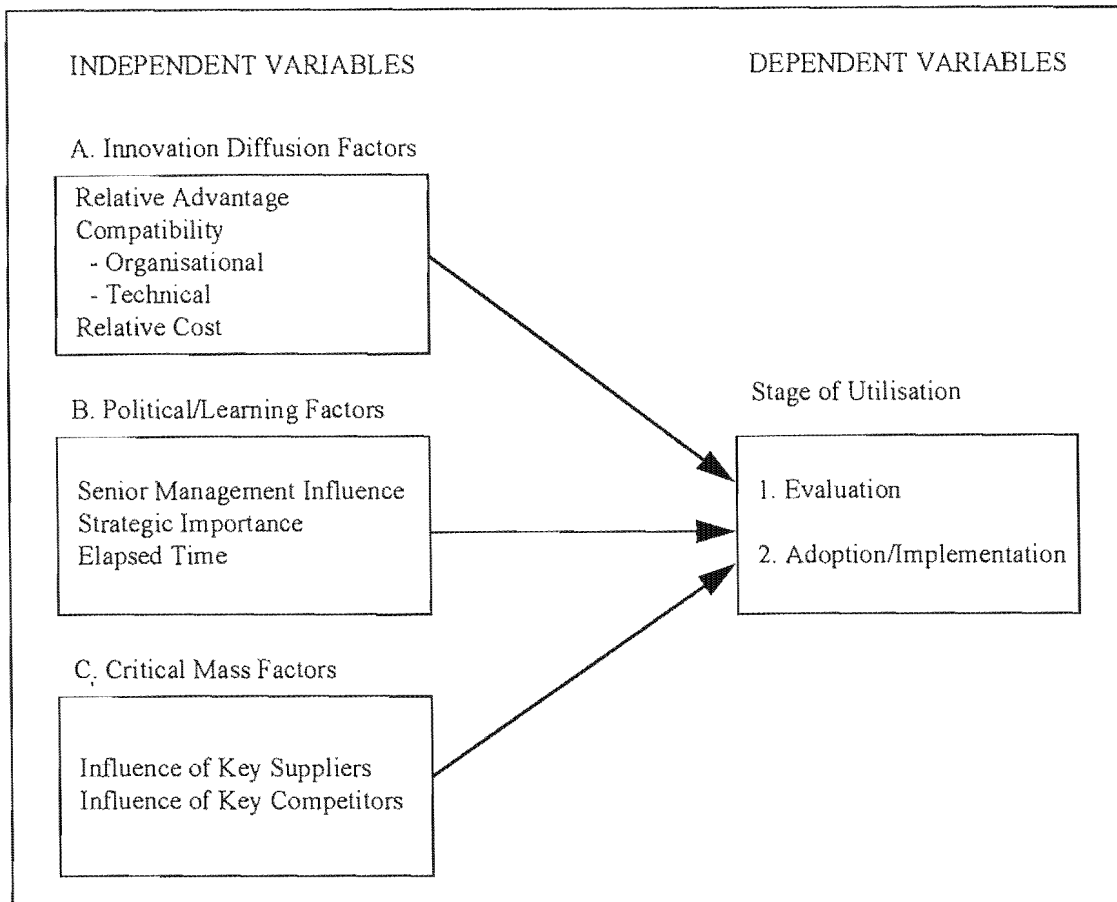
The ideas generated from the literature survey will now be placed in a framework. The research model comprises factors which are postulated to be associated with the evaluation, adoption and diffusion of EDI by retail companies in SA. The model is based on three theoretical frameworks: innovation diffusion theory, political and learning models, and critical mass theory. The model will be presented and the process of generating the framework will be discussed.

3.1 The Research Model

This research study aims to determine which factors influence an organisation's progress through the stages of initiation, adoption and diffusion, where diffusion includes implementation as an initial step. However, practical considerations influence the feasibility of any model. Hart et al (1994) studied 24 relatively large retailers in SA in 1993 and found that their use of EDI was low, although many of the retailers were planning to increase their use. Furthermore, discussions with market research firms, as well as consultants who deal with EDI and retailing, revealed that EDI is still not being used extensively by the retail industry in SA. Therefore, it was decided to concentrate on the initial stages of use. In addition, the decision to not use EDI was also included, as recommended by O'Callaghan et al (1992) and Cooper and Zmud (1990). Consequently, the process of evaluation was defined as the first dependent variable.

The process spanning adoption and implementation was defined as the second dependent variable. Figure 3.1 presents the variables of interest in a framework.

Figure 3.1: The Research Model



The independent variables originate from the theoretical models described previously. The first set of independent variables were drawn from innovation diffusion theory. Moore and Benbasat (1991) created a questionnaire instrument specifically to measure these factors. They found that it is the perceived characteristics of *using* the innovation in the task, and not merely the perceived characteristics of the innovation, that are important. Therefore, the important variables have been measured as the perceived characteristics of using the innovation. However, that questionnaire is intended to be

broad enough to cover most IT innovations and it is aimed at the initial adoption decision by individuals rather than organisations and where this decision is voluntary. Tornatzky and Klein (1982) carried out a meta-analysis of studies that have examined innovation characteristics. They found that three variables, relative advantage, compatibility and complexity, have had the most consistent significant relationships with innovation adoption and diffusion.

These findings have been largely supported in the study of EDI. O'Callaghan et al (1992) found that relative advantage and compatibility were significantly, positively related to EDI adoption. They did not measure complexity. Premkumar et al (1994) showed that relative advantage and compatibility were significantly, positively related to at least one stage of EDI diffusion. They distinguished between technical and organisational compatibility because both have been mentioned as important in EDI literature. However, they did not find complexity to be significantly, negatively related to EDI diffusion as expected. Another innovation characteristic that they included is communicability. However, they did not find a significant, positive relationship with EDI diffusion. Premkumar et al (1994) also state that costs relative to benefits are considered important for the adoption of an innovation and found that lower costs relative to benefits were significantly related to the diffusion of EDI. This variable was not derived from innovation diffusion literature but was measured similarly, in other words as a perception rather than necessarily reality. The importance of this factor is emphasised by additional studies. Bamfield (1994) considered costs important for the adoption of EDI by retailers in the UK. Jelassi and Figon (1994) highlighted the relatively heavy investment on the customer side as a barrier to the implementation of

EDI. The customers in this case were retailers. The reason for the investment seems to have been a lack of an existing IT architecture. For this study, the perceived characteristics of using the technology will be included in four variables: relative advantage, organisational and technical compatibility, and relative cost.

Political and learning models have also been applied to the study of IT implementation research. The influence of senior management has often been mentioned as an important factor in an organisation's use of an IT. In addition, the strategic importance of the IT to the organisation has also been considered critical. Finally, the organisation's capacity to learn the technology has been recognised as important as well (Kwon and Zmud, 1987; Cooper and Zmud, 1990; Premkumar et al, 1994; Bamfield, 1994; Manross and Rice, 1986; O'Callaghan et al, 1992; Jelassi and Figon, 1994; Neo, 1994). Premkumar et al (1994) used an organisation's length of experience with EDI, termed "elapsed time", as a surrogate measure of the learning effect. This measure will be used in this study as well.

The third set of variables relates to critical mass theory. O'Callaghan et al (1992) point to marketing theory that examines technology adoption in the social and relational context in which it takes place. Bouchard (1993) supports this with critical mass theory that relates to innovations that are collectively provided, in other words that require collaboration among potential adopters if any adopter is to receive any benefit. Bamfield (1994) identified the importance of peer networks in the adoption process, which supports this theory as well. Therefore, the influence of key suppliers and key competitors will be considered as external forces in the retail industry.

Environmental and structural (organisational) variables have also been considered important in the innovation literature (Kwon and Zmud, 1987; Damanpour, 1991). Since this study is applying theory to a specific IT innovation in a specific context, namely the retail industry, the potential moderating effect of these variables will be controlled to a certain extent. Nevertheless, data on organisational size and industry sector will be collected.

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3.2 Research Hypotheses

Based on the research model, the following hypotheses will be tested:

H₁: Relative advantage is positively associated with EDI evaluation.

H₂: Relative advantage is positively associated with EDI adoption/implementation.

H₃: Organisational compatibility is positively associated with EDI evaluation.

H₄: Organisational compatibility is positively associated with EDI adoption/implementation.

H₅: Technical compatibility is positively associated with EDI evaluation.

H₆: Technical compatibility is positively associated with EDI adoption/implementation.

H₇: Relative cost is positively associated with EDI evaluation.

H₈: Relative cost is positively associated with EDI adoption/implementation.

H₉: Senior management influence is positively associated with EDI evaluation.

H₁₀: Senior management influence is positively associated with EDI adoption/implementation.

H₁₁: Strategic importance is positively associated with EDI evaluation.

H₁₂: Strategic importance is positively associated with EDI adoption/implementation.

H₁₃: Elapsed time is positively associated with EDI evaluation.

H₁₄: Elapsed time is positively associated with EDI adoption/implementation.

H₁₅: Influence of key suppliers is positively associated with EDI evaluation.

H₁₆: Influence of key suppliers is positively associated with EDI adoption/implementation.

H₁₇: Influence of key competitors is positively associated with EDI evaluation.

H₁₈: Influence of key competitors is positively associated with EDI adoption/implementation.

4. RESEARCH METHODOLOGY

The research methodology will be outlined in the following section. This serves as the basis for the measurement of constructs, and the collection and analysis of the data.

4.1 Introduction

The research strategy is the blueprint that specifies the approaches used for gathering and analysing data. The research procedures should be described in enough detail to enable another researcher to replicate the research study. In addition, the procedural design of the research should yield results that are as objective as possible (Emory, 1985).

Thus, the objective of this section is to outline the research design, from the research method chosen to the measurement process and the data analysis methods. First, the research method chosen, in this case a mailed questionnaire, will be justified. Then the process of developing the questionnaire as the research instrument will be detailed.

This includes a definition of the variables, the questions, and the instrument testing and validation process. Next, the sampling strategy will be outlined and, finally, the data collection methods will be specified. The data analysis methods will be detailed under the *Findings*.

4.2 The Research Strategy

The research strategy comprises the approach that will be used to test the hypotheses.

There are a number of taxonomies that have been developed to suggest appropriate research methods based on the focus of the particular study. The suggestions from these frameworks will be compared to the approaches used by similar studies.

The research model described above builds on different theories that have been developed and tested to a certain extent. This has enabled specific hypotheses to be developed for this study. As a result, the focus of this study is theory testing and possible theory extension. This is consistent with Galliers' (1992) description of the typical process that research follows in a specific area, from theory building through to theory testing and extension. For instance, there have been case studies that have developed certain aspects of the theory (cf. Jelassi and Figon, 1994; Neo, 1994), while there have been field surveys that have tested the theory in specific contexts (cf. Premkumar et al, 1994; O'Callaghan et al, 1992)

The object of a study is an important determinant in the choice of a research methodology. The object of this study is the use of a specific IT in an organisational context. However, there is the additional effect of external forces, such as suppliers and competitors, since the IT in this case is an IOS. Bariff and Ginzberg (1982) developed a framework of MIS research that classifies studies along two dimensions: the process and the level of analysis. In terms of that framework, this study falls within

the process category of “Design and Implementation of the MIS” and is categorised at the level of “Inter-organizational” analysis.

An additional aspect in the choice of the methodology is the body of cumulative knowledge in the area of research. In this case, specific hypotheses are being tested based on variables and relationships identified in the literature and empirical validation for these theories are being sought in the retail industry in SA. Pinsonneault and Kraemer (1993) suggest that survey research is the most appropriate research method in this context. Both Galliers and Land (1987) and Jenkins (1985) support this assessment in their respective taxonomies of research approaches, given that the object of the study is the organisation. The field survey method was also used for similar studies (cf. Premkumar et al, 1994; O’Callaghan et al, 1992).

Survey research on Information Systems can, in turn, be sub-divided into various categories. Kraemer and Dutton (1991) classified survey research into a framework. This study falls into the area called “Patterns of Utilization” which describes the adoption, implementation and extensiveness of use of an IT in an organisation. Surveys in this area have considered influences from both within the organisation and from the external environment. That is consistent with this research study, which is also examining the adoption and implementation of an IT in an organisation. Moreover, the factors of interest originate from both within the organisation and from the external environment. For example, an internal factor is the compatibility of EDI with business processes within the organisation, and an external factor is the influence of suppliers.

4.3 Instrument Design

The following section on instrument design explains the construction of the questionnaire that was used as the data collection instrument in this study.

4.3.1 Introduction

“Science may be said to progress on its methods.” (Pinsonneault and Kraemer, 1993, p. 76)

Pinsonneault and Kraemer (1993) believe that the same is true of Information Systems. The production of knowledge depends on the accurate measurement of that knowledge. Consequently, the application of techniques for collecting, analysing and interpreting data determine the usefulness of the study. For, if conclusions are drawn from data that does not measure the theoretical construct or if that data does not reflect the truth, then the results of the study have little value. Since many survey methods have been largely borrowed from related disciplines, appropriate application of these methods is important.

Survey research is generally useful because a greater number of variables can be studied than in the case of experimental approaches. It also facilitates the description of real world situations, and generalisations about the population under study can be made more easily. However, there have been many criticisms of survey research. A major one is that it is often difficult to gain an insight into the causes or processes

behind the phenomena being studied, and there is possible bias from the respondents, the researcher and the moment in time in which the research is undertaken (Galliers, 1992).

A number of critical appraisals have been published regarding the use of survey research in IS. Pinsonneault and Kraemer (1993) conclude that the quality of research in IS is lacking overall. They found that inadequate sampling procedures, such as convenience samples, were being used in many surveys. Low response rates have compounded this problem. Daft's ad hoc analysis of the reasons for rejecting 11 manuscripts submitted to the *Administrative Science Quarterly* and the *Academy of Management Journal* revealed that insufficient research design and the misalignment of constructs and their operationalisation were two of the main reasons given (cited in Zmud and Boynton, 1991).

For this survey, a mailed questionnaire was selected as the research instrument because the scope of the survey is national and because sufficient data to conduct statistical tests of the hypotheses was being sought. The questionnaire was designed from previously validated instruments as far as possible and multiple items were used to measure most constructs. The questionnaire was pretested by various means before being mailed to retail companies in the sample. The questionnaire was validated through statistical and qualitative means using the responses before further statistical analyses were completed to test the hypotheses.

4.3.2 Operationalisation of the Constructs in the Research Model

This section will outline the important issues in instrument design. Then the instrument design process for this study will be described and the resultant questions will be explained.

It is important to design items (questions) that accurately measure the theoretical construct under study. One of the most common methods is to use multiple items/questions for each construct (Lucas, 1991). Zmud and Boynton (1991) used a set of criteria developed by Venkatraman and Grant for assessing MIS survey instruments. These criteria are: that scales use higher-level items rather than single, nominal items (to provide measures with high discriminatory power and low levels of measurement error), that scales be internally consistent (for example, characterised by unidimensionality and reliability), and that scales be valid (for example, characterised by adequate construct validity). It was recommended that instruments be based on existing, previously-validated instruments to try to improve the reliability and validity of the data collection process. However, if items need to be modified, the modified instrument needs to be validated (Pinsonneault and Kraemer, 1993; Lucas, 1991).

Taking into account these recommendations, multiple items were used to measure most constructs and these questions were based on those from previously validated instruments as far as possible. Most items were measured using five-point Likert scales, with responses ranging from “strongly disagree” to “strongly agree”. These

scales would then be summed to generate a score for the construct being measured (Emory, 1985). This approach was used in a similar study by Premkumar et al (1994).

The operationalisation of the variables in the model will now be described and the complete questionnaire is contained in *Appendix A*. First, the scales measuring the dependent variables, the stages of evaluation, adoption and diffusion, were constructed from studies by Premkumar et al (1994) and Kwon and Zmud (1987)

Figure 4.1: Scales used to Measure the Dependent Variables

1. Evaluation Scale

Decided not to evaluate	Undecided	Decided to evaluate	Evaluated	Evaluated extensively
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2. Adoption/Implementation Scale

Decided not to adopt	Undecided	Adopted	Implemented	Implemented extensively
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Secondly, the scales used to measure the independent variables were drawn from a number of studies. The first set of independent variables were drawn from innovation diffusion theory and include relative advantage, organisational compatibility, technical compatibility, and relative cost. The items for these constructs were drawn from the scales developed by Premkumar et al (1994), who had adapted these questions to EDI specifically. The set of constructs from political and learning models were mostly self-constructed, based on the factors considered important in the literature. Ideas were generated from papers by Kwon and Zmud (1987), Cooper and Zmud (1990), Manross and Rice (1986), Bamfield (1994), Jelassi and Figon (1994) and Neo (1994). The length of experience (elapsed time) was used as a surrogate measure of the

learning variable and was taken from Premkumar et al (1994). Finally, the scales to measure the external factors, originating from critical mass theory, were constructed from studies by Bouchard (1993), Bouchard and Markus (1995), O'Callaghan et al (1992), Teo, Tan, Wei and Woo (1994) and Neo, Khoo and Ang (1994). All the independent variables, except elapsed time, were measured using five-point Likert scales, with responses ranging from "strongly disagree" to "strongly agree". The variable elapsed time was measured using different categories representing the organisation's length of experience with EDI. Table 4.1 shows the questions used.

Table 4.1: Items used to Measure the Independent Variables

Construct	Items
Relative Advantage	<ol style="list-style-type: none"> 1. EDI cuts/would cut costs in operations. 2. EDI improves/would improve clerical efficiency through reduced paperwork. 3. EDI allows/would allow the organisation to speed up order response time. 4. EDI facilitates/would facilitate improved inventory control. 5. EDI provides/would provide timely and accurate information for decision-making. 6. EDI improves/would improve customer service. 7. EDI enhances/would enhance the organisation's service differentiation. 8. EDI generates/would generate competitive advantage for the firm.
Organisational Compatibility	<ol style="list-style-type: none"> 1. EDI is/would be compatible with our supplier relationships. 2. EDI fits/would fit our organisation's existing operating practices. 3. EDI fits/would fit our organisation's work style, values and beliefs.
Technical Compatibility	<ol style="list-style-type: none"> 1. The EDI format and standard is/would be compatible with existing hardware and software in our organisation.

Relative Cost	<ol style="list-style-type: none"> 1. The resultant benefits of EDI outweigh/would outweigh the costs of the initial investment (hardware, software and systems development). 2. The resultant benefits outweigh/would outweigh the cost of training users to make effective use of EDI. 3. The resultant benefits of EDI outweigh/would outweigh the cost of integrating EDI with other systems.
Senior Management Influence	<ol style="list-style-type: none"> 1. Senior management are/would be committed to the success of EDI in the organisation. 2. Senior management are/would be involved in decision-making regarding EDI. 3. Senior management are/would be involved in monitoring EDI's progress in our organisation. 4. There is/would be a senior line sponsor for EDI.
Strategic Importance	<ol style="list-style-type: none"> 1. EDI is/would be considered a strategic necessity by our company. 2. EDI is strategic to the retail industry as a whole.
Elapsed Time	<i>measured on a time scale (included in Appendix A)</i>
Influence of Key Suppliers	<ol style="list-style-type: none"> 1. Our key suppliers are using or are likely to be using EDI soon. 2. Our use of EDI is/would be required by our key suppliers.
Influence of Key Competitors	<ol style="list-style-type: none"> 1. Our key competitors are using EDI.

The categories for retail sector were based on previous studies as well (cf. Hart et al, 1994; Bureau of Market Research, 1994), while the number of employees was used as a measure of organisation size and these categories were based on discussions with consultants and retailers (Grover and Goslar, 1993; Damanpour, 1991).

4.3.3 Instrument Testing

Pretesting the questionnaire is important to ensure that the questions are understandable and to ensure the content validity of the instrument. However, Pinsonneault and Kraemer (1993) found that many surveys in IS did not pretest questionnaires or did not report whether pretests were done.

An instrument is valid in content if the measures are drawn from all possible measures of the properties under investigation (Straub, 1989). This is obviously difficult because the universe of possible content is almost limitless. Cronbach (cited in Straub, 1989) has suggested using a review process whereby experts in the field evaluate the questionnaire. Therefore, the content of this questionnaire was initially debated with academics in the Information Systems Department at the University of Cape Town and at the Graduate School of Business at the University of Cape Town. The questionnaire was then sent to prominent academics in America who have experience in the subject area as well as with this type of study. Their comments were used to modify the questionnaire. Further comments were received from consultants who have experience in the retail industry. The questionnaire was finally pretested on two retail companies in the Western Cape.

The layout of the questionnaire is also important because a poor layout increases the risk of a low response rate (Straub, 1989). Therefore the ordering of the questions and the wording of questions were also discussed during the process described above.

4.4 Sampling

Sampling is another important issue in a research study because it can impact on the general applicability of the results to the underlying population of interest. The sample frame should constitute a representative subset of the population from which the sample is drawn. Furthermore, sampling is also concerned with the representativeness in selection of individual respondents from the sample frame (Pinsonneault and Kraemer, 1993). Pinsonneault and Kraemer (1993) found that the sample frame is seldom discussed and unsystematic sampling procedures are often employed in IS surveys.

For this study, the population was identified as all retail companies that have a knowledge of EDI. Consequently, after contacting market research firms and consultants who have experience in the retail industry, only retail chains were included in the study. These sources indicated that independent retailers did not have the necessary knowledge which would most likely result in unusable responses and/or a very low response rate. The retail chains were identified through McGregor's database of companies (McGregor and McGregor, 1996). Most of the retail chains were linked to the Johannesburg Stock Exchange (JSE) through holding companies. In addition, one holding company typically controlled more than one retail company and the distribution system was usually centralised. Subsequently, the initial population estimate was reduced from approximately 150 retail chains to approximately 65 distribution networks. This was considered to be the relevant population under study and was also used as the sample.

4.5 Data Collection Methods

The data collection methods include the unit of analysis and the process by which responses are acquired.

The key respondent method was chosen as the approach to use for collecting responses, an approach also used by Bouchard (1993). The key respondent was identified by telephoning the organisation to make contact with the person responsible for EDI in the organisation. This person held the title of "IS Manager" or "Project Manager" in most cases. Time was spent identifying this person and contact was made to try to prevent respondent bias and to ensure that the respondents' views were representative of the organisation. The respondent was usually a senior manager of the company which would hopefully result in reliable responses.

Due to the small population size, achieving a high response rate was considered to be critical to the analysis that could be performed on the results. There have been a number of techniques suggested to improve mail survey response rates that were taken into account (Forsgren, 1989; Emory, 1985):

- Good questionnaire design to ensure that it is easy to understand and complete.
- A cover letter to outline the purpose of the study.
- Confidentiality when sensitive information is sought.
- Follow-ups or reminders through letters or postcards.
- Stamped return envelopes and deadline dates.

Once the questionnaire had been designed and the data collection procedures decided on, the mailing process was carried out. A cover letter and the questionnaire were mailed to the key respondent identified earlier, along with a stamped return envelope. The cover letter introduced the background to the study, its importance and encouraged responses by the deadline date. In addition, it stressed that the questionnaire had been designed to be as short as possible and as easy to answer as possible because a high response rate is important. The confidentiality of responses was also assured and a summary of the results was promised. Follow-up letters were sent to encourage response a few weeks after the initial mailing and thank-you letters were sent if the company name was included with the returned questionnaire.

5. INSTRUMENT VALIDITY AND RELIABILITY

The validation of an instrument is important for a number of reasons. First, there is a need to guide research efforts in IS and to add rigour to the methods used. Secondly, greater rigour can promote cooperative efforts whereby confirmatory research can use previously validated instruments. Attention to the instrument also forces the researcher to focus on the practical operationalisation of theoretical constructs. In other words, the researcher confirms whether the theoretical formulation of problems matches practitioners' experiences. Finally, validation of an instrument increases confidence in the findings (Straub, 1989).

5.1 Instrument Validity and Reliability Assessment

The validity and reliability of the instrument are both important. Instrument validation attempts to ensure that the instrument is measuring what it is supposed to be measuring. Instrument validation comprises content validity and construct validity. An instrument is valid in *content* if it has drawn representative questions from a universal pool. A review process with experts in the field can help to achieve this. An instrument has *construct* validity if the measures chosen are true constructs describing the event and not merely artefacts of the methodology itself. Consequently, one would expect high correlations between measures of the same construct and low correlations between measures of different constructs. Construct validity can be sub-divided into

convergent and *discriminant* validity and can be assessed using principal components factor analysis (Straub, 1989; Emory, 1985; Pervan and Klass, 1992).

The other important issue is the reliability of the instrument. *Reliability* is a measurement of instrument accuracy. While construct validity attempts to determine whether there has been systematic response to the instrument by respondents that differs from the reality, reliability attempts to determine whether any differences have arisen as a result of misunderstanding. Cronbach's alpha is typically used to determine the extent to which respondents can answer the same or approximately the same questions the same way each time (Straub, 1989; Emory, 1985; Pervan and Klass, 1992).

Although instrument validation in IS research is increasing, overall the incidence is still low. Newsted and Huff (1991) carried out an appraisal of 672 IS studies in 35 different journals since 1970. In 1988, 20 percent were pretested, 20 percent were tested for validity and 20 percent were tested for reliability. However, 73 percent were not tested for validity and 71 percent were not tested for reliability over all years. Moreover, only 1 percent employed factor analysis to determine validity and only 6 percent used Cronbach's alpha to determine reliability.

The pretesting described earlier was used to try to ensure the content validity, while the validity and reliability of the instrument were tested on the final responses. The responses were validated using cluster analysis and factor analysis, and Cronbach's alpha was used to test the reliability of the scales (Straub, 1989). Both Premkumar et al

(1994) and Grover and Goslar (1993) used pretest and pilot studies to measure the content validity of the research instrument, and both used Cronbach's alpha to measure the reliability of the research instrument, namely a questionnaire. Cronbach's alpha measures the correlation between different items (questions) that are supposed to be measuring the same construct. However, it could also be used to measure the correlation of answers to the same question in a test-retest situation and in the situation where different methods are used.

Premkumar et al (1994) assessed construct validity by measuring the convergent and discriminant validities. They followed a two-step process. First, the convergent validity of each construct was measured using a principal component analysis of all the items (questions) relating to the construct. Any outliers were then removed and any subdimensions of each construct were identified. The second step was to evaluate the discriminant validity by performing a principal component analysis on all the items measuring the various constructs to determine if the items loaded on the appropriate constructs. However, they tested the independent and dependent variable sets separately. Grover and Goslar (1993) also used factor analysis (principal component analysis) to assess the construct validity of the research instrument.

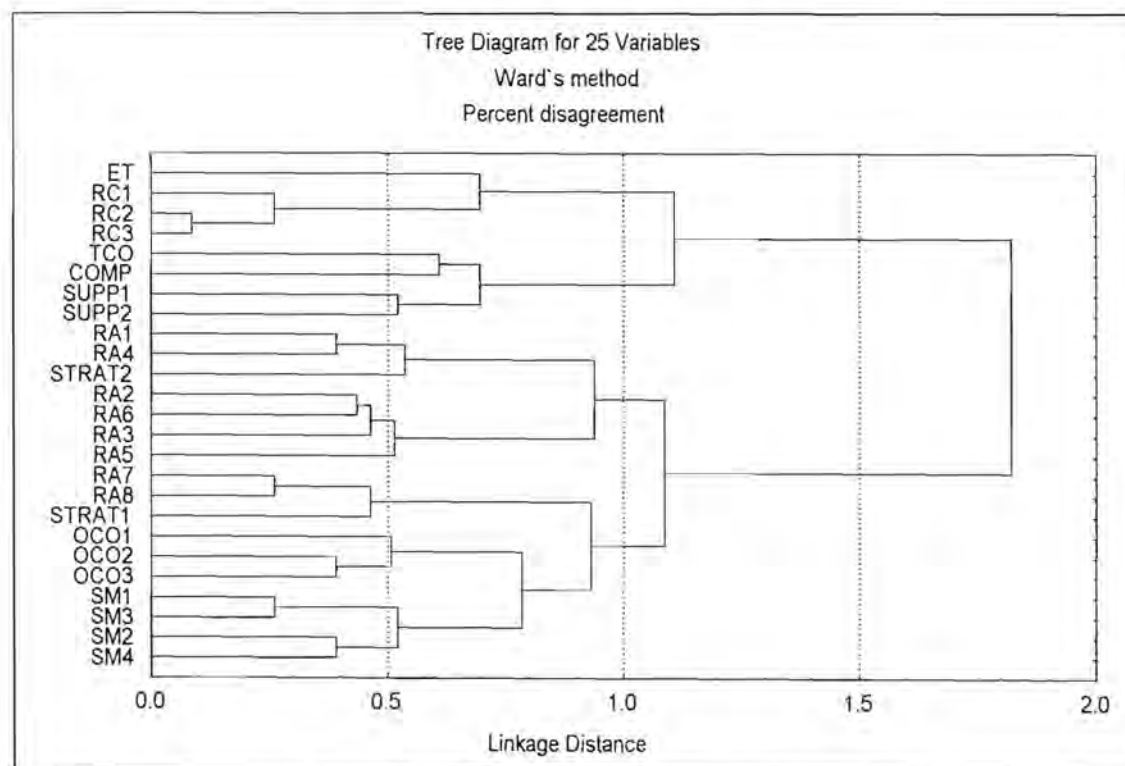
5.2 Instrument Validity and Reliability Test Results

The items in the questionnaire were initially analysed using cluster analysis. Cluster analysis is a descriptive technique that classifies objects or variables into homogenous groups when there is no *a priori* definition of groups (Hair, Anderson, Tatham and Grablovsky, 1979). In this case, the variables are being classified into groups. There are two parameters associated with this procedure, the method used to measure the similarity between variables (the distance measure) and the clustering or amalgamation rule used to classify variables into groups. In this case, the percent disagreement method for categorical data was used as the distance measure between variables, and Ward's method was used as the amalgamation rule. Ward's method uses an analysis of variance (ANOVA) approach to minimise the sums of squares of any two (hypothetical) clusters that can be formed at each step. This approach is efficient but tends to result in clusters of small sizes. The tree diagram is presented in Figure 5.1 and the codes for the items used in the diagram are listed in Table 5.1. Clusters are indicated by the line joining two or more variables, and the less the distance, the greater the similarity. Therefore, a large increase in the distance when a variable joins a cluster indicates possibly an unnatural grouping (Statistica for Windows Reference Guide, 1995).

Table 5.1: Item Codes used in Cluster Analysis Tree Diagram

Variable	Items
Relative Advantage	RA1 through RA8
Organisational Compatibility	OCO1 through OCO3
Technical Compatibility	TCO
Relative Cost	RC1 through RC3
Senior Management Influence	SM1 through SM4
Strategic Importance	STRAT1 and STRAT2
Elapsed Time	ET
Influence of Key Suppliers	SUPP1 and SUPP2
Influence of Key Competitors	COMP

Figure 5.1: Tree Diagram for Cluster Analysis of Independent Variables



From the tree diagram, the items measuring the *Relative Cost* construct appear to cluster together (RC1, RC2 and RC3), as do those measuring the constructs *Organisational Compatibility* (OCO1, OCO2 and OCO3), *Senior Management*

Influence (SM1, SM2, SM3 and SM4) and *Influence of Key Suppliers* (SUPP1 and SUPP2). The *Influence of Key Competitors* variable (COMP) consists of only a single item and clusters with the *Influence of Key Suppliers* factor, which is the other critical mass factor and, therefore, not too surprising. The items measuring the *Relative Advantage* factor seem to form two clusters, with RA1 and RA4 initially forming a separate cluster to the rest. This indicates the possibility of sub-dimensions in this construct. The *Strategic Importance* variable is measured by two items, STRAT1 and STRAT2, which do not cluster together well. This indicates the possibility of sub-dimensions in this construct, which is plausible since the one question examines the strategic importance of EDI for the firm and the other the strategic importance for the retail industry as a whole. However, this also indicates the possibility of a lack of reliability and validity for this construct. This statistical technique is merely descriptive and, therefore, there is no test for the significance of any group of items. The validity and reliability of the scales will now be examined in more detail using factor analysis and Cronbach's alpha.

The construct validity of the instrument was evaluated using factor analysis. Factor analysis is a data reduction technique that analyses the relationships between a set of variables and, while preserving most of the information in the full data set, constructs a smaller set of variables, each of which is a linear combination of some of the original set of variables. Hair et al (1979) state that factor analysis should only be used for relatively large sample sizes ($n > 50$) and where the number of observations is four to five times the number of variables. This has not been achieved in this study, which the following section on the findings will show. Therefore, the results of these tests cannot

be considered conclusive statistical proof of the validity of the questionnaire.

Nevertheless, an indication of the validity will still be useful and is necessary.

The process for testing the construct validity using factor analysis is similar to that used by Premkumar et al (1994). First, the set of items measuring each construct were evaluated using principal components factor analysis to analyse the convergent validity and to determine whether there are any subdimensions in the construct. Then all the items in the instrument were analysed together using principal components factor analysis to evaluate the discriminant validity by checking whether the items load on the appropriate constructs. The VARIMAX oblique rotation procedure was used to simplify the factors and to determine which variables load highly on the extracted factors. Oblique rotation allows the extracted factors to be correlated with each other (Hair et al, 1979). This approach is considered appropriate because the answers to some of the questions measuring different constructs need not necessarily be uncorrelated. For example, the question for STRAT1 relates to the strategic importance of EDI to the organisation, while the questions for RA7 and RA8 ask whether EDI generates service differentiation or competitive advantage for the firm. It is reasonable to expect that there may be an association between the answers to these questions because competitive advantage and service differentiation are considered to be strategic to a retailer.

The results of the factor analyses to determine the convergent validity of each scale are presented in Table 5.2. All of the items for each construct load on one factor, except for *Relative Advantage*, and the factor loadings are relatively high for most of the

variables, given that the loading score ranges between 0 and 1, with 1 representing a perfect loading. The items measuring the *Relative Advantage* construct split into two. Premkumar et al (1994) achieved similar results, the only difference being that the second factor (Relative Advantage - 2) contained the second item (RA2) and not the sixth item (RA6). Nevertheless, Premkumar et al (1994) state that, although it is technically desirable to treat them as separate factors, it may be acceptable to aggregate them as a single variable if there is sufficient theoretical justification and high correlations between the extracted factors. The items used for the *Relative Advantage* construct were based on previous research and the correlation between the factors is 0.39. Premkumar et al (1994) achieved a correlation of 0.40 which proved to be significant. This provides some justification for combining all the items. Therefore, the evidence suggests that the scales demonstrate sufficient convergent validity.

Table 5.2 Convergent Validity Analysis

Variable	Item	Loading
Relative Advantage - 1	RA1	0.71
	RA2	0.47
	RA3	0.62
	RA4	0.81
	RA5	0.63
Relative Advantage - 2	RA6	0.62
	RA7	0.92
	RA8	0.86
Organisational Compatibility	OCO1	0.48
	OCO2	0.91
	OCO3	0.87
Technical Compatibility	TC	<i>only 1 item used</i>
Relative Cost	RC1	0.95
	RC2	0.96
	RC3	0.97
Senior Management Influence	SM1	0.75
	SM2	0.83
	SM3	0.86
	SM4	0.61
Strategic Importance	STRAT1	0.86
	STRAT2	0.92
Elapsed Time	ET	<i>only 1 item used</i>
Influence of Key Suppliers	SUPP1	0.74
	SUPP2	0.90
Influence of Key Competitors	COMP	<i>only 1 item used</i>

Table 5.3 contains the results of the factor analysis to determine the discriminant validity of the scales. Seven factors were extracted for six constructs. All loadings of 0.25 or greater are shown and the highest loading for each variable is highlighted. The variables *Elapsed Time* and *Influence of Key Competitors* were not included because they were measured with single-item scales. *Factor 1* seems to represent the *Relative Cost* construct, with all three items loading highly on the factor and no other items loading on the factor. *Factor 2* seems to represent the second component of the *Relative Advantage* construct, although one item measuring *Organisational*

Compatibility also loads on the factor. *Factor 3* appears to represent *Organisational Compatibility*, with two of the three items loading on the factor and a reasonably high loading for the other item. However, a few other items load on this factor as well. Only one item, measuring *Relative Advantage*, loads on *Factor 4*, although a few other items measuring the same construct load relatively highly. The items measuring *Influence of Key Suppliers* load on *Factor 5*, along with a few other items. *Factor 6* consists of the two items measuring *Strategic Importance*. The final factor, *Factor 7*, seems to represent *Senior Management Influence*, with two of the four items measuring this construct loading on the factor and one other item attaining a reasonably high loading. However, one other item relating to the *Relative Advantage* construct also loads on this factor, although the loading value is not too high. Therefore, in summary, most of the scales demonstrate a reasonable degree of discriminant validity. However, the *Relative Advantage* scale demonstrates relatively poor discriminant validity.

Table 5.3 Discriminant Validity Results (with highest loadings in bold)

Variable	Item	Factor Loadings						
		Factor 1	Factor 2	Factor 3	Factor 4	Factor 5	Factor 6	Factor 7
Relative Advantage	RA1	0.27				0.79		
	RA2	0.25	0.28	0.47		0.38	0.27	
	RA3	0.28			0.30		0.31	0.38
	RA4				0.53	0.66		
	RA5				0.92			
	RA6		0.51		0.51		0.40	
	RA7		0.97					
	RA8		0.72					
Organisational Compatibility	OCO1		0.54	0.33		0.33		
	OCO2			0.81				
	OCO3			0.80				
Relative Cost	RC1	0.85						
	RC2	0.94						
	RC3	0.95						
Senior Management Influence	SM1			0.67				0.56
	SM2					0.29	0.41	0.48
	SM3							0.86
	SM4	0.33			0.25	0.36	0.31	
Strategic Importance	STRAT1		0.46				0.53	
	STRAT2	0.28		0.32			0.85	
Influence of Key Suppliers	SUPP1					0.43	0.36	
	SUPP2					0.67		

Table 5.4 presents the results for the reliability analysis of the scales using Cronbach's alpha. The acceptable level of reliability depends on the purpose of the research study. An alpha value of above 0.70 is considered acceptable for a study that is testing theory, while an alpha of between 0.50 and 0.60 is considered acceptable for basic research (Nunnally, cited in Moore and Benbasat, 1991). This study tests theory that has been developed already and, therefore, the target for reliability is 0.70. The scores for the reliability analysis indicate that all the scales, except for *Organisational Compatibility* and *Influence of Key Suppliers* have alpha values above 0.70, although they are all at least above 0.50. Therefore, the scales will be regarded as reliable.

Table 5.4: Reliability Analysis of the Scales

Construct	Cronbach's alpha
Relative Advantage	0.75
Organisational Compatibility	0.64
Relative Cost	0.96
Senior Management Influence	0.76
Strategic Importance	0.79
Influence of Key Suppliers	0.57

6. FINDINGS

The results of the statistical analyses of the responses will now be detailed. The data types of the variables will first be described, after which the data analysis methods will be introduced, given the hypothesised relationships among the variables. The data analysis methods incorporate descriptive statistics to profile the responses, some initial analysis of responses to certain questions, and hypothesis testing. Thereafter, these results will be interpreted.

6.1 Description of the Data Analysis Methods

The data types of the variables need to be specified and certain properties of the data need to be checked before the appropriate statistical tests can be selected.

6.1.1 Data Types of the Variables

The dependent variables, the *Evaluation* and *Adoption/Implementation* scales, are both ordinal. The independent variables are mostly ordinal as well and, in addition, items will be summed where multiple items were used to measure a construct. Furthermore, the scales for the dependent variables are all five-point Likert scales with responses ranging from “strongly disagree” to “strongly agree”, except for the scale *Elapsed Time*. The contextual variables, retail sector and organisational size, are both categorical in nature. The following table (Table 6.1) presents all the variables, their respective data types and the number of multiple items used to measure each construct.

Table 6.1: Variable Data Types and Number of Multiple Items

Variables		Data Type	Multiple Items (Number)
DEPENDENT	Evaluation	Ordinal	No
	Adoption/Implementation	Ordinal	No
INDEPENDENT	<i>Innovation Characteristics:</i>		
	Relative Advantage	Ordinal	Yes (8)
	Organisational Compatibility	Ordinal	Yes (3)
	Technical Compatibility	Ordinal	No
	Relative Cost	Ordinal	Yes (3)
	<i>Political/Learning Forces:</i>		
	Senior Management Commitment	Ordinal	Yes (4)
	Strategic Importance	Ordinal	Yes (2)
	Elapsed Time	Ordinal	No
	<i>Critical Mass Factors:</i>		
	Influence of Suppliers	Ordinal	Yes (2)
	Influence of Competitors	Ordinal	No
CONTEXTUAL	Retail Sector	Categorical	No
	Organisational Size	Categorical	No

6.1.2 Statistical Analysis Methods

The computer package used for the data analysis was Statistica for Windows, release 5 (see Statistica for Windows Reference Guide, 1995).

The first step is to profile the responses and to provide additional descriptive statistics of the data. Descriptive statistics are required to classify the respondents and to provide an indication of the representativeness of the sample. Initial descriptive statistics were calculated for the responses to all questionnaire items, including the mean, median and variance. Frequency tables were also be computed for the items. These frequency tables were used further to classify the respondents along certain dimensions (Hopkins and Glass, 1978). The responses were classified by both retail sector and organisation size. The dependent variables can also be viewed as categorical

and, subsequently, can be used to classify the respondents by stage of EDI utilisation. Similarly, the scale *Elapsed Time* can be used to classify the respondents by length of experience with EDI.

By using the ordinal (ranking) properties of the scales, comparisons can be made of differences in the ratings of certain scales over the retail sector and organisational size classifications. Parametric tests are not appropriate because the data is not interval- or ratio-scaled. Therefore, the Mann-Whitney and/or Kruskal-Wallis tests were used to test for differences between rankings over retail sector and/or organisation size. The difference between these two tests is that the Mann-Whitney test only compares two independent samples, while the Kruskal-Wallis test compares two or more independent samples. The equivalent parametric test is the t-test (Sprent, 1989). The samples in this case are independent because, in one group (such as one retail sector), an organisation's response to an item does not influence the response of organisations in other groups. These tests were used to find any differences between retail sectors and different organisational sizes for responses to the following variables: both dependent variables, the scale *Elapsed Time* that is used as a surrogate measure of an organisation's learning, and the individual items (i.e. not the summed scales) that measure the *Relative Advantage* construct.

Although the objective of this study is not to determine the benefits of EDI, the perception of certain benefits were measured as part of the innovation diffusion characteristic *Relative Advantage*. Descriptive statistics of these items can be used to gauge whether respondents generally consider EDI as advantageous or not. In

addition, the responses to the different scales can be compared with each other to determine whether the respondents generally rated certain benefits differently than others. In this case, the samples are matched because one respondent rates each of the items. Therefore, the Wilcoxon Matched Pairs test is appropriate. Again, the nonparametric test was used because the data is ordinal in nature (Sprent, 1989).

The hypotheses of this study concern the relationship between the dependent and independent variables. These hypotheses were tested using three approaches. First, the correlation between each dependent and independent variable combination was calculated as an initial measure of the association (Hopkins and Glass, 1978). Since the data is ordinal, a nonparametric version of the correlation coefficient, Spearman's rank order correlation, was calculated.

Next, the relationship between each dependent variable and all the independent variables was tested using multiple discriminant and multiple regression analysis. Discriminant analysis is appropriate when the dependent variable is categorical and the independent variables are interval- or ratio-scaled. The dependent variables in this study consist of scales that were designed to be ordinal but can nevertheless be used as categorical. The independent variables in this study consist of summed scales to try to simulate the characteristic of ratio-scaled data which makes the magnitude of differences between scores meaningful. This approach was used in previous studies by Premkumar et al (1994) and Grover and Goslar (1993). Discriminant analysis involves deriving a linear combination of the two or more independent variables that discriminate best between the *a priori* identified groups. In this case, the *a priori*

identified groups are the stages of *Evaluation* and *Adoption/Implementation*. The approach is to maximise the between-group variance relative to the within-group variance. Discriminant analysis is therefore appropriate for testing the hypothesis that the group means of the two or more groups are equal (Hair et al, 1979). In this study, it was used to test the hypotheses that the independent variables discriminate between, or are associated with, the stages of *Evaluation* and *Adoption/Implementation*. Hair et al (1979) note that discriminant analysis is a robust technique that is not very sensitive to violations of the assumptions unless these are extreme.

The third approach used was regression analysis, which is similar to discriminant analysis except that the dependent variables need to be ratio-scaled. In this study, the responses to the *Evaluation* and *Adoption/Implementation* scales were used as the dependent variables. Again, the summed scales were used as the independent variables. The assumption of ratio-scaled data is violated for both dependent and independent variables. However, Emory (1985) states that regression analysis is a robust statistical technique as well, and has been shown to provide accurate results even when the actual conditions have been substantially different from those theoretically required. Furthermore, Emory (1985) notes that it is common to find this test being used in circumstances where, under a strict interpretation, only nonparametric tests are appropriate.

The rationale behind using these three approaches, namely nonparametric correlation coefficients, discriminant analysis and regression analysis, is to try to increase confidence in the findings. The disadvantage with only using nonparametric tests is that

they are less powerful than parametric tests. In other words, there is a greater chance of not finding a relationship when it does exist. However, some of the assumptions for the parametric tests, particularly those regarding the type of data, are violated. Tests of the relevant assumptions are included in *Appendix B*. Therefore, conclusions drawn, particularly from the results to the regression analysis, need to be done so prudently.

6.2 Data Analysis Results

The results of the statistical analyses of the responses to the questionnaire survey will now be described, including statistical tests of the hypotheses.

6.2.1 Sample Profile

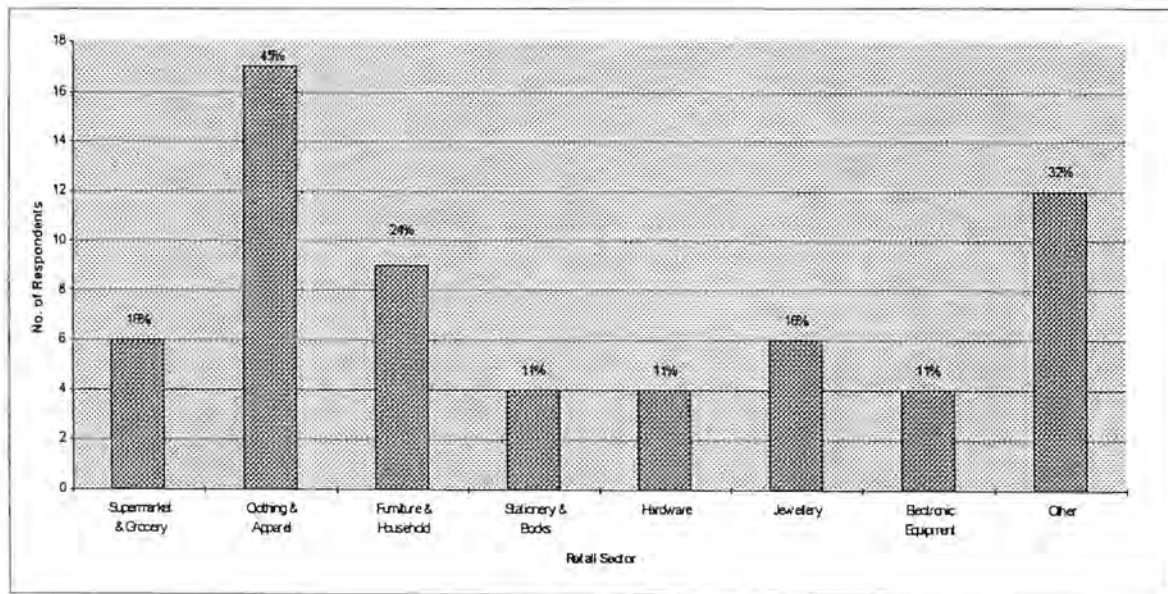
A response rate of 58% was achieved after 38 questionnaires were returned out of a mailing of 65. Several questionnaires had missing data for certain questions. When a construct comprised more than one question, it was entered as missing when at least one question's response was missing. The respondents will first be profiled by retail sector and organisation size, and then by their stage of utilisation.

6.2.1.1 Classification of Respondents by Retail Sector and Organisation Size

Data about the retail sector and the organisation's size were collected. The frequency distribution of respondents by retail sector is presented in Figure 6.1. Note that the respondents classified themselves in more than one sector where appropriate. There is

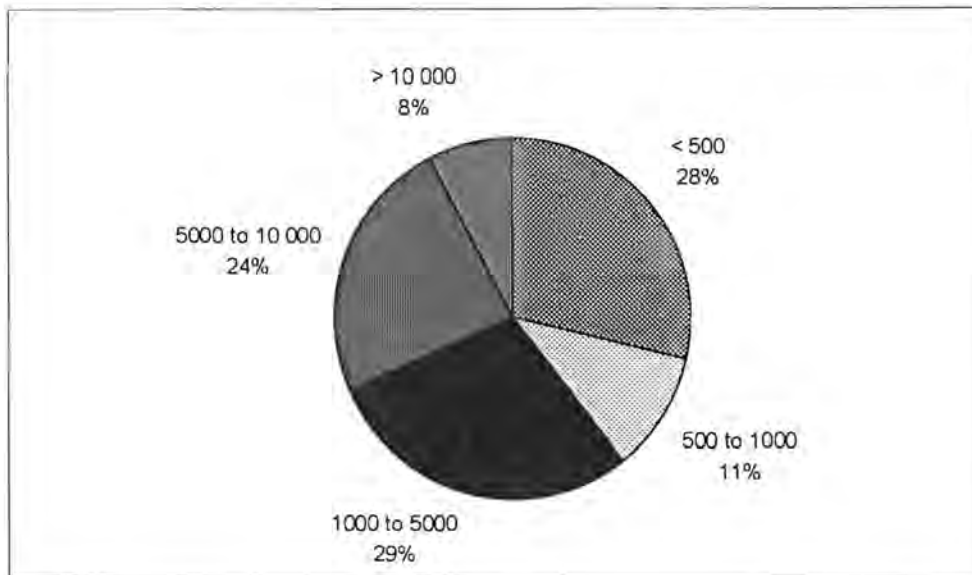
a large concentration of respondents in the supermarket & grocery, clothing & apparel, and furniture & household sectors. Many respondents classified themselves in the “other” category, although in a number of cases they included themselves in another category as well.

Figure 6.1: Classification of Respondents by Retail Sector



The distribution across the organisation size categories is presented in Figure 6.2. The size of the organisation was measured by the number of employees in the organisation. The categories with the highest frequencies are “less than 500 employees” and “between 1000 and 5000 employees”. Thirty-nine percent (39%) of respondents have less than 1000 employees, 53% have between 1000 and 10,000 employees, and 8% have more than 10,000 employees.

Figure 6.2: Classification of Respondents by Organisation Size



Since the sample is relatively small, the number of categories along each of these dimensions was reduced. Two super-categories were created to classify respondents by retail sector. The first group consists of those firms that are considered to operate on a relatively faster turnover cycle, while the second group consists of those firms that are considered to operate on a relatively slower turnover cycle. Firms that indicated that they are in the supermarket or stationery categories are included in the first group, labelled the “fast turnover” retail format. In addition, firms that could be identified as being in the fashion clothing sector and firms in the “other” category who operate a similar format to supermarkets are also included. The second group consists of furniture, hardware, electrical, and jewellery retailers, as well as the remaining firms in the clothing and “other” categories. The second group is labelled the “slow turnover” retail format. This distinction appears to be relevant in the SA retail industry (Ryan and Furlonger, 1991). As a result, 16 firms are classified in the *fast* turnover sector (42%) and 21 firms are classified in the *slow* turnover sector (58%).

Two super-categories were also created to classify the respondents by firm size. Those firms with less than 1,000 employees are labelled as “small” and those with more than 1,000 employees are labelled as “large”. There are 15 *small* firms (39%) and 23 *large* firms (61%).

Table 6.2 classifies respondents by the new retail sector and organisation size categorisations. A large proportion of respondents are *large* firms in the *fast* turnover sector or *small* firms in the *slow* turnover sector. This is intuitive since firms in the *fast* turnover sector, such as supermarkets, seem to concentrate on generating economies of scale through high volume sales. It is evident in a survey by The Economist (1995) that the larger retail firms around the world tend to operate in the fast-moving consumer goods (FMCG) sector. Alternatively, firms in the *slow* turnover sector seem to be smaller. They may have fewer employees and keep less stock at the stores since there should be more time to order stock from the supplier when the turnover of goods is slower.

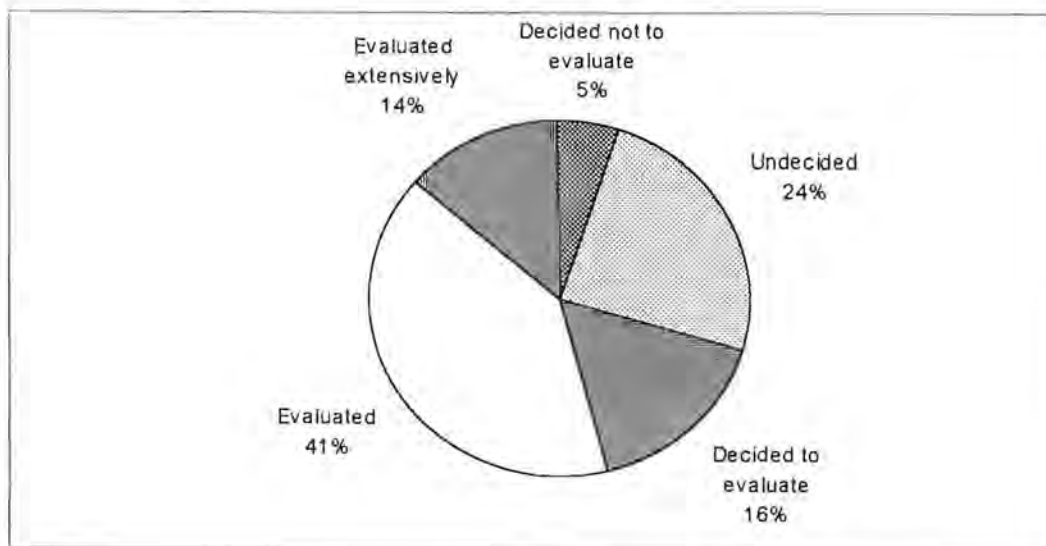
Table 6.2: Cross-tabulation of Respondents by Retail Sector and Organisation Size

Sector	Size		Row Totals
	Small	Large	
Fast	1	15	16
Slow	14	8	22
Column Totals	15	23	38

6.2.1.2 Classification of Respondents by Stage of Utilisation of EDI

The respondents classified their utilisation of EDI on two scales. The first indicates whether the firm has evaluated EDI or not. The classification of responses by the stage of *Evaluation* is presented in Figure 6.3 which shows that more retail firms are at the stage of having evaluated EDI than any other stage. In addition, approximately 52% of firms have either evaluated EDI or have evaluated it extensively. Consequently, the mode is 4 (evaluated).

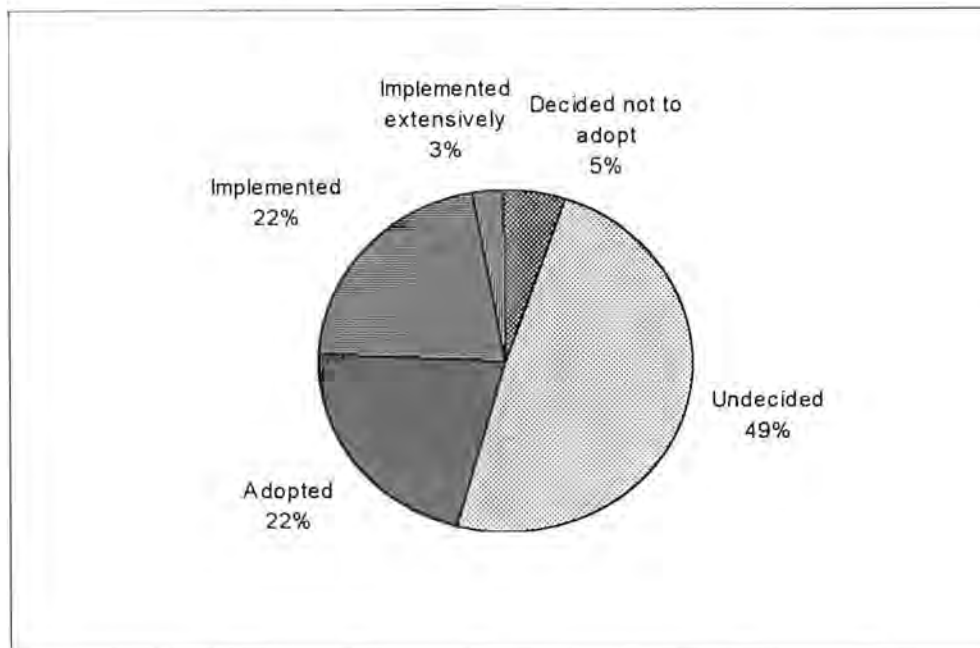
Figure 6.3: Classification of Respondents by Stage of *Evaluation*



The second scale used to classify EDI utilisation was the *Adoption/Implementation* scale. The classification of the responses by stage of *Adoption/Implementation* is depicted in Figure 6.4. The category with the highest frequency of responses includes those firms undecided about whether to adopt and implement EDI. Over 50% of firms either have decided not to adopt or are undecided, while approximately 22% of firms

have decided to adopt. Only 22% of firms have implemented EDI and only 1 firm has implemented EDI extensively.

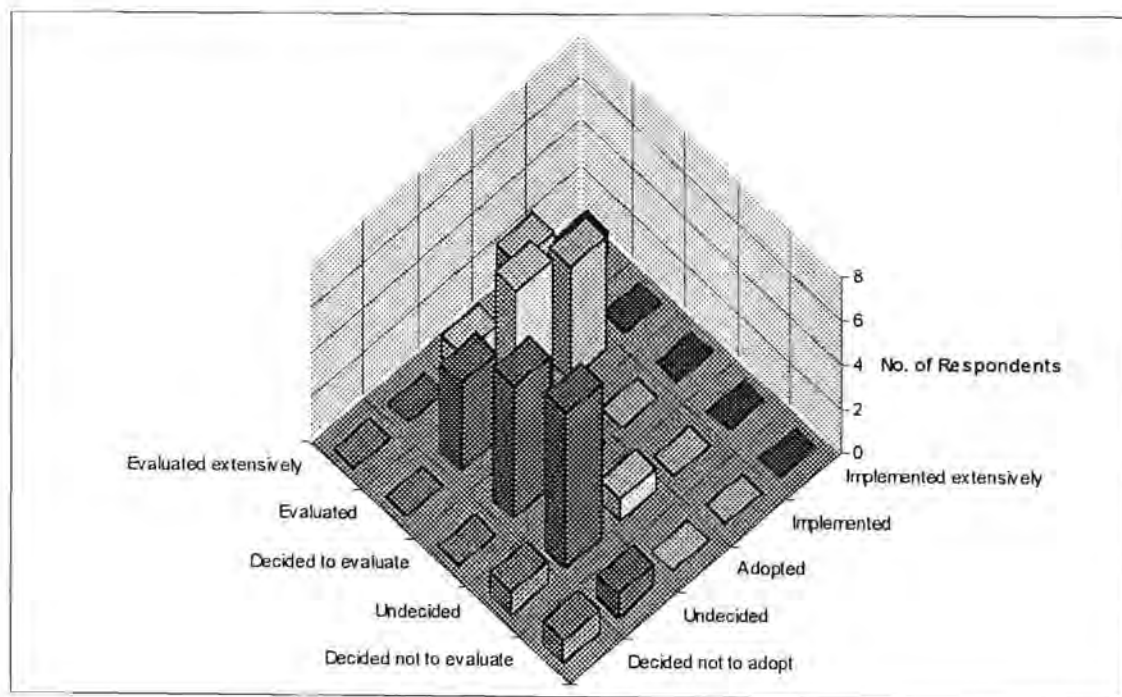
Figure 6.4: Classification of Respondents by Stage of *Adoption/Implementation*



The respondents were then compared on both the *Evaluation* and *Adoption/Implementation* scales together. Figure 6.5 classifies the respondents along these two scales simultaneously. Although this histogram is not too clear, the general trend is fairly clear. The 2 firms that have decided not to evaluate have either decided not to adopt or are undecided as to whether to adopt or not. Of the 9 firms that are undecided as to whether to evaluate or not, 7 are also undecided about adoption, while 1 has decided not to adopt and, surprisingly, 1 has decided to adopt. The 6 firms that have decided to evaluate EDI are all undecided about adoption. Of the 15 firms that have evaluated EDI, 4 are still undecided about whether to adopt or not, 6 have decided to adopt and 5 have gone on to implement. Therefore, two-thirds of the firms

that have evaluated EDI have also adopted and/or implemented this technology. Five firms have evaluated EDI extensively and, of these, 1 has also decided to adopt EDI, 3 have also implemented EDI and 1 has implemented EDI extensively. Therefore, 80% of the firms that have evaluated EDI extensively have at least progressed to implementation. Hence, the graph shows that there seems to be a general progression from evaluation to adoption and/or implementation. In addition, none of the firms that have evaluated EDI have decided not to adopt.

Figure 6.5: Classification of Respondents by *Evaluation and Adoption/Implementation*



6.2.1.3 Classification of Stage of Utilisation by Retail Sector and Organisation Size

Responses to the *Evaluation and Adoption/Implementation* scales were then classified by sector and size to determine whether there are any differences along these dimensions. Since there are only two groups for both sector and size, the Mann-

Whitney test was used to test for differences in median ratings between the two groups along both scales (Spren, 1989). First, responses to the *Evaluation* scale were classified by sector. Figure 6.6 presents two histograms, showing the distribution of responses within each sector. In the *fast* turnover sector, all firms have at least decided to evaluate, while in the *slow* turnover sector a number of firms have either decided not to evaluate EDI or are undecided. Table 6.3 presents the result of the statistical test of the difference between the medians of the two groups. A Mann-Whitney test found a significant difference (at the 5% level) between the medians for the two sectors.

Responses to the *Adoption/Implementation* scale were also compared in the same way and the frequency histograms are presented in Figure 6.7. In the *fast* turnover sector no firms have decided not to adopt and most firms have at least adopted EDI. In the *slow* turnover sector most firms are undecided and 2 have decided not to adopt. Table 6.3 also presents the result of the Mann-Whitney test which revealed a significant difference between the medians across these two groups at the 5% level.

Figure 6.6: Histogram of *Evaluation* by Retail Sector

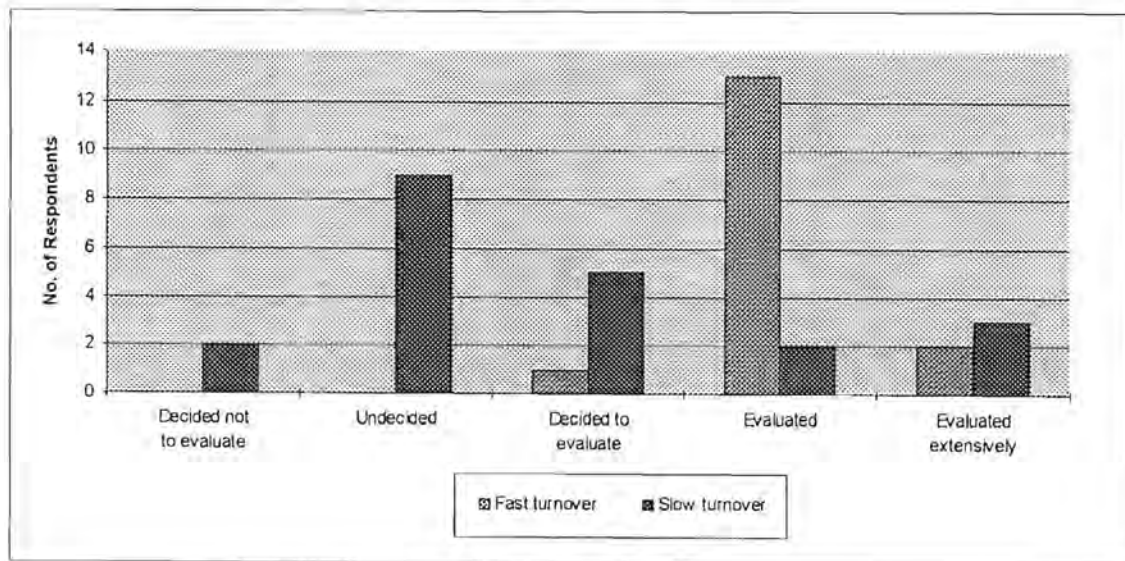


Figure 6.7: Histogram of Adoption/Implementation by Retail Sector

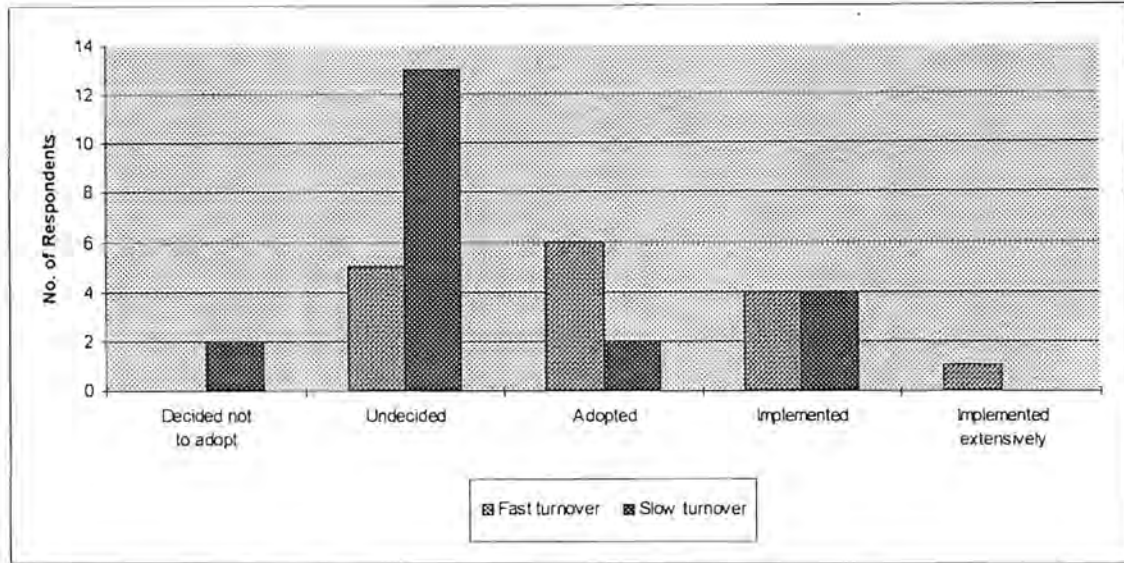


Table 6.3: Mann-Whitney test results for comparison of Stage of Utilisation across Retail Sectors

Variable	z-score	p-level
Evaluation	-3.234	0.001221
Adoption/Implementation	-2.069	0.038522

The same analysis was done for the classification by size categories. Responses to the *Evaluation* scale were first assessed. Among *large* firms, only 1 is undecided while the rest have at least decided to evaluate and the majority have either evaluated EDI or have evaluated it extensively. A Mann-Whitney test revealed a significant difference (at the 1% level) between these two groups. Secondly, responses to the *Adoption/Implementation* scale were assessed. Among *large* firms, many are undecided but none have decided not to adopt, and the majority have either adopted, implemented or implemented EDI extensively. However, among *small* firms, many are also undecided, but the majority have either decided not to adopt or are undecided.

Nevertheless, these differences are not significant. These results are presented in the graphs and table below.

Figure 6.8: Histogram of Evaluation by Organisation Size

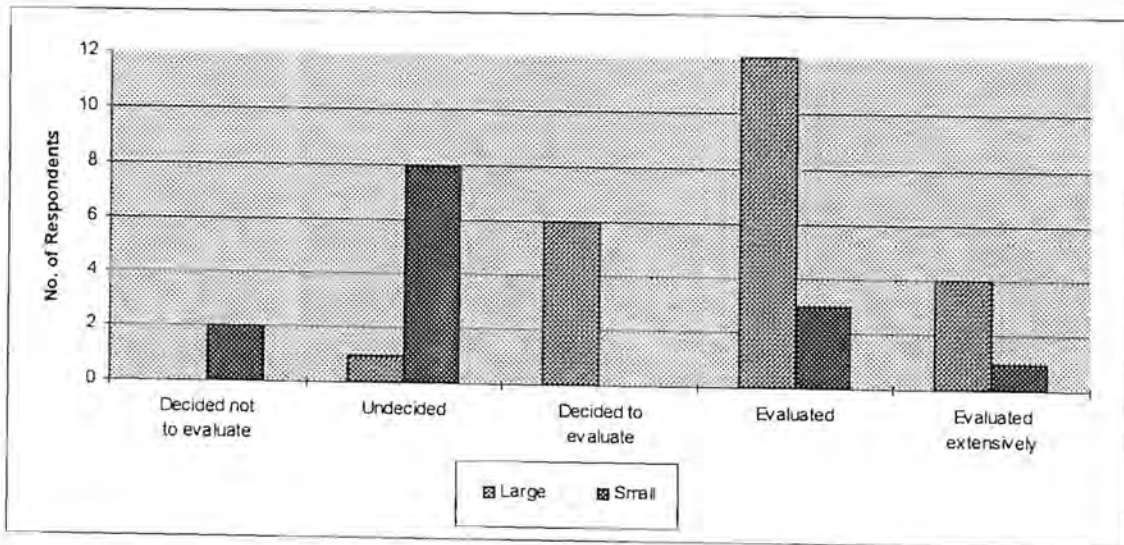


Figure 6.9: Histogram of Adoption/Implementation by Organisation Size

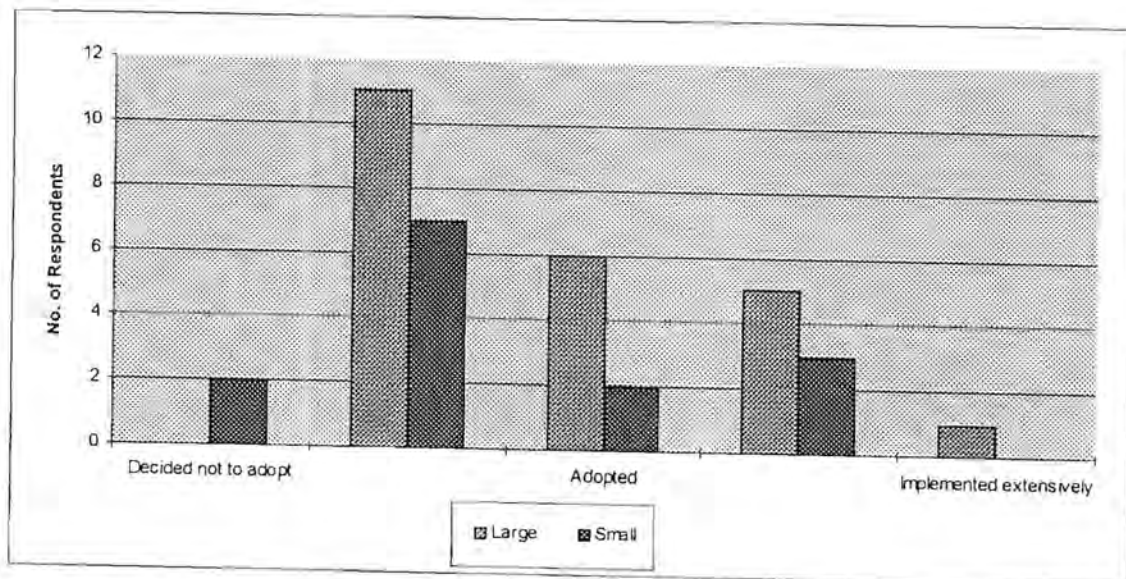


Table 6.4: Mann-Whitney test results for comparison across Organisation Size

Variable	z-score	p-level
Evaluation	-3.038	0.002386
Adoption/Implementation	-1.127	0.259587

Both these scales were then analysed by both sector and size together. Table 6.5 presents the classification for the *Evaluation* scale and Table 6.6 presents the same for the *Adoption/Implementation* scale. Unfortunately, there are insufficient responses in each category to complete any statistical tests and, in particular, there is only 1 *small* firm in the *fast* sector. *Large* organisations in the *fast* sector appear to be the most advanced users of EDI. All these firms have evaluated EDI except one which has decided to evaluate. In addition, most of these firms have decided to adopt EDI or have already implemented it. However, a number are still undecided about whether to adopt or not. In contrast, *small* firms in the *slow* sector appear to be the least advanced users of EDI. Two of these firms have decided not to evaluate EDI and the majority are still undecided. In addition, a majority are also undecided about whether to adopt or not. Nevertheless, three of these firms (23%) have either evaluated EDI or have evaluated it extensively, and four (31%) have either adopted or implemented EDI.

Table 6.5: Cross-tabulation of Responses by Stage of *Evaluation* x Sector x Size

Sector	Size	Decided not to evaluate	Undecided	Decided to evaluate	Evaluated	Evaluated extensively	Row Totals
Fast	Small	0	0	0	1	0	1
Fast	Large	0	0	1	12	2	15
Slow	Small	2	8	0	2	1	13
Slow	Large	0	1	5	0	2	8
Column Totals		2	9	6	15	5	37

Table 6.6: Cross-tabulation of Responses by Stage of *Adoption/Implementation* x Sector x Size

Sector	Size	Decided not to adopt	Undecided	Adopted	Implemented	Implemented extensively	Row Totals
Fast	Small	0	0	0	1	0	1
Fast	Large	0	5	6	3	1	15
Slow	Small	2	7	2	2	0	13
Slow	Large	0	6	0	2	0	8
Column Totals		2	18	8	8	1	37

6.2.2 Analysis of the Perceived Benefits

The objective of this study is not to assess the benefits of EDI. However, since data was collected about respondents' perceptions of the benefits of using EDI (*Relative Advantage*), these were analysed to provide an indication of whether respondents regard EDI as beneficial or not. Individual scales were used for each type of benefit and were not individually. However, the purpose of this section is primarily description.

The responses to these questions were coded from "1" to "5", where "1" indicates strong disagreement and "5" strong agreement. Table 6.7 shows the descriptive statistics for these scales. The median rating for all the benefits is 4. Moreover, the range of responses is relatively low, with three of the eight scales having a range of 2 and the rest a range of 3. This implies general agreement with the benefits cited. However, the mean for the second scale, "EDI improves/would improve clerical efficiency through reduced paperwork", is the only one above 4.

Table 6.7: Descriptive Statistics for Scales measuring Perceived Benefits

Benefit	Median	Mean	Range	N
Cuts/would cut costs in operations	4	3.78	3	36
Improves/would improve clerical efficiency through reduced paperwork	4	4.14	2	36
Allows/would allow the organisation to speed up order response time	4	3.91	3	35
Facilitates/would facilitate improved inventory control	4	3.77	3	35
Provides/would provide timely and accurate information for decision-making	4	3.83	3	35
Improves/would improve customer service	4	3.80	2	35
Enhances/would enhance the organisation's service differentiation	4	3.68	2	34
Helps/would help to generate competitive advantage	4	3.71	3	35

Wilcoxon Matched Pairs tests were performed to determine whether there are significant differences in the median ratings (Sprent, 1989). Table 6.8 presents the results of these tests. Significant differences, at the 5% level, were found with the first, third, fifth, sixth and seventh scales. Furthermore, the differences with the sixth and seventh scales are also significant at the 1% level. These scales, "EDI enhances/would enhance the organisation's service differentiation" and "EDI helps/would help to generate competitive advantage for the firm", relate to the more strategic benefits. This is consistent with the findings in the literature review which established that administrative benefits from simple automation are more obvious and more easily achieved, but strategic benefits become greater when EDI is implemented in an integrated manner. As revealed earlier, not many firms have implemented EDI and only 1 respondent to this survey has implemented EDI extensively.

Table 6.8: Wilcoxon Matched Pairs test results comparing the Median Rankings between the benefit “Improves/would improve clerical efficiency through reduced paperwork” and all other benefits

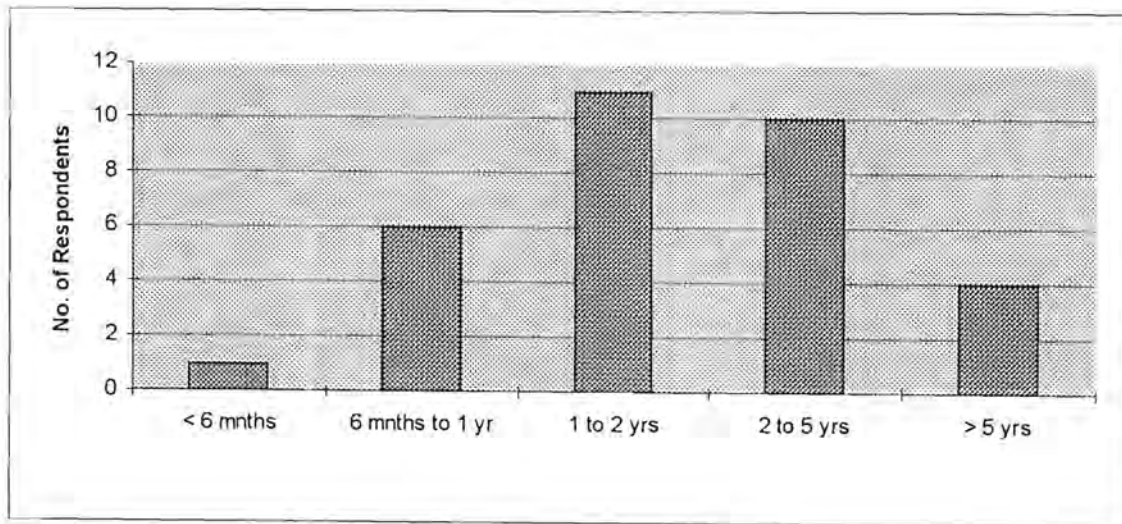
Benefit	T	z-score	p-level	N
1. Cuts/would cut costs in operations	30.0	2.20	0.028	35
2. Allows/would allow the organisation to speed up order response time	48.0	1.35	0.177	35
3. Facilitates/would facilitate improved inventory control	35.0	2.20	0.028	35
4. Provides/would provide timely and accurate information for decision-making	38.5	1.80	0.072	35
5. Improves/would improve customer service	19.5	2.30	0.021	34
6. Enhances/would enhance the organisation’s service differentiation	7.5	3.13	0.002	33
7. Helps/would help to generate competitive advantage	11.0	2.61	0.009	34

Mann Whitney tests were also completed to compare the ratings for these scales across the retail sector and organisation size classifications. The only significant difference found when comparing the ratings across sectors is a significant difference between the median ratings for the second scale, “EDI improves/would improve clerical efficiency through reduced paperwork”. Respondents in the *fast* turnover sector rated this benefit significantly higher than respondents in the *slow* turnover sector. There are no significant differences, at the 5% level, when comparing the ratings for these scales across the organisation size classifications. However, the median ratings for the second scale are significantly different across organisation size at the 6% significance level. *Large* firms rated this benefit higher than *small* firms. Therefore, *large* firms in the *fast* turnover sector seem to gain the most from this administrative benefit. This seems logical since these types of retail firms should be able to achieve the most out of the administrative efficiencies through economies of scale.

6.2.3 Description of Retail Firms' Experience with EDI

Elapsed Time is the variable that has been used in the hypotheses tests as a surrogate measure for the learning curve effect associated with an IT innovation. However, this also provides another dimension along which to classify respondents. This scale measures the length of time since the firm's initial investigation of EDI. Figure 6.10 depicts a frequency histogram of the responses. Category 3, firms with 1 to 2 years experience of EDI, has the highest frequency of responses and this is also the median. The majority of responses (55%) fall into categories 3 and 4. Therefore, most firms have had between 1 and 5 years experience with EDI.

Figure 6.10: Histogram of Respondents by Length of Experience (Elapsed Time)



No significant differences were found when comparing respondents' length of experience across retail sector or organisation size.

6.2.4 Descriptive Statistics Using Summed Scales

The individual items for each construct were summed. Table 6.9 contains the descriptive statistics for the summed scales.

Table 6.9: Descriptive Statistics for the Summed Scales (Constructs) of the Independent Variables

Variable	Dimension(s)	N	Median	Mean	Standard Deviation	Range
Relative Advantage	8	30	30.5	30.8	3.57	16
Organisational Compatibility	3	34	10	10.0	1.92	8
Technical Compatibility	1	32	4	3.5	0.92	4
Relative Cost	3	32	12	11.1	2.26	9
Senior Management Commitment	4	36	16	15.3	2.21	11
Strategic Importance	2	37	8	7.6	1.62	6
Elapsed Time	1	32	3	3.3	1.03	7
Influence of Key Suppliers	2	33	6	6.0	1.77	3
Influence of Key Competitors	1	32	3	2.6	0.93	4

6.2.5 Results of the Hypotheses Tests

The hypotheses were analysed using three methods. The association between each dependent variable and each of the independent variables was analysed using correlation coefficients. Then the relationship between both dependent variables and all the independent variables together were initially analysed using multiple discriminant and multiple regression analyses.

6.2.5.1 Correlations between the Variables (Bivariate)

Spearman rank order correlations were computed for all combinations of the variables. Significant correlations were found between *Evaluation* and the following variables: *Organisational Compatibility*, *Technical Compatibility*, *Relative Cost* and *Strategic Importance*. Table 6.13 shows these results. This supports hypotheses 3, 5, 7 and 11.

Table 6.13: Spearman Rank Correlations between *Evaluation* and each Independent Variable

Variable	Spearman R	p-level	N
Relative Advantage	0.1171	0.5379	30
Organisational Compatibility	0.5089	0.0021	34
Technical Compatibility	0.4402	0.0117	32
Relative Cost	0.3700	0.0372	32
Senior Management Commitment	0.1803	0.2926	36
Strategic Importance	0.4168	0.0103	37
Elapsed Time	-0.0985	0.5916	32
Influence of Key Suppliers	0.1497	0.4135	32
Influence of Key Competitors	-0.0144	0.9367	33

Significant correlations were found between *Adoption/Implementation* and the following variables: *Organisational Compatibility*, *Technical Compatibility* and *Strategic Importance*. These correlations are included in Table 6.14 below. This supports hypotheses 4, 6 and 12.

Table 6.14: Spearman Rank Correlations between *Adoption/Implementation* and each Independent Variable

Variable	Spearman R	p-level	N
Relative Advantage	0.0931	0.6220	30
Organisational Compatibility	0.4922	0.0031	34
Technical Compatibility	0.3639	0.0406	32
Relative Cost	0.2474	0.1722	32
Senior Management Commitment	0.0213	0.9019	36
Strategic Importance	0.5326	0.0007	37
Elapsed Time	0.0282	0.8781	32
Influence of Key Suppliers	0.2204	0.2255	32
Influence of Key Competitors	-0.1232	0.4947	33

Among the independent variables, significant inter-correlations at the 5% level were found between *Relative Advantage* and *Relative Cost*, *Organisational Compatibility* and *Technical Compatibility*, *Organisational Compatibility* and *Senior Management Influence*, *Relative Cost* and *Strategic Importance*, and *Influence of Key Suppliers* and *Influence of Key Competitors*. At the 10% level, significant inter-correlations were found between *Relative Advantage* and *Strategic Importance*, *Relative Advantage* and *Influence of Key Suppliers*, *Organisational Compatibility* and *Strategic Importance*, and *Relative Cost* and *Senior Management Influence*. This illustrates the relatively low

discriminant validity of the scales. These correlations are presented in Table 6.15 and Table 6.16 below.

Table 6.15: Significant Correlations between Independent Variables (5% level)

Variable	Spearman R	p-level	N
Relative Advantage & Relative Cost	0.5321	0.0043	27
Organisational Compatibility & Technical Compatibility	0.3688	0.0449	30
Organisational Compatibility & Senior Management Commitment	0.3550	0.0394	34
Relative Cost & Strategic Importance	0.4752	0.0060	32
Influence of Key Suppliers & Influence of Key Competitors	0.5172	0.0029	31

Table 6.16: Significant Correlations between Independent Variables (10% level)

Variable	Spearman R	p-level	N
Relative Advantage & Strategic Importance	0.3537	0.0552	30
Relative Advantage & Influence of Key Suppliers	0.3461	0.0770	27
Organisational Compatibility & Strategic Importance	0.2882	0.0983	34
Relative Cost & Senior Management Commitment	0.2971	0.0987	32

6.2.5.2 Multiple Discriminant Analysis

A multiple discriminant analysis was performed on each of the dependent variables, namely *Evaluation* and *Adoption/Implementation*. These scales were first converted to fewer categories because of the small sample size.

The responses to the *Evaluation* scale were classified into two groups: group one consists of those firms who have decided not to evaluate, those who are undecided, and those who have decided to evaluate EDI, and group two consists of those firms who have evaluated EDI, and those firms who have evaluated EDI extensively. Group one was labelled "Not Evaluated" and group two was labelled "Evaluated". The discriminant model was tested for the assumptions, a discussion of which is included in *Appendix B*.

Two discriminant analyses were performed. The first was the standard discriminant analysis which includes all variables in the model and determines which are significant in discriminating or differentiating between the *a priori* identified groups (Hair et al, 1979). Table 6.17 presents a summary of the model. The variable *Organisational Compatibility* is significant at the 10% level ($p < 0.0915$) but none of the other variables are significant at this level. Consequently, the entire model does not have good discriminating power ($p < 0.2106$). Wilk's lambda is a statistic that provides an indication of the discriminating power of the model. This statistic varies between 0 (no discriminating power) and 1 (perfect discriminating power) (Statistica for Windows Reference Guide, 1995). The value of this statistic for the discriminant model is 0.68,

which supports the conclusion that the model does not exhibit good discriminating power.

Table 6.17: Discriminant Function Analysis Summary for Evaluation

Independent Variables	F-to-remove	p-level
Relative Advantage	0.1702	0.6831
Organisational Compatibility	3.0532	0.0915
Technical Compatibility	0.5817	0.4520
Relative Cost	0.0071	0.9335
Senior Management Influence	0.0496	0.8253
Strategic Importance	2.0076	0.1675
Elapsed Time	0.6408	0.6408
Influence of Key Suppliers	0.1040	0.7495
Influence of Key Competitors	0.3372	0.5661

Discriminant analysis produces classification functions to categorise responses. Each group has a classification function, which is a linear combination of the variables in the model. The group with the highest classification score, given the values of the independent variables, determines the group to which the case is classified (Hair et al, 1979). The classification functions are presented in Table 6.18. Therefore, the greater an organisation’s perception of the organisational compatibility of EDI, the more likely the retailer is to fall into the “Evaluated” group. This provides support for hypothesis 3. The direction of association is also the same as that hypothesised for the variables *Relative Advantage*, *Technical Compatibility*, *Strategic Importance*, and *Influence of Key Competitors*, although these associations are not significant at the 10% level. On the other hand, the direction of association is opposite to the hypothesised direction for

the variables *Relative Cost*, *Senior Management Influence*, *Influence of Key Suppliers*, and *Elapsed Time*, although these associations are not significant at the 10% level

Table 6.18: Classification Functions for *Evaluation*

Independent Variables	“Not Evaluated”	“Evaluated”
Relative Advantage	3.729	3.813
Organisational Compatibility	0.843	1.385
Technical Compatibility	9.112	9.595
Relative Cost	-2.490	-2.514
Senior Management Influence	2.662	2.606
Strategic Importance	0.529	0.983
Elapsed Time	3.747	3.511
Influence of Key Suppliers	-0.073	-0.190
Influence of Key Competitors	2.544	2.906
Constant	-93.429	-104.758

Typically the classification functions are tested on a subset of cases that are omitted from the determination of the model. However, due to the small sample size, all the cases were used to calculate the model and these were again used to test the model. This approach may introduce bias and, consequently, the usefulness of the model may be overstated (Hair et al, 1979). Using this approach, 56% of the cases in the “Not Evaluated” group are correctly classified in that group using the discriminant function, and 80% of the cases in the “Evaluated” group are correctly classified in that group. The overall accuracy is 68%, which is not particularly good, given that there may have been possible bias.

The second analysis completed was the stepwise discriminant analysis procedure. This method starts from the position that there are no variables in the model. The variable with the highest association with the dependent variable (based on an F test) and which is greater than a criterion value (typically an F-value of 4 with a 5% significance level) is first entered in the model. The F-to-enter values for the variables not in the model are then re-computed, given the model which now consists of one dependent variable. The variable with the highest F-to-enter value which is greater than the criterion value is then entered in the model, and so on. This process eliminates multicollinearity among the independent (or predictor) variables (Dillon and Goldstein, 1984). Following this approach, the only variable that enters the model is *Organisational Compatibility* and the model is significant at the 1% level ($p < 0.0029$). The direction of association is positive as hypothesised, in other words, the higher the rating for *Organisational Compatibility*, the more likely the respondent is to fall into the "Evaluated" category. However, the accuracy of the model is not high. Only 50% of the respondents in the "Not Evaluated" group are classified correctly, while 85% of respondents in the "Evaluated" category are classified correctly. Overall, 68% of respondents are classified correctly.

Similar discriminant analyses were also run for the *Adoption/Implementation* scale. First, the responses were categorised into a reduced set of categories for this scale because there are too few responses in each of the original categories. Those respondents in the first two categories (those firms that have decided not to adopt EDI or are undecided about whether to adopt or not) are classified as "Not Adopted". Those firms in categories three to five (those firms that have decided to adopt EDI or

have implemented EDI or have implemented EDI extensively) are labelled as “Adopted/Implemented”. Two different variations of the discriminant analysis procedure were then run: the standard discriminant analysis was performed on all variables and the stepwise discriminant procedure was completed.

Again, the standard discriminant analysis includes all variables in the model and determines which are significant in discriminating or differentiating between the *a priori* identified groups. The entire model, consisting of all variables, is significant at the 5% level ($p < 0.0311$). Wilk’s lambda is 0.32, which means that the model exhibits reasonably good discriminating power. The variable *Strategic Importance* is significant at the 1% level ($p < 0.0081$), while *Organisational Compatibility* is significant at the 10% level ($p < 0.0522$). None of the other variables were found to be significant at the 10% level. A summary of the model is presented in Table 6.19.

Table 6.19: Discriminant Function Analysis Summary for Adoption/Implementation

Independent Variables	F-to-remove	p-level
Relative Advantage	2.1270	0.1685
Organisational Compatibility	4.5678	0.0522
Technical Compatibility	0.1130	0.7422
Relative Cost	0.0249	0.8770
Senior Management Influence	0.0339	0.8568
Strategic Importance	9.7510	0.0081
Elapsed Time	0.1209	0.7336
Influence of Key Suppliers	1.6426	0.2224
Influence of Key Competitors	0.0743	0.7895

Table 6.20 presents the classification functions which are used to determine the direction of association. The greater the perceived strategic importance of EDI, the more likely the retailer is to fall into the “Adopted/Implemented” category, and the greater the perceived organisational compatibility of EDI, the more likely the retailer is to fall into the “Adopted/Implemented” category. This supports hypotheses 4 and 13. All the other associations, except with the variables *Relative Advantage* and *Influence of Key Competitors*, are in the hypothesised direction, although they are not significant. The greater the perceived relative advantage of EDI over alternatives and the greater the perceived influence of competitors, the more likely the retailer is to fall into the “Not Adopted” category. However, these relationships are not significant.

Table 6.20: Classification Functions for Adoption/Implementation

Independent Variables	“Not Adopted”	“Adopted/Implemented”
Relative Advantage	2.846	2.208
Organisational Compatibility	1.405	2.648
Technical Compatibility	6.369	6.816
Relative Cost	-1.527	-1.427
Senior Management Influence	2.684	2.782
Strategic Importance	2.659	4.637
Elapsed Time	3.899	4.234
Influence of Key Suppliers	1.709	2.579
Influence of Key Competitors	2.762	2.378
Constant	-97.559	-114.482

The classification functions categorise each case correctly (i.e. 100% correct classification). However, this figure is likely to be high when there are many variables,

and when the same responses that were used to determine the classification functions are used to test it (Statistica for Windows Reference Guide, 1995).

A stepwise discriminant analysis was also performed. The two variables that are significant in the standard model are the only variables included in the final discriminant model when determined stepwise. The model is significant at the 1% level ($p < 0.0002$) and both variables are significant at the 5% level. The effects are in the directions hypothesised (as above). However, the classification percentages are a lot lower, especially for "Not Adopted". The model classifies 65% of cases in the "Not Adopted" category correctly and 88% of cases in the "Adopted/Implemented" category correctly, resulting in an overall correct classification of 76%.

6.2.5.3 Multiple Regression Analysis

Multiple regression analyses were completed in a similar manner to the discriminant analyses, except that the full scale was employed for each dependent variable (*Evaluation* and *Adoption/Implementation*). Each of these scales range from 1 to 5. For each dependent variable, regression functions were calculated using both the standard and stepwise procedures. A discussion of the model assumptions is contained in *Appendix B*. However, it must be noted that use of a scale with only 5 values as the dependent variable means that the results will need to be interpreted with particular care.

A multiple regression analysis was run against all independent variables using the *Evaluation* scale as the dependent variable. The standard regression analysis was first

completed, including all variables in the model. The adjusted R-square value of 0.53 indicates that all the independent variables together explain approximately 53% of the variation in the dependent variable, in this case *Evaluation*. The model is significant at the 5% level ($p < 0.0152$). The regression coefficients and their significance level are included in Table 6.21. The variable *Technical Compatibility* is significant at the 5% level, and the variables *Organisational Compatibility* and *Strategic Importance* are significant at the 10% level. Since the regression coefficients are positive, this adds support for hypothesis 5 and, to a lesser extent, for hypotheses 3 and 11.

Table 6.21: Regression Summary for the Dependent Variable *Evaluation*

Independent Variables	Coefficient	p-level
Relative Advantage	-0.1049	0.1584
Organisational Compatibility	0.1884	0.0642
Technical Compatibility	0.4659	0.0477
Relative Cost	-0.0074	0.9425
Senior Management Influence	0.0710	0.4220
Strategic Importance	0.2098	0.0592
Elapsed Time	0.0465	0.7683
Influence of Key Suppliers	-0.0117	0.9162
Influence of Key Competitors	0.0395	0.8640

In the same manner as the discriminant analyses, a forward stepwise regression analysis was performed on *Evaluation*. The regression summary is shown in Table 6.22. Only two variables enter the model, namely both compatibility variables. The adjusted R-square of 0.55 for this model indicates that these two variables explain approximately 55% of the variation in the *Evaluation* scale. The model is significant at the 1% level

($p < 0.0001$). The coefficients for these two variables are positive and significant at the 5% level, providing support for hypotheses 3 and 5.

Table 6.22: Stepwise Regression Summary for the Dependent Variable *Evaluation*

Independent Variables	Coefficient	p-level
Organisational Compatibility	0.2075	0.0134
Technical Compatibility	0.5686	0.0024

Regression analyses were run in the same way for *Adoption/Implementation*. Again, the standard multiple regression analysis was run first. The regression coefficients and their significance levels are included in Table 6.23. The model is significant at the 1% level ($p < 0.0002$). The adjusted R-square of 0.78 indicates that the variables together explain approximately 78% of the variation in the *Adoption/Implementation* scale. At the 1% level, the variables *Organisational Compatibility*, *Strategic Importance*, and *Elapsed Time* have a significant influence and their coefficients are positive. These figures support hypotheses 4, 12 and 14. At the 5% level, *Relative Advantage* also has a significant influence. However, since the coefficient is negative, the direction of association is opposite to that hypothesised (hypothesis 2).

**Table 6.23: Regression Summary for the Dependent Variable
*Adoption/Implementation***

Independent Variables	Coefficient	p-level
Relative Advantage	-0.1186	0.0171
Organisational Compatibility	0.2114	0.0029
Technical Compatibility	0.0695	0.6070
Relative Cost	-0.0001	0.9993
Senior Management Influence	0.0423	0.4367
Strategic Importance	0.3081	0.0003
Elapsed Time	0.3814	0.0016
Influence of Key Suppliers	0.0878	0.2147
Influence of Key Competitors	-0.1593	0.2753

Finally, a forward stepwise regression analysis was performed on *Adoption/Implementation*. The regression coefficients and their significance levels are included in Table 6.24. The four variables with significant coefficients (at the 5% level) in the standard model all enter the stepwise model. This model has an adjusted R-square of 0.81, which indicates that these four variables together explain approximately 81% of the variation in the *Adoption/Implementation* scale. The model is significant at the 1% level ($p < 0.000001$). Again, there is support for hypotheses 4, 12 and 14, given the positive and significant coefficients. Furthermore, *Relative Advantage* again has a significant, negative coefficient, disputing hypothesis 2.

**Table 6.24: Stepwise Regression Summary for the Dependent Variable
Adoption/Implementation**

Independent Variables	Coefficient	p-level
Relative Advantage	-0.1177	0.0019
Organisational Compatibility	0.2507	0.0000
Strategic Importance	0.3216	0.0000
Elapsed Time	0.3824	0.0003

6.3 Discussion of Findings

In this section, the findings will be interpreted, in particular the implications for theory and practice.

The findings need to be applicable to the underlying population of interest. In this study, the population consists of larger retailers, typically retail chains. Therefore, the findings are not necessarily relevant to smaller, typically independent retailers. As explained in the section describing the research methodology, what was considered the entire population was sampled. The relatively high response rate of 58%, especially when compared to many other IS surveys, adds confidence to the general applicability of the findings to the underlying population. However, although there is a fair spread of respondents across the retail sectors, there is a relatively large concentration in the supermarket & grocery, furniture & household, and clothing & apparel sectors. On the other hand, this concentration may be representative of the SA retail industry. This breakdown is also similar to that obtained by Hart et al (1994) in a study which targeted larger retailers as well. In that study, 32% of respondents were in the clothing

sector, 31% in the supermarket/grocery sector and 14% in the furniture sector. There is also a fairly even spread across the organisation size categories, measured by the number of employees.

When both these categorisations are reduced, it becomes evident that there is a concentration of retail firms who are either relatively large and generate a relatively faster turnover or are relatively small and generate a relatively slower turnover. These categories represent the opposite ends of the spectrum. According to the literature, large firms with a high turnover of stock should gain the most benefits from EDI and, therefore, should be the most advanced in their utilisation of this technology, whereas firms who are relatively small and generate a relatively slower turnover should be the least advanced. Another dimension along which the respondents can be viewed is their length of experience with EDI. Many firms have had between 1 and 2 years experience with EDI, and over half have had between 1 and 5 years experience. There is no distinction between retail sector or between organisation size. Therefore, since Hansen and Hill (1989) cite EDI surveys since 1988 which indicate that firms were using EDI in America, this sample appears to be relatively inexperienced with EDI. However, at the same time, Tan and Lung (1994) found very little utilisation of EDI in Taiwan. In summary, any conclusions need to be viewed in the light of these characteristics of the sample of respondents.

The retail firms in this sample generally agree that EDI offers potential advantages. However, the administrative efficiency benefits were rated higher than the strategic-type benefits. This is consistent with the findings in the literature since these retail firms

are using EDI in a relatively less advanced manner. This is despite the projections by Hart et al (1994) that retail firms in SA would increase their utilisation of EDI substantially. They still do not appear to be advanced, with very few firms having implemented EDI.

Despite this situation, there appears to be a general progression from evaluation to adoption and implementation. For example, of the 5 retail firms that have evaluated EDI extensively, 1 has decided to adopt, 3 have implemented, and 1 has implemented extensively. As a result, these variables are highly correlated. The Spearman rank correlation of 0.76 between these variables is significant at the 1% level. This implies that, typically, firms that evaluate the technology, particularly if they evaluate it extensively, believe that it should be adopted and implemented. However, this does not necessarily mean that these firms believe that the benefits outweigh the advantages. As Benjamin et al (1990) indicate, EDI has become a competitive necessity in many industries rather than a source of competitive advantage.

There does seem to be some influence from both retail sector and organisation size. Larger retailers operating in the higher turnover format tend to be more advanced in terms of both evaluation, and adoption and implementation. This seems logical because these firms should be able to generate economies of scale and therefore benefit more from the efficiency benefits. In other words, the total cost savings should increase as the volume of transactions increases. On the other hand, the role of organisation size is not clear. Larger retailers, in terms of number of employees, tend to be more advanced in terms of evaluating EDI but there does not appear to be any effect on adoption and

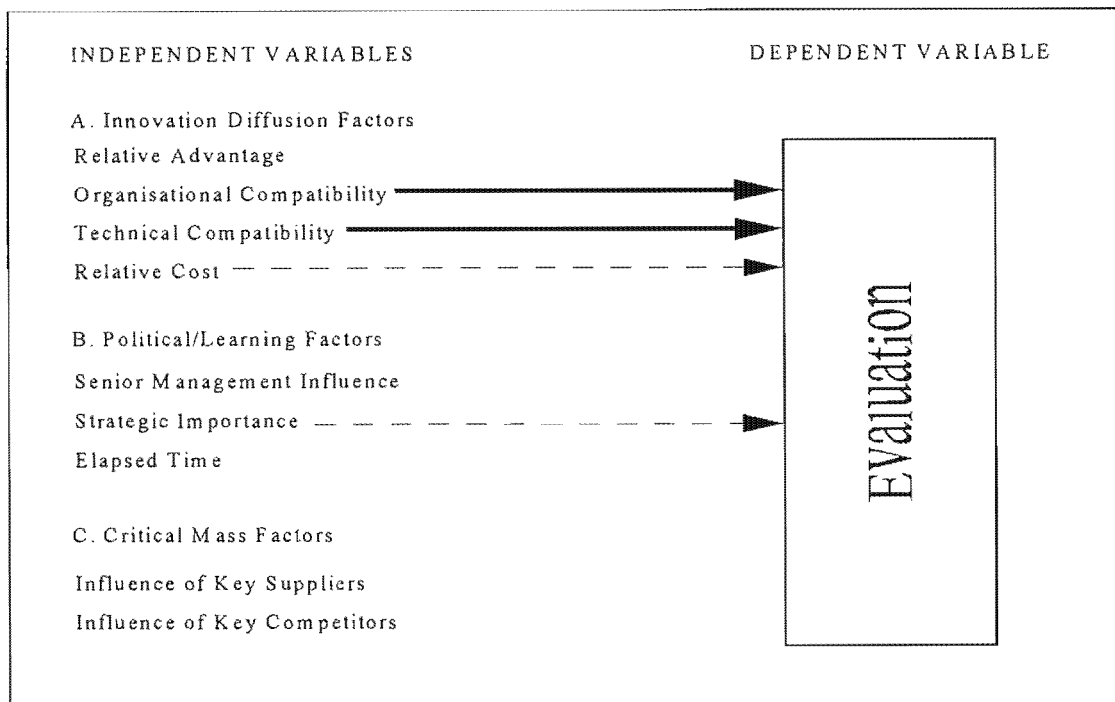
implementation. However, this seems to be consistent with Damanpour's (1991) assessment that larger firms have more slack resources to initiate an investigation into an innovation, but bureaucracy may then inhibit the adoption and diffusion of that innovation throughout the organisation.

These findings are congruent with those elsewhere, at least in America, where, despite the agreement on the potential of EDI, the diffusion of the technology throughout industry, in general, has not reached expectations (Bouchard and Markus, 1995). This implies that there are other factors at work which are inhibiting the diffusion of EDI in the retail industry. These factors will be interpreted in the next sections.

6.3.1 Implications for Theory

The findings will be interpreted from the point of view of theory and compared to previous studies in this area. The factors associated with the evaluation of EDI will be discussed first. Figure 6.11 depicts the association between *Evaluation* and the independent variables.

Figure 6.11: Association of the Independent Variables with *Evaluation*
(with strong associations shown in bold)



The perception that EDI is compatible with the organisation (supplier relationships, operating practices and work style) shows the greatest, significant, positive association with a retail firm’s evaluation of the technology. It is significantly correlated with the evaluation of EDI at the 5% level and emerges as significant in the stepwise multiple discriminant analysis (1% level) and the stepwise multiple regression analysis (5% level). The second variable that seems to be related to a retailer’s evaluation of EDI is the perception that it is technically compatible with the organisation (in terms of existing hardware and software). This variable is significantly correlated with the evaluation of EDI at the 5% level, along with *Organisational Compatibility*, in the multiple stepwise regression analysis. However, it does not emerge as significant in the multiple discriminant analysis. This may be due to its significant correlation with *Organisational Compatibility* at the 5% level.

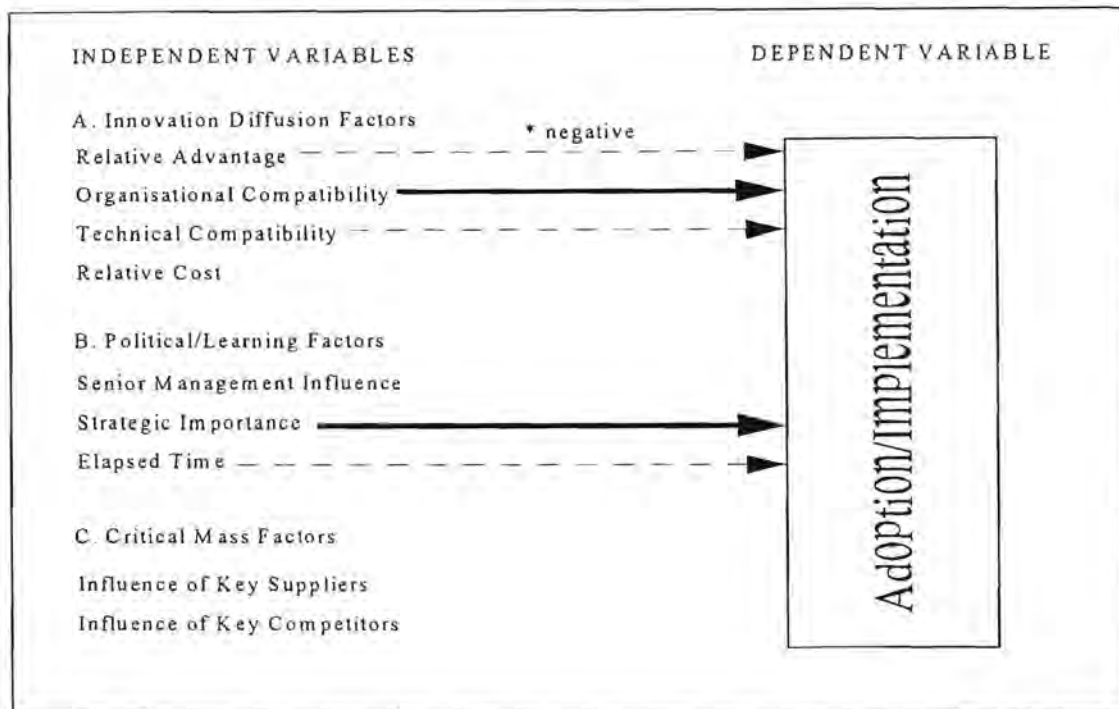
Overall, these two variables seem to be related to a retailer's evaluation of EDI.

However, the explanatory power of the models, although significant, indicate that there are other possible sources of variation not accounted for by these factors, nor by any of the other variables. The discriminant model (determined stepwise) only classifies 68% of responses correctly, with possible bias because the model was tested on the cases that were used to determine the model. In addition, the regression model (determined stepwise) only explains approximately 55% of the variation in the *Evaluation* variable.

There is also some support for a positive relationship between a retailer's perception of the strategic importance of EDI and evaluation of the technology, as well as between a retailer's perception that the benefits outweigh the costs (*Relative Cost*) and evaluation. Both these variables are correlated significantly with the dependent variable *Evaluation* at the 5% level and *Strategic Importance* is significant at the 10% level in the standard multiple regression model. However, this variable does not enter the regression model when determined stepwise, indicating that it does not explain significant additional variation in *Evaluation* not already explained by the compatibility variables. The F-to-enter value for this variable is significant with *Evaluation* by itself, but it decreases substantially in the stepwise multiple discriminant analysis after *Organisational Compatibility* has entered the model. Furthermore, *Organisational Compatibility* and *Strategic Importance* are also correlated significantly at the 10% level.

The relationship between the independent variables and *Adoption/Implementation* will now be discussed and figure 6.12 depicts these relationships.

Figure 6.12: Association of the Independent Variables with Adoption/Implementation (with strong associations shown in bold)



The perception that EDI is strategically important to the retailer and the retail industry as a whole shows the greatest, significant, positive relationship with a retail firm's adoption and implementation of the technology. The variable *Strategic Importance* is significantly correlated with *Adoption/Implementation* at the 1% level. It is also significant in the stepwise multiple discriminant analysis (5%) and the stepwise multiple regression analysis (1% level). The perception that EDI is compatible with the organisation (supplier relationships, operating practices and work style) is also significantly, positively associated with a retail firm's adoption and implementation of the technology. It is significantly correlated with *Adoption/Implementation* at the 1% level and emerges as significant in the stepwise multiple discriminant analysis (5% level) and the stepwise multiple regression analysis (1% level). These two variables seem to be related to a retailer's adoption and implementation of EDI. The explanatory

power of both models are significant and relatively good. The discriminant model (determined stepwise) has a Wilk's lambda of 0.42 and classifies 76% of responses correctly, with possible bias because the model was tested on the cases that were used to determine the model. The regression model (determined stepwise) explains approximately 81% of the variation in *Adoption/Implementation* with all the significant variables.

The variables *Technical Compatibility* and *Elapsed Time* also show some positive association with *Adoption/Implementation*. *Technical Compatibility* has a significant correlation coefficient with *Adoption/Implementation* at the 5% level, but it is not significant in either the standard multiple discriminant model or the standard multiple regression model. It is noteworthy that it is significantly correlated with *Organisational Compatibility* at the 5% level and its F-to-enter value decreases substantially when *Organisational Compatibility* enters the stepwise-determined multiple discriminant model. Therefore, this variable does not explain significant, additional variation in *Adoption/Implementation* that is not already explained by *Organisational Compatibility*. The variable *Elapsed Time* emerges as significant in both the standard and stepwise multiple regression analyses at the 1% level. However, it is not significantly correlated with *Adoption/Implementation* and it is not close to significant in the discriminant analysis. As a result, the evidence of a relationship from regression analysis cannot be considered conclusive.

The variable *Relative Advantage* is significantly, negatively related to *Adoption/Implementation* in the multiple regression model that is determined stepwise

(1% level). In the stepwise discriminant analysis, it has a negative relationship with *Adoption/Implementation* and its F-to-enter value increases when *Strategic Importance* and *Organisational Compatibility* enter the model, but it does not become significant. This disputes the direction of the hypothesised relationship. Therefore, this variable seems to be explaining an alternative source of variation in the *Adoption/Implementation* variable. However, since it is not significantly correlated with *Adoption/Implementation* nor is it significant in the discriminant analysis, this finding cannot be considered conclusive. On the other hand, the descriptive statistics seem to indicate that this relationship may exist. Respondents mostly rated the benefits highly but many have not implemented EDI.

These results support innovation diffusion theory. All the related variables emerged as important at some stage, although to differing degrees. The *Organisational Compatibility* variable, in particular, is significantly related to both the evaluation, and the adoption and implementation of EDI by retailers in SA. This provides another test of innovation diffusion theory but in a different context. There have been few, if any, similar studies in SA, while many similar studies have taken place in America. Therefore, this study also provides validation for this theory in a different environment. However, apparently contradictory findings were obtained for the relationship between a firm's perception of the relative advantage of EDI and the adoption and implementation of this technology, although this relationship is not considered to be strong.

The perceived strategic importance of EDI also emerged as an important factor. This variable is significantly related to the adoption and implementation of EDI by retailers in SA. This result emphasises the importance of political and learning forces, in addition to those advanced by innovation diffusion theory. However, despite the expected importance of senior management's influence on the process, this factor did not emerge as very important. The same can be said for the learning variable, *Elapsed Time*, although it is in the final stepwise regression model for *Adoption/Implementation*. Premkumar et al (1994) found a significant relationship between a firm's experience with EDI and their diffusion of the technology but not with its initial implementation. Therefore, a firm's experience with the technology, and the possible learning effect, seems to be more important when the firm starts to integrate EDI with both internal and supplier systems.

However, none of the variables identified from critical mass theory proved to be associated with evaluation or adoption and implementation. Nevertheless, this does not provide conclusive proof that variables such as the influence of suppliers and competitors are not important. There have been mixed findings regarding these factors in the literature. O'Callaghan et al (1992) did not find a significant relationship between external factors (previous adopters, industry, and the initiating firm) and the adoption decision. However, Bamfield (1994) considered external influences to be important in the adoption and diffusion process. In addition, Bouchard (1993) found support for the influence of trading partners on the adoption decision. A possible explanation for these mixed findings is the context of the study. Retail firms in SA, particularly since this sample consists of larger retailers, may be dominating suppliers

and, therefore, may not be influenced by them. In addition, since the level of adoption and implementation is relatively low, the strategic benefits to competitors may not be evident and there may not yet be a critical mass of industry participants.

6.3.2 Implications for Practice (Retailers)

Before any technology can be managed in an organisation, the process by which that technology is evaluated, acquired, implemented and modified needs to be understood. Management needs to understand that process so that it can be planned and controlled. This is particularly true for a technology innovation that can change the way that the organisation operates.

This research study has tried to examine this process in terms of EDI in the retail industry in SA. One proviso is that the study did not examine which factors influence the success of EDI in the organisation. However, an understanding of the factors which influence its progress through the organisation may also highlight the factors that influence its success because the success of an IS is often measured by whether it gets used or not, as well as by the users' satisfaction with that system.

Three variables emerge as the most important in this process. The first is the perception that EDI is compatible with the organisation, in terms of its operating practices, work style, and supplier relationships. This emphasises that an IT system is part of a broader system which, in the case of EDI as an IOS, encompasses the relationship with trading partners. Therefore, the technology needs to fit into that

system to be utilised. This may explain why the adoption and diffusion of EDI has not spread as rapidly as forecast, even though it has been evaluated and the potential benefits have been recognised. Thus, it appears that retailers may need to change the processes within the organisation, as well as those with suppliers, to take advantage of EDI. Alternatively, retailers may not be willing to do so. The argument advanced by Clemons and Row (1993) supports this assessment. The possibility of greater information sharing with suppliers and the potential change in the relative bargaining power with suppliers may be inhibiting retail firms.

Retailers may still be able to implement EDI at a simple level in order to gain efficiency benefits. Evidence in the literature suggests that integration with internal systems and supplier systems needs to take place before the strategic benefits, such as a faster trading cycle and reduced inventory costs, can be realised. This appears to be the case and may explain why retailers in the sample generally rated the simple administration benefits more highly than the strategic benefits. It would seem logical that the strategic benefits would be greater if they are realised because they should have a greater effect on the bottom line, in terms of profit.

The perception that EDI is technically compatible with existing hardware and software is also relatively strongly associated with its evaluation. Therefore, retailers in this sample may be reluctant to initiate an investigation into EDI if it cannot be integrated easily with existing systems. However, this variable is not strongly associated with the adoption and implementation of EDI. A possible explanation is that most retailers that have adopted and implemented EDI have already evaluated it and may be satisfied that

it is compatible technically. After all, EDI is meant to be a standard technology.

Moreover, evaluation is correlated with adoption and implementation. Alternatively, these retailers may only be implementing EDI at a simple level, which largely eliminates the need for technical compatibility.

The perception that the benefits of EDI outweigh the costs is associated with EDI's evaluation, but not strongly. Therefore, the compatibility issues seem to be dominating decisions regarding EDI, although the costs seem to be taken into account to a certain extent.

The other important variable is the perception that EDI is strategic to the retailer and to the retail industry as a whole. Typically, there are many competing demands for resources in an organisation. In terms of IT, there are many opportunities. In the retail industry, examples are EPOS systems and data warehousing systems. The priorities should naturally get resources allocated to them and it seems logical to suggest that a priority in the retail industry would be strategically important. The relatively low level of implementation and the relatively lower ratings for the strategic benefits emphasise that this sample of retailers in SA may not envisage the potential strategic impact or have not been able to reach the level of integration required.

This may help to explain the apparently contradictory findings for the relationship between a firm's perception of the relative advantage of EDI and the adoption and implementation of this technology. Higher ratings of the benefits are associated with low levels of adoption and implementation. The descriptive statistics seem to be

supporting these findings, since the retail firms in the sample generally rated the benefits highly while there are generally low levels of adoption and implementation. It was also noted that the administrative-type benefits were generally rated higher than the strategic-type benefits. Therefore, firms may be rating the benefits, particularly the administrative efficiency benefits, highly before adopting and implementing the technology. When the technology has been implemented, these benefits may not materialise as easily as envisaged or, alternatively, the simple benefits of automation may not be adequate. As a result, the strategic importance of EDI for the retailer and the retail industry seem to be the deciding factor rather than the relative advantage of the technology.

It has already been stated that a retail firm's experience with EDI is only weakly associated with its adoption and diffusion. However, this does provide some support for the influence of the learning curve effect. The argument has been put forward that organisational learning seems to be more important when the firm attempts to integrate the system with both internal and supplier systems. A further possible explanation is that, since SA retailers seem to be behind their American counterparts, organisational learning may be easier, through case examples of successful implementations.

There does not appear to be any relationship between the external (critical mass) factors and a retail firm's evaluation or adoption and implementation of EDI.

However, if these forces were to influence the retailer's decisions regarding EDI, it would be a potential source of concern because the retailer would then most likely be

reactive. The design of the system may not be compatible with the organisation which could increase the risk of failure.

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7. LIMITATIONS OF THE STUDY

No research project is likely to be flawless. There are many problems that need to be dealt with and choices that need to be made during the course of a research study.

Attewell and Rule (1991) stress the importance of outlining the difficulties and the limitations of the study so that researchers, especially new ones, can learn from those mistakes. Therefore, the limitations of each aspect of the research methodology used in this study will be outlined here.

There are a number of general concerns with survey research as well as a number of limitations relating to this study. Although this study aimed to determine which factors influence the process by which retail firms evaluate, adopt and implement EDI systems, it incorporated an ex post facto design. Therefore, since it was not feasible to control the variables, causation can only be inferred from the association between the various factors (independent variables) and the stage of evaluation, adoption and diffusion (dependent variables). However, temporal validation of the findings will add confidence to any inferences. In other words, the independent variables should occur or be present before the expected change in the dependent variable occurs (Emory, 1985; Lucas, 1991). This is emphasised by Franz and Robey (1987) who state that hypothesis testing in a single time period can only test static associations. Cause and effect relationships need to be tested over multiple periods using longitudinal designs.

One of the constant concerns with survey research is the possible self-selecting nature of respondents (Galliers, 1992). In this study, the organisations in the sample were

each telephoned to identify the key respondent and to encourage that individual to reply. This approach also provided the opportunity to check postal details. This proved to be valuable since many postal addresses obtained from the mailing list were incorrect.

The data collection procedures targeted a single respondent in the organisation who was identified as the key respondent. However, there may be alternative views in the organisation, necessitating employing several individuals as respondents (Pinsonneault and Kraemer, 1993). Despite this concern, it was felt that the response rate would be negatively affected for a sample that was already relatively small. These conflicting concerns were raised in previous studies in SA (cf. Hart, Segal and Stocks, 1994). It also appears that low response rates are a general problem with IS survey research. Pinsonneault and Kraemer (1993), in their analysis of IS survey research, found that 74 percent of the 122 studies surveyed had response rates of less than 51 percent.

Pinsonneault and Kraemer (1993) also suggest that multiple methods be used to collect data to enhance the understanding of the subject. However, this would have increased the costs of the survey substantially, including the additional time that would have need to be spent.

It was important to pretest the instrument to try to ensure its reliability, and content and construct validities. However, the reliability and construct validity of the questionnaire were only discussed with two retailers in the population under study, thus eliminating the possibility of testing these validities statistically. Again, it was felt

that the reduction in the sample size would have jeopardised the statistical analyses that could have been performed on the final data set. Therefore, these validities were only tested on the final responses. This limits the corrective action that can be taken if the instrument is proved to be unreliable or invalid. The ultimate test for reliability is the test-retest situation or the use of multiple methods, such as a mail survey combined with interviews (Lucas, 1991; Emory, 1985).

Grover and Goslar (1993) recommend randomising the order of the questions.

However, discussions with retailers during the pretest revealed that this approach may have annoyed respondents, especially because the questionnaire is fairly short.

Therefore, this may have defeated the object of randomisation, that is an increase in the reliability of the questionnaire. Furthermore, it may also have influenced the respondents to not return the questionnaire.

As described in the section on the research methodology, the sample drawn was considered to be the population of interest. Small retailers were not included because they were not considered to be in a position to answer the questionnaire. Nevertheless, conclusions cannot be made regarding the evaluation, adoption and diffusion process in smaller, typically independent retail firms in SA.

Due to the relatively small sample size and because of the ordinal nature of the data, the assumptions of parametric tests were not met. Therefore, nonparametric tests were used, although parametric tests were still performed in some cases as well.

Nonparametric tests typically have less statistical power than parametric tests and are

usually more conservative because they place less onerous assumptions on the data (Spren, 1989). Therefore, since the statistical power of the tests is lower, there is more chance of accepting the null hypothesis when it is false. In other words, there is less chance of finding a significant association that exists, referred to as a *Type II* error (Baroudi and Orlikowski, 1989). As a result, parametric tests were still performed in some cases as well, despite the violation of assumptions.

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8. CONCLUSIONS

The bottom line in the retail business, as in any business venture, is profit, where profit is the difference between revenue and costs. In a retail firm, the variables that make up revenue are the price of goods and the quantity sold, and some of the major cost areas include the cost of buying inventory and holding it, the opportunity cost of lost sales, the cost of coordination with the supplier, and overhead costs.

One of the strategic options for a retailer is to develop closer relationships with suppliers. At the opposite ends of the spectrum, the retailer can either maintain antagonistic relationships with suppliers or develop close partnerships. In an antagonistic relationship, the retailer focuses on trying to reduce the price that the supplier charges for a particular good. On the other hand, the system of Quick Response (QR) distribution is the ultimate supplier partnership, where information is shared freely. The aims are to increase sales through greater availability of goods, to reduce the cost of holding inventory through faster replenishment in smaller batches, and to reduce coordination costs through automation. However, a retailer may become tied in to a few suppliers, and the supplier may gain more bargaining power in the relative power relationship. Hence, the supplier may increase the price of goods. More importantly, though, this system requires a radical change in the retailer/supplier relationship for a retailer who currently engages in tough price negotiations with many suppliers to lower the price of goods.

EDI is a technology that can facilitate the automation of the information flow between retailer and supplier. At a simple level, it can potentially reduce coordination or administration costs by increasing the efficiency and accuracy of the information exchange. Alternatively, at a more complex level, it can potentially facilitate a QR partnership. Despite these potential advantages and subsequent predictions, EDI has generally not become as widespread as forecast. In particular, even though this study has focused on larger retail chains in SA, it has revealed that the same seems to be evident in the retail industry in SA. This prompted an investigation into the process by which this technology is utilised in order to manage this technology more effectively.

This study has revealed that, despite the general perception that EDI offers advantages, there are other factors which are important to focus on. The technology's compatibility with existing systems (hardware and software) and its compatibility with the organisation's work style and practices seem to be important factors that influence a retailer's decision to evaluate the technology. The perceptions that EDI is strategically important and compatible with organisational issues are associated with and, therefore, seem to influence a retailer's decision to adopt and implement the technology.

These findings provide retail management with areas to focus on when trying to understand and manage the process of evaluation, adoption and diffusion of EDI. First, organisational readiness for change appears to be important in addition to the technical aspects of compatibility. Therefore, retail management probably needs to examine the firm's internal processes, as well as those with suppliers to make sure that EDI will be able to be integrated with them. Secondly, since there are competing demands for

resources, strategically important investments would most likely be prioritised. This implies that the strategic value of EDI needs to be examined and communicated to senior management. These findings also indicate that it is the perception, regardless of the reality, that is important. In particular, it is important to perceive EDI as being compatible and strategically important. The reality, by whichever method it is assessed, may be important as well. However, it may be difficult and time-consuming to determine that reality.

The findings do not support any relationship between the influence of suppliers and competitors on a retail firm's utilisation of EDI. This implies that there may be no influence from suppliers or, alternatively, retailers in SA may be more dominant. In addition, there may not yet be a critical mass of SA retailers that are using the technology in a manner that demonstrates the advantages.

These findings are biased towards larger retailers in SA. Therefore, alternative or additional factors from those concentrated on in this study may be more important for smaller retailers. In particular, one may expect costs to be more of an issue for smaller retailers with typically less financial resources. In addition, suppliers and competitors may have a greater influence on retailers than seems to be apparent in this sample.

Retailers in this sample may be dominating the relationship with suppliers, which would be consistent with larger retailers in Europe, Asia and America (The Economist, 1995). However, smaller retailers may be dominated by larger suppliers and may be led by larger competitors as well.

9. RECOMMENDATIONS FOR FURTHER RESEARCH

It is important to identify areas for further investigation to guide research efforts and to try to develop a cumulative body of knowledge (Gorla, 1989). Recommendations will be made regarding the research question, from both retail and IT perspectives.

The research model was developed from those constructs that are considered to be the most important to understand the process by which EDI is utilised in the retail industry. The explanatory power of some of the models suggests that alternative and/or additional variables may be important. The constructs used in this study originated from three main schools of thought, namely innovation diffusion theory, political and learning models, and critical mass theory. Not all of the variables in these models were included in this study. However, some of the omitted constructs may still prove to be important. Furthermore, there may be other schools of thought that introduce additional variables. For example, Bouchard and Markus (1995) applied the concept of impression management to EDI.

This research study did not take into consideration the suppliers' views. It did not look at whether there was any forced compliance on the part of either trading partner. This aspect may prove to be important when examining smaller retailers.

The model developed for this study encompasses evaluation, adoption and diffusion. However diffusion was not examined in detail because of the state of the retail industry

in SA. The investigation of diffusion was largely restricted to the initial implementation and did not include the process of further modifications to the system over time. If the extent of utilisation of EDI increases in the retail industry in SA, diffusion can be studied in greater detail.

The findings in this study can be applied to various, related areas. First, the findings offer some worthwhile areas to focus on when examining the evaluation, adoption and diffusion of EDI in other industries. Secondly, the findings can also be applied to the study of other technologies in the retail industry. Thirdly, in terms of IT theory, EDI has been the definitive Interorganisational System that has been studied. Subsequently, the conclusions reached in EDI studies can be used for studies of alternative IOSs.

Finally, the success of EDI in the retail organisation was not measured in any way in this research study. That represents the other major stream of IT implementation research (Grover and Goslar, 1993). Further studies could measure the success and determine whether the factors that influence success are the same factors that influence the initiation, adoption and diffusion process.

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APPENDIX A: QUESTIONNAIRE INSTRUMENT

A. Experience with EDI

Please mark one of the boxes, using a tick or a cross, for the following questions.

Evaluation of EDI is the investigation of EDI's requirements, capabilities and costs through discussions, attending seminars, practical demonstrations, reading journals, and any other means.

Has your organisation evaluated EDI or not?

Decided not to evaluate	Undecided	Decided to evaluate	Evaluated	Evaluated extensively
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Estimate the time since your organisation's first investigation of EDI.

Less than 6 months	6 months to a year	1 to 2 years	2 to 5 years	More than 5 years
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The **adoption** decision implies a commitment to invest in resources, including people, computer hardware and software and communications technologies, for the future development of EDI application(s). **Implementation** activities include the development, installation and use of EDI application(s).

Has your organisation adopted and/or implemented EDI or not?

Decided not to adopt	Undecided	Adopted	Implemented	Implemented extensively
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B. Your Perceptions of EDI

Please mark one of the five blocks, using a tick or a cross, for the following statements.

	Strongly disagree	Disagree	Neutral	Agree	Strongly agree	Don't know
1. EDI cuts/would cut costs in operations.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
2. EDI improves/would improve clerical efficiency through reduced paperwork.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
3. EDI allows/would allow the organisation to speed up order response time.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
4. EDI facilitates/would facilitate improved inventory control.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

- | | | | | | | |
|---|----------------------------|----------------------------|----------------------------|----------------------------|----------------------------|--------------------------|
| 5. EDI provides/would provide timely and accurate information for decision-making. | <input type="checkbox"/> 1 | <input type="checkbox"/> 2 | <input type="checkbox"/> 3 | <input type="checkbox"/> 4 | <input type="checkbox"/> 5 | <input type="checkbox"/> |
| 6. EDI improves/would improve customer service . | <input type="checkbox"/> 1 | <input type="checkbox"/> 2 | <input type="checkbox"/> 3 | <input type="checkbox"/> 4 | <input type="checkbox"/> 5 | <input type="checkbox"/> |
| 7. EDI enhances/would enhance the organisation's service differentiation . | <input type="checkbox"/> 1 | <input type="checkbox"/> 2 | <input type="checkbox"/> 3 | <input type="checkbox"/> 4 | <input type="checkbox"/> 5 | <input type="checkbox"/> |
| 8. EDI helps/would help to generate competitive advantage for the firm. | <input type="checkbox"/> 1 | <input type="checkbox"/> 2 | <input type="checkbox"/> 3 | <input type="checkbox"/> 4 | <input type="checkbox"/> 5 | <input type="checkbox"/> |
| 9. EDI is compatible/would be compatible with our supplier relationships . | <input type="checkbox"/> 1 | <input type="checkbox"/> 2 | <input type="checkbox"/> 3 | <input type="checkbox"/> 4 | <input type="checkbox"/> 5 | <input type="checkbox"/> |
| 10. EDI fits/would fit our organisation's existing operating practices . | <input type="checkbox"/> 1 | <input type="checkbox"/> 2 | <input type="checkbox"/> 3 | <input type="checkbox"/> 4 | <input type="checkbox"/> 5 | <input type="checkbox"/> |
| 11. EDI fits/would fit our organisation's work style, values and beliefs . | <input type="checkbox"/> 1 | <input type="checkbox"/> 2 | <input type="checkbox"/> 3 | <input type="checkbox"/> 4 | <input type="checkbox"/> 5 | <input type="checkbox"/> |
| 12. The EDI format and standard is/would be compatible with existing hardware and software in our organisation. | <input type="checkbox"/> 1 | <input type="checkbox"/> 2 | <input type="checkbox"/> 3 | <input type="checkbox"/> 4 | <input type="checkbox"/> 5 | <input type="checkbox"/> |
| 13. The resultant benefits of EDI outweigh/ <u>would</u> outweigh the costs of the initial investment (hardware, software & system development). | <input type="checkbox"/> 1 | <input type="checkbox"/> 2 | <input type="checkbox"/> 3 | <input type="checkbox"/> 4 | <input type="checkbox"/> 5 | <input type="checkbox"/> |
| 14. The resultant benefits outweigh/would outweigh the cost of training users to make effective use of EDI. | <input type="checkbox"/> 1 | <input type="checkbox"/> 2 | <input type="checkbox"/> 3 | <input type="checkbox"/> 4 | <input type="checkbox"/> 5 | <input type="checkbox"/> |
| 15. The resultant benefits of EDI outweigh/ <u>would</u> outweigh the cost of integrating EDI with other systems. | <input type="checkbox"/> 1 | <input type="checkbox"/> 2 | <input type="checkbox"/> 3 | <input type="checkbox"/> 4 | <input type="checkbox"/> 5 | <input type="checkbox"/> |

C. Your Perceptions of the Influence of Management and External Factors

Please mark one of the five blocks, using a tick or a cross, for the following statements.

	Strongly disagree	Disagree	Neutral	Agree	Strongly agree	<u>Don't know</u>
1. Senior management is/would be committed to the success of EDI in the organisation.	<input type="checkbox"/> 1	<input type="checkbox"/> 2	<input type="checkbox"/> 3	<input type="checkbox"/> 4	<input type="checkbox"/> 5	<input type="checkbox"/>
2. Senior management is/would be involved in decision-making regarding EDI.	<input type="checkbox"/> 1	<input type="checkbox"/> 2	<input type="checkbox"/> 3	<input type="checkbox"/> 4	<input type="checkbox"/> 5	<input type="checkbox"/>
3. Senior management is/would be involved in monitoring EDI's progress in our organisation.	<input type="checkbox"/> 1	<input type="checkbox"/> 2	<input type="checkbox"/> 3	<input type="checkbox"/> 4	<input type="checkbox"/> 5	<input type="checkbox"/>
4. There is/would be a senior line sponsor for EDI.	<input type="checkbox"/> 1	<input type="checkbox"/> 2	<input type="checkbox"/> 3	<input type="checkbox"/> 4	<input type="checkbox"/> 5	<input type="checkbox"/>
5. EDI is/would be considered a strategic necessity by our company.	<input type="checkbox"/> 1	<input type="checkbox"/> 2	<input type="checkbox"/> 3	<input type="checkbox"/> 4	<input type="checkbox"/> 5	<input type="checkbox"/>
7. EDI is strategic to the retail industry as a whole.	<input type="checkbox"/> 1	<input type="checkbox"/> 2	<input type="checkbox"/> 3	<input type="checkbox"/> 4	<input type="checkbox"/> 5	<input type="checkbox"/>
8. Our key suppliers are using or are likely to be using EDI soon.	<input type="checkbox"/> 1	<input type="checkbox"/> 2	<input type="checkbox"/> 3	<input type="checkbox"/> 4	<input type="checkbox"/> 5	<input type="checkbox"/>
9. Our use of EDI is/would be required by our key suppliers.	<input type="checkbox"/> 1	<input type="checkbox"/> 2	<input type="checkbox"/> 3	<input type="checkbox"/> 4	<input type="checkbox"/> 5	<input type="checkbox"/>
10. Our key competitors are using EDI.	<input type="checkbox"/> 1	<input type="checkbox"/> 2	<input type="checkbox"/> 3	<input type="checkbox"/> 4	<input type="checkbox"/> 5	<input type="checkbox"/>

APPENDIX B: TESTS OF MODEL ASSUMPTIONS

B1: Multiple Discriminant Analysis

The assumptions of discriminant analysis and tests of those assumptions are as follows (Hair et al, 1979; Statistica for Windows Reference Guide, 1995):

1. The data for the variables represent a sample from a multivariate normal distribution. The Shapiro-Wilk test was used to test the assumption of normality. The table below indicates that the hypothesis of a normal distribution can not be rejected for the variables *Relative Advantage*, *Senior Management Influence* and *Influence of Key Suppliers*. Therefore this assumption is violated for most of the variables. Even though discriminant analysis is regarded as a robust test, this means that the results should be interpreted with caution.

Table B.1: Normality Test Results for All Variables

Variable	N	Shapiro-Wilk W statistic	p-level
Evaluation	37	0.877	0.001
Adoption/Implementation	37	0.848	0.000
Relative Advantage	30	0.974	0.713
Organisational Compatibility	34	0.930	0.040
Technical Compatibility	32	0.872	0.001
Relative Cost	32	0.915	0.017
Senior Management Influence	36	0.938	0.058
Strategic Importance	37	0.929	0.027
Elapsed Time	32	0.911	0.013
Influence of Key Suppliers	32	0.947	0.151
Influence of Key Competitors	33	0.874	0.001

2. The variance/covariance matrices of variables are homogenous across groups. Again, minor deviations are not important. Levene's test was used to test this assumption, which amounts to performing a one-way analysis of variance on the

absolute deviation scores (from the respective cell means). The results in Table B.2 show that the variances are homogenous across both dependent variable groups for most variables, except for the variable *Influence of Key Suppliers* (at the 5% level of significance).

Table B.2: Tests of Homogeneity of Variances

Variable	Evaluation		Adoption/Implementation	
	F	p-level	F	p-level
Relative Advantage	0.153	0.699	0.912	0.350
Organisational Compatibility	0.905	0.352	3.622	0.071
Technical Compatibility	0.337	0.567	0.021	0.885
Relative Cost	0.753	0.395	0.144	0.707
Senior Management Influence	0.094	0.761	0.341	0.565
Strategic Importance	0.525	0.476	0.061	0.807
Elapsed Time	0.146	0.705	0.945	0.341
Influence of Key Suppliers	15.664	0.001	17.451	0.001
Influence of Key Competitors	0.237	0.631	2.700	0.115

3. The means for each group are not correlated with the variances. The correlations between these two statistics were all close to zero for the groups of each independent variable (*Evaluation* and *Adoption/Implementation*).
4. The variables that are used to distinguish between the groups are not completely redundant. Tolerance values are used to test this assumption and are calculated as 1 minus R^2 of the respective variable with all other variables included in the model. Thus, it is the proportion of variance that is unique to the respective variable. Consequently, a variable is almost completely redundant when the tolerance value is close to zero. Tolerance levels can be set in STATISTICA and can be controlled for automatically. In the analysis, the tolerance levels were adequate for all variables.

B2: Multiple Regression Analysis

The assumptions of regression analysis and tests of those assumptions are as follows (Neter et al, 1988; Statistica for Windows Reference Guide, 1995):

1. The relationship between the dependent and independent variables is linear. An examination of scatter plots of the dependent variable and each independent variable can confirm or dispute this assumption. The scatter plots indicate linear relationships and there do not appear to be any outliers.
2. The data for the variables represent a sample from a multivariate normal distribution. The same test as that done for discriminant analysis is applicable here. Again, the results need to be interpreted with caution since this assumption is not met for most variables.
3. The variables that are used as predictors of the dependent variable are not completely redundant. This assumption is the same as that for discriminant analysis and, again, tolerance limits can be set in STATISTICA. The variables all exhibited adequate tolerance values during the analysis.
4. The residuals are uncorrelated. Scatterplots can be used here to check that the residuals are not correlated with the observed or predicted values. These plots do not reveal any major signs of high correlations.