THE IMPACT OF ELECTRONIC DATA INTERCHANGE ON THE AUSTRALIAN AUTOMOTIVE INDUSTRY

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A thesis submitted in total fulfilment of the requirements for the degree of Doctor of Philosophy.

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I certify that the thesis entitled *The Impact of Electronic Data Interchange on the Australian Automotive Industry* submitted for the degree of **Doctor of Philosophy** is the result of my own research, except where otherwise acknowledged, and that this thesis in whole or in part has not been submitted for an award including a higher degree to any other university or institution.

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Information technology continues to play an increasingly significant role in the development of firms competing in the vast array of markets from those classified as global markets, such as the automotive industry, to the smaller nationally-based markets such as retailing. An objective of electronic commerce is to assist organisations to remain competitive and gain entry to markets which were previously unattainable.

This study focuses on the organisational impact of one form of electronic commerce (electronic data interchange) on the component sector of the Australian automotive industry and examines the extent to which trading partner relationships have been affected. The research investigates the extent to which the integration of electronic data interchange (EDI) with an organisation’s internal application system may facilitate specific net benefits. The automotive industry became the first Australian industry to cooperatively adopt EDI. Research to date has not adequately examined the organisational impact of the nature and extent of net benefits gained from EDI adoption.

To achieve the objective of assessing EDI net benefits, a conceptual model was developed. The model proposed that the level of EDI net benefits expected is influenced by the size of the organisation and the concentration of trade achieved within the industry via intervening links through (a) the level of senior management commitment and (b) the extent of system integration. Nine empirically testable research propositions are derived from the model, each testing the relationship between model constructs.

Data was collected from 114 component suppliers to Ford Australia in 1992 and 1994 using a repeated cross-sectional longitudinal design. Structural equation modelling using partial least squares was adopted in the analysis of the data. A pure longitudinal model together with 12 case studies of selected component manufacturers supplemented the research design.

The results of the research showed that the proposed conceptual model is a good description of the data. In particular, net benefits obtained from EDI adoption are directly determined by the size of the organisation, and the extent to which firms integrate EDI into their internal application systems. The level of net benefits is only indirectly influenced by the level of senior management commitment to the EDI project through (a) management commitment’s direct effect on integration, and (b) the direct
effect the volume of trade a supplier achieves with the automotive industry on senior management commitment and system integration.

The major benefits organisations experienced from EDI were enhanced productivity, clerical staff savings, improved data accuracy, enhanced customer service and reduced administration costs. The research showed that few suppliers gained inventory savings from EDI, a frequently claimed benefit from EDI adoption. Evidence of small improvements in product quality emerged from the results.

In summary, this research attempts to make two primary contributions to knowledge, first in providing a method by which net benefits from electronic commerce can be measured within an industry adopting electronic trading, and second, by providing organisations with the knowledge of the specific net benefits organisations could expect from EDI adoption, together with the four major factors affecting these benefits. The research concludes with possible directions for future research, in particular an assessment of the impact of incorporating financial EDI into electronic trading.
Exhibit 2.4  EDI Document Flows: in Australian Automotive Industry

Exhibit 2.5  Origin of Ford Australia’s Key Components

Exhibit 2.6  Integration of EDI with Evaluated Receipts System

Exhibit 2.7  Integration of EDI with CMMS
Chapter 1
Introduction and Research Outline

Traditionally, the organisation of business activity has centred around the well established notion of the firm. The firm, as described by Bonini (1963), may be viewed as an interconnected array of participants which includes entrepreneurs, managers, customers, employees and suppliers, linked together in some vast network of relationships. It is these relationships that have tended to receive little attention in the past from economic researchers. Economists have often treated the firm merely as a black box, in which changes in the exogenous variables within the market, effect corresponding automatic changes in the endogenous variables within the firm. These changes were assumed to lead to appropriate output changes that ultimately satisfied the wants of consumers. This reliance on the black box perception of a production function approach to analytical models of the firm has limited the focus of economists’ attention to issues such as firm behaviour and organisation (Holmstrom and Tirole 1989).

Holmstrom and Tirole (1989) extend the criticism of blindly following a black box approach in concluding that the theory of the firm has indeed been a continuing problem for economists, who have progressed the frontiers of knowledge in areas such as the analysis of market performance but have failed to fully understand the nature of firm behaviour and organisation. To fill the gap, researchers, including Williamson (1985, 1989, 1990), Aoki (1990), Barney and Ouchi (1986), Langlois (1984), Langlois and Everett (1992), Schmalensee and Willig (1989), Tirole (1989) and Eliasson (1994), have made significant contributions to the theory of the firm through principal-agent, transactions cost and property rights approaches.

However, Zeleny (1989), Simon (1991), Lamberton (1992) and Antonelli (1992b) have highlighted the need for development of the theory of the firm to include an examination of the use and role of information in revealing the nature of the black box. Lamberton (1992:64) issues a challenge to researchers, that

*There is a need to move beyond the predominantly theoretical work of the kinds inspired to date by principal-agent, transaction cost and property rights approaches.*
Lamberton (1992) advises that, ideally, empirical studies should examine the information flows emanating from observations of the market, internal organisations and the linkages that loosely bind them. Lamberton (1992:64) further suggests such studies would include ‘information linkages and their costs; a mapping of changing boundaries; and the impact of new information and communication technology.’

Other disciplines, including the behavioural sciences, have attempted to use their skills in unravelling the mystique surrounding the black box by developing theories specifically relating to how and why the relationships cited above occur and impact the endogenous factors causing changes in the nature and responsiveness of the firm. One of the major influences that has occurred, particularly within the last decade, has been the use made of telecommunications by organisations operating within the emerging global economy.

This thesis investigates the impact that electronic commerce has had on organisations in the process of the redesign of business practices.¹ Often the catalysts for business redesign initiatives are imposed regulatory pressures of government policy and self-imposed global competitive pressures felt by an industry undergoing structural adjustment. Specifically, the focus of this study is on a particular form of telecommunications integration (or electronic integration) called EDI (*electronic data interchange*) and the impact that EDI makes on changing the way that firms do business with each other. This study seeks to contribute in closing the knowledge gap relating to the use of information as identified by Lamberton (1992), by providing empirical evidence of the impact of one form of new information and communication technology on organisations.

¹ Sometimes called BPR (Business Process Redesign or Business Process Re-engineering, after Galliers 1993).
1.1 NATURE OF THE PROBLEM ADDRESSED BY THIS THESIS

The manufacturing sector has developed a growing dependence on timely information, particularly among those firms competing in global markets, and so has come to rely on the high speed transmission of data between trading partners. This sector has been one of the principal beneficiaries of the industry growth in the adoption of information technologies, in particular telecommunication-based technologies.

Telecommunications is one important part of the business infrastructure that a firm necessarily relies upon in meeting customer needs. This in turn indirectly impinges on the overall performance of the national economy in terms of national economic development. The way firms make use of the telecommunications infrastructure may directly and indirectly affect their competitive advantage within the markets in which they operate, through both the efficiency (cost-benefit) and effectiveness (quality) of how they make use of the services provided.

The adoption by organisations of these new or enhanced services will, to a large extent, depend upon the perceived benefits to be gained from adoption. Firms which trade in highly competitive domestic and international markets, expect improved methods of communications to make a direct positive contribution to their own wellbeing (i.e. produce higher profits) and to indirectly benefit the national economy through reductions in foreign debt and improved balance of payments.

In the past, telecommunications has been generally regarded by firms as simply a cost of production. While some firms still treat their expenditure on telecommunications as a cost factor, others now recognise that telecommunications is an integral part of their production process in the same way as they traditionally regarded resource inputs of land, labour and capital.

Firms that treat telecommunications as a resource find that the nature and extent of their success in business, that is, the way the firm operates and takes decisions, is directly affected by this input. In particular, the efficiency and reliability of their production process; the nature of what they actually produce (diversity and quality of product); the way they respond to customers; the way they react to competitors; the way they interact with suppliers; their ability to substitute the resource telecommunications for labour and/or other capital inputs.

In essence, the principal effect in some firms has been to significantly improve the overall business performance of the firms in not only improving the quality of their
product, but also in allowing them to extend their markets. Much of this may be attributed to the extent of electronic integration adopted by individual firms, or cooperatively within an industry.

Venkatraman and Zaheer (1989:353) define electronic integration as ‘the creation of a business network among selected firms that centrally exploit the capabilities offered by inter-organisational (information) systems’. Such technologies include electronic funds transfer (EFT), electronic funds transfer at point of sale (EFTPOS), EDI, data recognition equipment, and so on. The move toward industries embracing these technologies has in part been motivated by global industry restructuring.

1.2 WORLD INDUSTRY RESTRUCTURING

The last three decades have been characterised by substantial change throughout the international economy. The decade of the 1960s saw a period of reasonable stability, attributed by many economists to the following of Keynesian economic principles. This led to positive rates of growth for most Western countries that followed the well-established paradigms of Keynesian discipleship.

The decades of the 1970s and 1980s saw significant changes to this approach, as periods of affluence gave way to the recessionary affects of stagflation—of rising rates of inflation yet high unemployment. In fact, both the decades of the 1970s and 1980s were characterised by early periods of economic recession. This trend has continued into the 1990s.

The recession has affected most developed countries. The economist’s measure of economic progress—economic growth—has been severely affected, with some countries, including Australia, recording not just low growth but short periods of negative growth.

Western governments have reacted to such macroeconomic consequences by proposing solutions based on the latest politically accepted orthodoxy of the time. From the Great Depression until the early 1970s, Keynesian economics dominated both fiscal and monetary policy during this period. Keynesian orthodoxy was centred on government manipulation of aggregate demand and supply and may best be described as a managed interventionist policy approach.
The 1970s was characterised by a following of Monetarist principles, essentially economic policy based on the manipulation of the supply of money as the fundamental instrument of government activity. The principal exponent of this philosophy was Milton Friedman of the Chicago School of Economics. Friedman advocated, amongst other things, minimal government intervention, and a return to a classical (non-Keynesian) laissez-faire policy approach to managing the economy.

The 1980s has been described by van Tulder and Junne (1988) as a period of Schumpeterian influence, based primarily on Schumpeter’s interpretation of the theory of long waves of economic development. The theory hypothesises that in order for an economy to grow, it needs to start a new long-term upswing of economic activity. Stimulation of economic activity is achieved through the employment of new applications of technology. Early examples were the innovations flowing from the invention of the steam engine and establishment of networks of railways linking and creating major centres of population. The boom following the Second World War was, in many countries, based on the economic stimulus given to developments in the automobile and petrochemical industries (van Tulder and Junne 1988).

The problem described by Schumpeter was that once technologies had matured and investment in them had ceased, the positive economic stimulus on the economy withered away, leading ultimately to stagnation and recession. To start a new period of economic growth (a new long wave), the theory suggests a new positive economic stimulus is needed. Schumpeterian disciples propound that Keynesian, classical and monetarist approaches proposed by misguided, but well-intended economists, would simply not work today. What is currently required is a need for the production of a range of new products and investment opportunities following the successful diffusion of new technologies internationally.

**The Global Economy**

Few large international trading corporations (mostly described as multinationals or MNCs) have escaped the recessionary impacts. Recovery in each decade has been slow and led to fundamental structural reform in almost all international industrial sectors.

The relative performance of many (Western) national economies has been affected by a combination of international trends:
(a) the decline in the international significance of the USA, partly brought about by significant problems at home, but also by the relative decline in the benefits reaped from the postwar successes of mass production techniques;

(b) the rapidly rising influence of Japan as an international economic power, particularly through its investment abroad, and the permeating of new innovations originally adopted domestically; and

(c) the failure of previously successful internationalisation techniques employed by MNCs in gradually catching up with their global competitors, following very much the traditional diffusion model approach (BRIE 1991).

(d) the rise of what has become known as the Third World (Robertson 1992).

The challenge for many MNCs has been the attempt to imitate the seemingly successful Japanese innovations incorporating flexible specialisation (flexible-volume/lean-production) techniques. For any corporation or national economy, lean production has major implications as summarised somewhat oversimply by Womack et al. (1990:13) as requiring

less of everything compared with mass production—half the human effort in the factory, half the manufacturing space, half the investment in tools, half the engineering hours to develop a new product in half the time. Also, it requires keeping far less than half the needed inventory on site, results in fewer defects, and producers a greater and ever growing variety of products.

Few MNCs can ignore the challenge, which is heightened by the significance of the rapid growth in world trade which now exceeds the growth in world GDP (Butler Cox 1991b:2).

In summary, the challenge for most MNCs for meeting the necessary structural reforms of the 1990s is one of adapting to a rapidly changing global environment. This has been called the Japanisation—or more formally, the globalisation—of production through international trade and direct investment (van Tulder and Junne 1988).

The implications for the global economy (including Australia) in the 1990s and beyond suggest radical changes in: the patterns of consumption (greater range); labour processes (fewer workers required, and more control over them); heightened international competition; and the ultimate destiny of many traditional national industries (for
Australia this includes both agricultural and manufacturing products) (van Tulder and Junne 1988).

Part of the response to global pressures has been the formation of three great trading blocs—North America (including USA and Canada, and perhaps Mexico), representing about 25 per cent of world GDP; Europe (including the 12 countries making up the EC and other Western European countries (25 per cent of world GDP) plus the newly formed Eastern European countries); and the Pacific Rim (basically includes Japan, Australia and the four newly industrialised countries of South-East Asia, representing about 16 per cent of world GDP and growing the fastest) (BRIE 1988; Butler Cox 1991a).

**Globalisation of Production**

The simplest, yet perhaps naive, explanation of the processes involved in globalisation is to suggest that it means a move towards the restructuring of world markets at all levels (BRIE 1988). BRIE believes that there is evidence that this restructuring is taking place now, and implies significant changes at all levels of the international hierarchy, including global regions (the three newly developing world trading blocs), within nations themselves and throughout individual communities within these nations.
BRIE (1988:4) defines globalisation as:

rival innovators, operating in multiple dimensions from at least three national (regional) bases, the result of which heightens competition and dramatically heightens uncertainty.

In particular, it sees the end of Fordist mass production techniques as the dominant mode of organising production, and at the same time the heightening of intense competitive pressures from rival innovators and the consequent increase in uncertainty because of generated market volatility. The Australian Bureau of Industry Economics (BIE 1989) describes globalisation more simply as the recognition of the increasing interdependence of markets, industries and enterprises which transcend national boundaries. The implications follow that global participants (including corporations and governments) devise new strategies to meet the new competitive rules of the international markets. Both these definitions appear to accord more closely with Lamberton’s (1993) conclusion that the term regionalisation would be a more accurate description of world market evolution than globalisation. Lamberton suggests that globalisation, which really emphasises capital flows, is incorrectly applied when referring to the emergence of international markets.

Van Tulder and Junne (1988) and BRIE (1988) differentiate true globalisation of production from its antecedents by the nature of the coordination of its activity. Essentially, four global strategies for organising international production can be identified:

1. The Exporter Strategy
This approach is typical of larger domestic companies seeking to internationalise and expand their activities (typically through the expansion of markets) by the direct export of their products or services to other countries. Associated strategies include domestic control of financial management, planning and operations. This strategy is characterised by dispersed marketing, sales and customer services, but with little overall coordination of these functions.

This was a typical strategy of companies, such as Toyota, over 20 years ago. It was seen as a low-risk entry into the international arena.
2. The National Adaptor Strategy
The principal difference between this strategy and that of the exporter, is the dispersion of operations as well as marketing, sales and customer service. Like the exporter strategy, there is little or no coordination of activity across borders. Unlike the exporter strategy, however, there is some attempt to adapt products to meet the requirements of local markets, for example, as found with business periodicals.

3. Central Coordinators Strategy
The third prominent strategy differs from the first two in that there is a much higher degree of coordination of most activities (operations, marketing, sales and customer service) between countries. However, there is still a tendency for overall financial management, control and planning to be kept central in the original domestic base as in, for example, McDonald’s Family Restaurants and other fast food producers. Image creation becomes an important consideration by firms employing this strategy.

4. Global Coordinators
This strategy ultimately forms into what Butler Cox (1991b) calls a global web. The strategy is essentially country neutral, with overall production arrangements based on: coordination of all activities internationally; all primary value-adding activities designed to exploit a country’s local factor endowments (such as low-cost labour found in most South-East Asian locations); and ultimately, the origin or the domestic base which formed the initial thrust for internationalisation of the corporation may well disappear as the headquarters.

It would appear that few MNCs have reached full globalisation or full global coordination. Butler Cox (1991) suggest that the contenders for achievement might be Citicorp, Sony, Whirlpool, Hewlett-Packard and Ford. No doubt there will increasingly be new contenders, such as Toyota and others, which could be added to the list. However, Lamberton (1993) suggests that in accord with his definition, only IBM should be considered a contender for title of global firm.

BRIE (1988:3) stresses that:

*Globalisation by contrast to internationalisation and multi-nationalisation should be characterised by an era of multiple innovative methods which originate in a variety of places in the world.*

The first attempts at internationalisation/multinationalisation (strategies 1 and 2) typically displayed the traditional diffusion model of one basic innovator being followed by a set of followers. The competitors were generally well known. The challenge for *full*
globalisation is to adapt to a variety of innovations combined with quite different approaches to the organisation of production. The Japanese flexible-volume/lean-production model seems to fit this approach, as do the Italian and German flexible specialisation models. Although it should be stressed that while Japan is showing primary leadership in the application of these techniques, technologies to implement them have been developed in other countries around the world, for example, robotics from Europe, telecommunication networks from the USA.

**Driving Forces to Globalise**

Butler Cox (1991b) outlines a number of business imperatives that appear to be driving international companies (MNCs) to undertake full globalisation. They are:

- *economies of scale*—the push to achieve larger volume output for the purposes of reducing unit costs of production;

- *homogenisation of markets*—a drive to contain the rise in research and development (R & D) expenditures by establishing universal approaches to activities, including establishing consumer needs, fashions, advertising and distribution across national boundaries;

- *relatively open trading and financial systems of the industrialised economies*, which include taking advantage of local factor endowments such as cheap labour;

- *the changing demands of customers*—many customers are themselves MNCs, with their own changing demands which must be accommodated;

- *availability and ease of communications*—particularly the establishment of international networks in areas such as finance, advertising of products through international television facilities, the reducing cost of travel through the provision of teleconferencing facilities and other telecommunication’s applications; and

- *market fragmentation*—has involved MNCs in overcoming and commonising the varied legal, cultural and political impediments and instabilities involved in international trade, including the trading impediments of protectionist policies.

Essentially, globalisation has meant managing the risks involved in being a MNC in a rapidly expanding and complex global environment. It should be stressed that this process is not new. For a number of companies it began more than half a century ago,
when corporations like Singer, Gillette and Otis went from being an exporter to a national adaptor as they endeavoured to snare an increasing share of world markets.

**Implications From the Globalisation of Production**

If the Schumpeterian theory of long waves is accepted, Australia and much of the rest of the world will need to heavily invest in the application of new and innovative technologies to overcome the present recession—to cause a long-term upswing in economic activity that will be sustainable.

The role of governments will be to assist in speeding up technological development and the diffusion of new technologies using any innovative means at their disposal. For Australia, this has meant a substantial focus on a process of microeconomic reform, primarily through Federal Government initiatives on building infrastructure including waterfront reform, telecommunications and manufacturing (of which the automotive industry is a significant contributor). The intention is to achieve the stated objectives of improved employment (at least reducing unemployment below present levels); favourable Balance of Payments by increasing export income and improving the Balance of Trade; achieving significant improvements in the rate of economic growth, and so enhancing the overall wealth and wellbeing of all members of the national economy.

Some of the implications of globalisation, however, may not seem initially so attractive. Van Tulder and Junne (1988) suggests that analysis of the *Japanisation* of the global economy necessarily implies three things: first, fewer workers in MNCs; second, some of the labour force formerly working with MNCs will work with suppliers instead; and third, workers will have an ever reducing influence on corporate decision-making.

The move of MNCs to fully achieve globalisation implies a need to improve coordination (Butler Cox 1991b: strategy 4). This means significant restructuring of many internal operations and improvements in external relationships with trading partners. In particular, relationships between the corporation and both suppliers and customers, as well as known competitors and other third parties.

The internal restructuring of operations, suggest Butler Cox, may mean moving toward an inverted organisational hierarchy where national boundaries become blurred and the primary focus is on the product or service and how best to deliver it to customers. This relatively new, yet seemingly obvious, approach makes countries subservient to activities, drastically reducing the problems of coordination. The traditional approach
(refer strategy 2. National Adaptors Strategy) makes internal operations of MNCs and activities subservient to countries or regions.

Addressing external relationships in essence means creating opportunities for greater cooperation with both suppliers and customers throughout the value chain (Porter 1985). At times, it may mean that improved coordination of a company’s activities is enhanced by cooperating with competitors. For example, after some initial deliberate period of market domination, American Airlines offered its SABRE airline reservation system to its competitors and other third parties, claiming to have made more money from this activity than from running an airline itself. In this example, American Airlines gave up any notion of maintaining a competitive advantage, an advantage it sustained from its debut in 1963 and throughout the 1970s and 1980s. The global focus of American Airlines changed from a concentration on building systems to coordinating the use of the systems to better use the information contained within, to their competitive advantage (Hopper 1990).

A second link in establishing external relationships is the formation of strategic alliances for the purposes of establishing new markets, launching new products, and the transfer of technology (Sutton-Brady 1995).

Butler Cox (1991b) conclude that there is an unmistakable trend among leading international businesses (generally MNCs) to the increased coordination of business activities between countries (following 4. Globalisation Strategy described earlier). The clear intention is, first to make the distinction between countries less explicit and less important, and to focus on the product or service and so to take advantage of the factor endowments of the national country concerned. Second, to establish closer links with other parties through strategic alliances, joint ventures, mergers and acquisitions.

Implications for Coordination Activities: The Role for EDI

One of the key roles MNCs play in the internationalisation and globalisation process is to be carriers of new technologies. In fact, they take primary responsibility for the commercialisation of these innovations in their striving to remain competitive (van Tulder and Junne 1988).

To remain competitive and continue the process of accumulation, van Tulder and Junne (1988) outline six obstacles which need to be overcome. These are:

(a) the increasing cost of labour and achieving productivity increases;
(b) increasing capital intensity, especially increased automation;
(c) increasing pollution of the environment;
(d) increasing energy consumption (energy-intensive production brought about through *cheap* oil);
(e) increasing consumption of other raw materials and their steadily rising price; and
(f) increasing inflexibility of the production apparatus (e.g. mass production).

In overcoming these problems, suggest van Tulder and Junne, both corporations and governments looked to ways of reducing the obstacles. Indeed, *innovation* became the keyword in boardrooms and cabinet meetings. Innovation was seen to be the way ahead for developing new products and establishing new markets, while at the same time developing new production processes to reduce production costs and any associated negative side-effects.

The push for applying new technologies is likely to have a significant impact on the production process. The move by Japanese producers (especially in the automotive industry) from *Fordist* mass production to the process of flexible-volume production, involving flexible specialisation and lean-production techniques, is described in the work of the MIT study of Japanese production in Toyota (Womack *et al.* 1990).

EDI has already had an influence in many areas of the production process. In the automotive industry, both in the USA and Australia, it has been used in the logistics of production to ensure better coordination of supply and greater control over the production activity. The Japanese experience has shown that to achieve the benefits from the new production processes (lean-production, flexible-automation, including just-in-time manufacturing), greater links (and perhaps *control*) with suppliers is essential.

The process of globalisation of production, as described earlier, is unmistakably leading businesses to greater coordination of all activities. Inevitably this attempt is designed to blur the distinctions between countries and to ensure closer links with customers, suppliers, competitors and any other parties.

The role for EDI can be seen as a means to facilitate the restructuring of internal activities and external relationships of MNCs, in particular, to improving
communication with suppliers, as part of the vertical integration of the production process. Achieving benefits from supply-chain and logistics management are critical to most manufacturing processes. It is especially important in the aerospace, automotive and consumer durables sectors of the international economy.

This study attempts to contribute to the debate on the globalisation of production, particularly in regard to assessing the policy implications for a country like Australia in the restructuring process of its automotive industry.

1.3 RESEARCH OBJECTIVES

The principal objective of the research outlined in this thesis is to investigate the extent to which the integration of EDI into organisations information systems in the Australian automotive industry contributes to the achievement of net benefits. The formal research question can be stated as:

To what extent does electronic commerce (in particular EDI) change the nature of a firm’s activities through its use of people, technology and capital? In particular, in what way does electronic commerce affect the nature of internal decision making of firms, its relationship with its trading partners, its relationship with competitors, and its assessment of the market in which it operates?

The specific research questions investigated are:

1. To what extent are net benefits received by automotive component manufacturers affected by the level of management commitment to EDI adoption, the degree of system integration undertaken with internal application systems, the size of the organisation and concentration of trade on the automotive industry?

2. Is the level of management commitment to EDI adoption affected by the size of the company and the concentration of trade with the automotive industry?

3. Is system integration affected by the level of senior management commitment to integration, the size of the organisation, and the degree of concentration of trade on the automotive industry?

To assist in the achievement of the objectives of this study, and to assist in answering the research questions, a conceptual model was developed which describes the relationships between company size, concentration of trade, senior management
commitment, system integration and the net benefits component sector manufacturers may receive from EDI adoption.

Structural equation modelling and path analysis using Partial Least Squares (PLS) are applied to the conceptual model to determine how well the model fits the survey data and describes the interrelationships between model constructs. The results from the analysis are applied in testing the research propositions derived from the model. Both a repeated cross-sectional and pure longitudinal design are used.

This study differs from previous research in a number of ways. First, the study formulates and tests a model that describes the effects that company size and concentration of trade (a measure of industry dependence) have on the achievement of net benefits from EDI adoption, through their effects, either directly or indirectly, on senior management commitment and system integration. The significance of this approach is that both direct and indirect relationships can be measured, providing a more valuable insight into the interrelationships existing between model components. Torkzadeh and Xia (1992) confirm that no study has specifically examined the relationships between firm size, the use of steering committees, planning practices or top management support for the telecommunication function. This study attempts to contribute to a greater understanding of the interrelationships through an examination of the empirical evidence gained from the Australian automotive industry.

Second, the results of the research, which is undertaken in an organisational setting, provide component manufacturers of varying size and dependence with an insight into the nature of the expected benefits from EDI adoption.

Third, the study focuses on one of the most influential industries in the world, the automotive industry, an industry experiencing considerable structural adjustment.

1.4 RELATED PRIOR RESEARCH ON EDI

A range of studies covering the implementation of EDI in different industries (including Government) have been conducted in a number of countries. Clarke et al. (1990: Appendix F) summarised a number of these studies covering the USA, Canada and Australia from about 1988 to 1990. The studies were generally commissioned consultant reports, with dissemination of the results somewhat restricted. Many of the questions specifically related to reasons for using and intending to use EDI, rather than the actual impact that EDI has had on an organisation.
Perhaps the first serious study undertaken on EDI in the USA was by Emmelhainz (1990). Emmelhainz (1990:25) reports a number of survey results used to illuminate answers to particular contentions. In particular, the research highlighted the four main areas of benefits from EDI as being improved internal operations from a reduction in time, better responsiveness to customers, improved channel management, and the increased ability to compete in both national and international markets.

Many of the reported results relied on commercial sources for information. One in particular that bears directly on this study, found that ‘87 per cent of the respondents to a 1986 survey study believed that EDI improved relationships’ (Emmelhainz 1990:38), a theme picked up by Webster (1993).

Pfeiffer (1992) examined the diffusion of EDI in a broad-ranging survey covering the USA, UK and the rest of Europe. The research found that except for high volume users, EDI generally offered very little in the way of immediate financial benefits. In most cases, organisations did not bother to conduct an economic assessment of the benefits they may or may not be receiving. A number of organisations took EDI as a foregone conclusion, usually because of customer demand for its use in future trading partner relationships. The study found evidence for strategic benefits of EDI, citing respondents claiming a positive impact on customer service. Further analysis showed that EDI enabled users to avoid competitive disadvantage in contrast to suggestions that investment in EDI will in some way grant users lasting competitive advantages.

The research’s general conclusion was that few benefits were attained by companies adopting EDI. In fact, 70 per cent of the respondents indicated no impact on staff levels, and that little in the way of positive financial return was forthcoming (Pfeiffer 1992). This result is surprising, and not in accord with exploratory work conducted in the Australian automotive industry (see Mackay 1992).

In Australia, experience of EDI pioneers has been disseminated in the works of Zinn and Takac (1989), Swatman and Swatman (1991b, 1992), Swatman and Everett (1991), Swatman (1993) and Clarke et al. (1990, 1992b). Kimberley (1992, 1993a) recently completed a survey of South-East Asian countries’ EDI implementations and intentions. The Zinn and Takac study represented a thorough survey of various industry EDI implementations in Australia and New Zealand. Because of the timing of the study

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2 Pfeiffer reports a disappointing response rate of 15 per cent from his survey of 719 firms, representing 20 industries and covering 11 countries, in 1990.
(1988–89), few Australian organisations had had much experience with EDI, and so many of their conclusions related to forecasts of EDI usage and expected benefits. Most of the forecasts have proven to be quite misleading, generally and substantially overestimating the intentions of enthusiastic corporations.

The Swatman and Swatman broad-ranging studies focused particularly on the issue of integration and the benefits to be achieved from full integration of EDI into organisations’ internal application systems. On this issue of integration, Swatman and Swatman (1992:185) state:

\[
\text{while EDI per se is not a competitive weapon (except in the very short term), there is immense scope for competitive advantage to be gained from the way in which EDI is integrated into the organisation’s structure.}
\]

The surveys conducted by Clarke et al. (1990, 1992) focused on providing information about government agencies’ awareness, practices and intentions in using electronic funds transfer, electronic funds transfer at point-of-sale and EDI. Their initial study, published in 1990, was followed up by a second survey in 1992. The studies identified that there had been moderate growth in volumes within existing EDI schemes, but implementation was proceeding less quickly than respondents had expected. The systems had generally produced sufficient, and in some cases significant, benefits in terms of reduced cost, time-saving and improved client satisfaction. Many respondents regarded increased use of EDI as inevitable, but many also warned against excessively high expectations in the short term.

Chartered accountants Coopers and Lybrand (1990, 1991, 1992) surveyed Australia’s top 1,000 companies seeking various responses, including benefits received from adopting EDI. Response rates varied from 24 per cent to 26 per cent. While no specific industry data was publicly available, the two principal conclusions reached in the 1992 survey were: first, that nearly half of the respondents indicated improved speed in business transactions, and second, reductions in costs were the major areas of expected benefit, with more than half the companies surveyed expecting to increase earnings by more than $10,000 per year with EDI. The disappointing response rate, the general nature of the questions and the lack of representation by certain industry respondents, casts doubt on any worthwhile conclusions which were drawn from the surveys.

With the exception of Clarke et al. (1990, 1992) who surveyed the EDI practice and intentions of the Australian Government, and possibly Zinn and Takac (1989), all the surveys reviewed have generally been cross-industry based. Most of the benefits
following EDI adoption referred to in these surveys tended to suggest that there are benefits to be gained, or anticipated, but provided little or no actual empirical evidence in support of such claims. The contribution of these surveys is best related to outlining industry intentions to adopt EDI, including what they hope to gain from its adoption. Because of the varying state of EDI in many countries, an assessment of benefits and impacts was not always possible. In their survey of 560 Canadian enterprises, Bergeron and Raymond (1992) confirmed the absence of factual information relating directly to the impact that EDI has had on specific organisations, in particular, the assessment of benefits and costs.

This research extends the work of Swatman (1993) in particular through an examination of the Australian automotive industry’s use of EDI, by providing empirical evidence for the nature of net benefits from system integration. This study’s findings are in contrast to the reported experiences of both the European automotive industry (Webster 1994, Reekers and Smithson 1994) and the US automotive industry (Hill and Warner 1987), where significant departures from the cooperative industry development of EDI were found.

One of the objectives of this research is to test whether or not the stated industry strategy has been achieved or, at least, whether the industry has progressed in meeting some or all of the industry expectations (Department of Industry Technology & Commerce 1988). This study examines the extent to which component manufacturers have received net benefits from adopting EDI, and how trading relationships between customers and suppliers were affected following its adoption.

In recent years, a number of internal surveys have been conducted by each of the five Australian motor vehicle manufacturers of their component suppliers. Access to the survey results have normally been restricted to the organisation issuing the questionnaire. Only general comments have been released following closed industry meetings.

In August 1990, the FAPM conducted a limited survey of their membership (representing about 30 per cent of Australian component manufacturers) who were either using EDI, or seriously considering its adoption. The sample size was 31, of whom 28 were currently using EDI. Results of the survey were published in an FAPM newsletter and sent to all participating members.
This study is believed to be the first of its kind to focus on the specific impact EDI has had on trading organisations in an industry that has had such high international significance as the automotive industry.

The research strategy attempts to provide insight into the nature of the changes in the relationships both between firms (customer and supplier) and within firms, in particular, the way that EDI has changed how firms operate. This includes changes to efficiency, productivity, and quality of product.

As Venkatraman and Zaheer (1989) point out, there is a notable lack of empirical research that attempts to isolate the effects (if indeed there are any) of information technology systems (such as EDI) on business performance. Too many statements relating to the benefits flowing from the use of IT systems have relied on anecdotal evidence, which has too often developed into folklore. The stated benefits have too readily been implicitly accepted, but in reality have been largely untested. This thesis seeks to remedy this situation.

1.5 CONTRIBUTIONS OF THE THESIS

This thesis, incorporating an academic analysis of empirical evidence in assessing the net benefits organisations may gain from EDI adoption, contributes to knowledge in a number of ways. Individual organisations, particularly component suppliers in the automotive sector, whole industries, especially the automotive industry and industry sectors, may benefit from the results and conclusions presented in this study. This thesis makes a contribution to both theory and practice in a number of ways.

1.5.1 CONTRIBUTION TO THEORY

Theoretically, this thesis contributes to knowledge in four ways.

First, it adds to and extends existing theories of the way individual organisations adjust to using information technology resulting from both global and local competitive forces. In particularly, the research contributes to an unravelling of the black box notion of the nature of the firm through the construction of a conceptual model used to analyse the impact of EDI on individual organisations.
Second, the research provides confirmatory support to particular aspects of the process of EDI diffusion in a major global industry in Australia—the automotive industry.

Third, the research develops a validated instrument suitable for measuring research constructs in applied research, contributing to a theoretically more meaningful understanding of specific variables and the relationships between them.

Finally, the research allows for a comparison of empirical evidence between two directly related methodologies, the repeated cross-sectional longitudinal design and the pure longitudinal design.

1.5.2 CONTRIBUTION TO PRACTICE

Practically, this thesis contributes to knowledge in at least five ways.

First, the thesis provides evidence for the nature and extent of EDI diffusion in the Australian automotive industry.

Second, it provides organisations, particularly in the component sector of the automotive industry, with evidence of the type of benefits they may expect to gain following EDI adoption.

Third, the research provides individual organisations with a model which may be used in assessing the principal contributing factors leading to successful adoption of EDI, focusing on the extent of senior management commitment to EDI and the level of system integration of EDI with internal application systems.

Fourth, it provides evidence as to the consequences of coercively introducing cooperative technologies in highly vertically integrated industries.

Finally, it assists in dispelling the anecdotal support in much of the popular literature for EDI adoption that EDI comes without organisational adjustment.

1.6 ORGANISATION OF THE THESIS

Chapter 2 provides the contextual framework for the focus of this thesis in describing the industrial setting of the study, the world automotive industry. The chapter provides a
definition of EDI used in the study and locates it in the interorganisation systems domain of information systems research. An outline of the international experience with EDI is a prelude to a discussion of the adoption of EDI in the Australian automotive industry, the principal focus of study for this research. Chapter 2 concludes with a description of Ford Australia’s integration of EDI and some of the advantages Ford claims to have received in trading electronically with component suppliers.

Chapter 3 outlines the conceptual model used to analyse the data gathered in this study. Each component of the model is defined, before the theory underlying the relationships between component variables is presented. The chapter proposes nine research propositions to be tested in applying the model to the data.

Chapter 4 details the research design, environment and procedure followed in this thesis. The focus in the chapter is on the research instruments used to measure the model components described in Chapter 3. The chapter concludes with a summary of the validity and reliability techniques used in testing the instruments of measure.

Chapter 5 presents the results of the study by first assessing the characteristics of the collected data and then assessing the features of the statistical model used in the analysis. Results of the analysis are presented and used in testing each of the nine research propositions described in Chapter 3.

Chapter 6 summarises the major findings of this study and provides conclusions for theory and practice based on the evidence from the model and case study results presented in Chapter 5. The chapter concludes with a summary of perceived limitations of the study and suggestions for the direction of future research activity.
Chapter 2

The Industrial Setting

The previous chapter outlined the principal focus of this study, together with a statement of the formal research question. This chapter describes the industry setting for the study by delineating the characteristics of the automotive industry, government policy objectives for the automotive industry, and the nature of EDI integration within Ford Australia. The chapter is divided into four sections. Section one describes the characteristics of the automotive industry; section two defines EDI and its location within interorganisational systems; section three examines EDI’s global perspective, through an exploration of global strategies; section four describes the introduction of EDI to the Australian automotive industry; and section five examines the extent of EDI integration within Ford Australia. A summary of the chapter concludes Chapter 2.

2.1 THE AUTOMOTIVE INDUSTRY

2.1.1 INDUSTRY STRUCTURE

The World Automotive Industry

At the beginning of the 1990s, the international automotive industry consisted of just over 150 active motor vehicle manufacturers producing around 50 million passenger cars, vans, trucks, buses and other commercial vehicles annually. The top twenty-five manufacturers compete on an international scale and together produce about 90 per cent of world production. Over 100,000 suppliers provide original equipment (OE) parts and accessories to the assembly lines and the aftermarket (principally spare parts).

The industry is dominated by six major companies—General Motors, Ford, Toyota, Volkswagen, Nissan, and Chrysler. Motor vehicle production is the world’s largest industrial activity, accounting for approximately two per cent of the world’s GNP or approximately $600 billion in total revenues (Thompson 1992). Although world...
recessionary effects saw demand for new motor vehicles fall in the early 1990s, contributing to a slump in world car production to under 50 million vehicles in 1991, recent increases in sales in many countries have seen a resurgence in total production approaching the output levels of the 1980s.

In 1990–91, two thirds of all motor vehicles were produced in four countries: Japan, the USA, West Germany and France. Perhaps the greatest changes in the automotive industry have been reflected in the changes in market share. The traditional dominance of USA producers lasted until the early 1970s, when domination of the global car market by the Japanese occurred. At the end of the Second World War, the USA produced 75 per cent of the world’s motor vehicles, but by 1988 it accounted for less than 25 per cent of total production (Thompson 1992:583).

Lethbridge (1992:3) reports nine Japanese companies operating internationally in 1990, who jointly held a 30 per cent share of the global market, aiming to achieve a 35–40 per cent share by the year 2000. While the market for motor vehicles may be considered mature, overcapacity in production has been estimated by Womack et al. (1990:11) at about eight million vehicles per year, a factor which has caused many vehicle manufacturers to reassess their global operations as the 1990s world recession continued to reduce their revenues. One significant response to the overcapacity problem was a reassessment of the number and range of models on the market, which by 1990 had proliferated in response to increasingly diverse buyer requirements and preferences.

The global response to reduced sales and increasing costs—problems which particularly hit the USA-based manufacturers—was the establishment of joint ventures between producers (e.g. Ford and Nissan; General Motors and Toyota; Chrysler and Mitsubishi) to take advantage of economies of scale from longer production runs. This was particularly important in countries where production runs were insufficient to allow manufacturers to remain competitive. This was manifest in countries like Australia where domestic markets are relatively small, and export sales insufficient to make a significant impact on reducing unit production costs.¹

The Japanese introduction of lean production, with its roots in the 1950s, has developed into a formidable challenge to the more traditional mass production methods during the last two decades. With its emphasis on flexible manufacturing systems and the application of robotics, lean-production has almost completely displaced the traditional orthodoxy of mass production, so characteristic of the non-Japanese manufacturers. The

¹ Only Ford, GMH and Toyota achieved viable annual sales of 100,000 units in the 1980s.
ability of the Japanese producers to dominate the world market for motor vehicles sent shockwaves throughout the industry. The traditional (non-Japanese) manufacturers were forced to respond to the Japanese challenge. This they did, by adopting some of the same techniques pioneered by Toyota (Womack et al. 1990). The emphasis on lean production is facilitated by just-in-time (JIT) inventory management systems with their associated kanban system.  

Like their international counterparts and as subsidiaries of the largest multinational car manufacturers, the five Australian vehicle manufacturers sought to transform their local assembly plants from the traditional mass production techniques to lean manufacturing procedures based on JIT systems. However, unlike their Japanese counterparts, the Australian subsidiaries were not nearly so vertically integrated. This meant dealing with suppliers who were generally independent of their customers and often themselves subsidiaries of overseas-based multinationals.

**The Australian Automotive Industry**

Although only a small part of the global motor vehicle industry, the Australian automotive industry represents Australia’s largest manufacturing industry. Vehicle production contributes substantially to GDP, and accounts for approximately 6 per cent of direct employment in the manufacturing sector, with an annual turnover of around $8 billion.

The five (now four) local vehicle manufacturers are subsidiaries of much larger transnational corporations based in the USA or Japan (Ford, GMH, Mitsubishi, Nissan and Toyota). If the industry was to survive in Australia, it needed to significantly improve its international competitiveness by improving its efficiency. A number of reforms were considered, which included the adoption of EDI, electronic funds transfer (EFT), bar coding and common part numbering (personal communication with FAPM). Each proposed reform was viewed by the industry as a key element of automotive industry strategy, seeking to improve both the efficiency and quality of production in order to progress the objective of international competitiveness. The challenge of the Japanese producers’ drive for flexible production meant that Australian vehicle producers had to either meet the challenge or simply cease local production altogether.

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2 JIT inventory management benefits manufacturers by considerably reducing stocks of components and subassemblies and increasing the flexibility of the product mix, allowing production of vehicles almost on demand. Supplier inventories are expected to be reduced in line with those of their manufacturing customers. The Kanban pull system of production is used to facilitate JIT management and may be used in conjunction with EDI (AIA 1993).

3 In 1991, Ford seriously contemplated closing its Broadmeadows factory, relying on imported cars in much the same way Nissan actually did in October 1992 when it closed its Australian assembly plants.
According to the evidence provided by the Automotive Industry Authority (1994), a major change in productivity in the Australian automotive industry occurred between 1990 and 1993.\(^4\) Productivity rose by 31 per cent in the period 1992–93. The Authority’s research suggested that there were potentially three contributing factors to the productivity improvement. The first was through the combined effect of improved output of 7.6 per cent and a labour force significantly reduced by 17.8 per cent. The second potential contributor was increased investment in productive equipment without increases in total employment. Research by the Automotive Industry Authority (1994) shows that investment was not a significant contributor to the productivity increase, especially as investment in both the assembly and component sectors was half that of the period 1987–88.

The Authority concludes that the third and major factor in improved productivity is the adoption of lean manufacturing practice by local assemblers and component manufacturers. The concept and implementation of lean manufacturing practices has been widely reported (see Womack et al. 1990; Berggren 1992; AIA 1992; Keller 1993; Hogg 1993; Womack and Jones 1994). The Japanese success from this practice has stemmed from integrating lean production techniques throughout all aspects of vehicle manufacturing, from initial development to final marketing. This process includes research and development, production and stock management, purchasing and supplier alliances, as well as the organisation of improved customer relations and a high degree of senior management commitment (Womack et al. 1990; Hogg 1993).

Until 1985, the industry had been substantially protected by tariffs and import quotas. In 1978, the level of protection was 57.5 per cent with quotas in place to control the volume of imports. There was little incentive to seek ways of cost reductions. However, with the release of the Government policy statement in 1984, known affectionately as the Button Car Plan (or Car Plan), the industry was about to become transformed into a more globally competitive industry. Undoubtedly it was the Button Car Plan that drove the Australian automotive industry toward major productivity reform.

In January 1992, the Australian automotive industry comprised five major manufacturers with local production facilities, approximately 280–300 component parts manufacturers, and a number of motor vehicle importers and assemblers. By October

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\(^4\) Productivity is measured in two ways. First, by the number of hours required to assemble a standard vehicle. Australia’s involvement in this measure is part of the International Motor Vehicle Program coordinated by the Massachusetts Institute of Technology. Second, by the value of sales per employee, including all specialist component producers (AIA 1994).
1992, the number of local manufacturers had reduced to four following Nissan’s decision to confine its Australian operations to the reselling of imported vehicles directly from Japan.

Despite the general decline in manufacturing output in Australia, the automotive industry remains a major segment of the Australian manufacturing sector. The industry is particularly important to Victoria, where Ford Australia, GMH and Toyota have their headquarters and principal assembly plants located, accounting for 50 per cent of automotive activity. Additionally, vehicle production accounts for approximately 11 per cent of State employment and 13 per cent of annual turnover (Thompson 1992).

**Market Structure**

Exhibit 2.1 summarises the market share of passenger motor vehicles (PMVs) in the Australian automotive industry during the study period 1991–94.
Approximately three-quarters of all new vehicle sales are for passenger motor vehicles, of which about 65 per cent are produced in Australia. The remainder are imported, chiefly from Japan. The market dominance of three local producers of motor vehicles in the passenger car market, namely Ford, GMH and Toyota, is clearly shown in Exhibit 2.1. Together they account for nearly 60 per cent of all PMV sales.

Most of the producers’ trading partners are located within Australia (principally within the major capital cities of Melbourne, Sydney and Adelaide), while a few are located overseas. Irrespective of size, they all have one thing in common—the need to communicate their material requirements (car assembly line needs) to their trading partners, the component manufacturers.

In 1990, the Australian motor vehicle industry employed in excess of 63,000 people in the assembly, component manufacturing and importing segments of the PMV sector (a five-year employment peak). By the end of December 1993 and following the closure of Nissan’s plant in Victoria, total employment fell to 43,000.
Exports of vehicles and components have resulted in a growing contribution to total manufacturing revenue. The growth rate in the total value of automotive exports has reached a plateau, however, from an annual high of 56.2 per cent in 1990 ($1.0 billion) to 3.3 percent ($1.2 billion) in 1992. The high growth rate was primarily due to sales of the Ford Capri produced in Ford’s Victorian plant, destined for the US market. Despite the growth in sales, the Australian automotive industry made a combined loss on PMV manufacturing activities during the period 1990–92.\(^5\) A return to profitability occurred in 1993.

Unlike the North American automotive industry, the Australian automotive industry is relatively shallow in terms of the total number of suppliers available. Most of the

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\(^5\) The AIA (1992) reports that of the five local manufacturers, only one—thought to be GMH—made a profit.
Australian component producers supply more than one of the local car assemblers. In some cases, they produce for all four local manufacturers, including manufacturers operating in overseas markets. Communication difficulties have occurred as a result of the differing business practices of the local manufacturers. With the introduction of EDI, the industry believed these practices would become standardised.

The complexity of the automotive industry can be summarised by an address given by Robert Copley, Executive Officer of the FCAI (Federal Chamber of Automotive Industries), who stated that:

> In the car manufacturing industry, five companies produce Australian cars at about the rate of 1,500 per day. Concurrently, about 300 suppliers produce and distribute some 15 million parts for a day’s production of cars, and fifty or more suppliers of materials provide several thousand tonnes of materials to the industry. It takes one car-carrying truck about ten hours to shift three minutes of the industry’s output of finished cars. The total transport network for the industry involves thousands of sorties daily. The number of documents for ordering, forecasting, expediting, invoicing, receiving, debiting and paying, amounts to millions.

(Zinn and Takac 1989:51)

The inference of Copley’s address, is the scope for EDI to assist the automotive industry in improving its communication effectiveness and efficiency among trading partners in achieving their objective of lean and flexible manufacturing. However, it took government policy initiatives to impel the automotive industry into becoming internationally competitive.

The next section describes the principal components of government policy which set in motion the reforms undertaken by the Australian automotive industry since 1985.

### 2.1.2 Policy Objectives for the Automotive Industry

The essential elements of reform in the Australian automotive industry are contained in two Australian Government policy initiatives. The initial policy statement was released as the Passenger Motor Vehicle Manufacturing Plan by the then Minister for Industry, Technology and Commerce, Senator John Button on 29 May 1984, followed by a mid-term review completed in April 1988. The second initiative was a policy statement issued by Prime Minister Bob Hawke on 12 March 1991. This section reports the main elements of each policy statement.
The Industrial Setting

The Button Car Plan

The Passenger Motor Vehicle Manufacturing Plan came into effect on 1st January 1985 and contained five fundamental policy objectives to be achieved for the survival of the Australian automotive industry including: (a) creating a time frame in which to restructure and modernise (1985 to 1992); (b) increasing the industry’s efficiency; (c) holding down vehicle price rises to no more than rises in the consumer price index; (d) minimising disruption during restructuring; and (e) reducing job losses and providing job stability.

The principal strategies whereby these objectives were to be achieved included: increased economies of scale (reducing the number of models from 13 to 6 or less); gradual increases in competitive pressures (through progressive tariff reductions); encouragement of a stronger local industry with commitment to innovation and design skills (supplier cooperation to retain local manufacturing industries); and promotion of stronger links with the global automotive industry (promotion of a world car concept).

To assist the industry restructuring process, the Government provided direct financial support by allocating $150 million over five years for Australian design and research activities. In addition, the Government established the Automotive Industry Authority (AIA) to oversee the restructuring process (Department of Industry Technology and Commerce 1988).

The clear intention of the Button Car Plan was to reduce the PMV industry’s reliance on government assistance so as to rely more on the industry improving its own efficiency for its continuing survival. The major weapon the government adopted in achieving its stated objectives was the progressive reduction in tariffs. The 1988 mid-term review of the Button Car Plan saw tariffs immediately reduced from 57.5 per cent to 45 per cent, with reductions of 2.5 per cent annually until 1992 when the rate would become 35 per cent. Tariff quotas were also immediately abolished to further facilitate the industry’s restructuring process.

EDI adoption was one of the communication and information technologies employed by the automotive industry in its response to achieving some of the Button Car Plan’s objectives. One of the principal objectives of using EDI was to achieve efficiency in communicating the needs of the manufacturers’ production lines to the suppliers of component parts.
Electronic trading was expected to bring about a number of benefits to the industry, including improvements in general logistics, increased productivity, improved product quality, enhanced customer service, and a movement toward lower inventory requirements as manufacturers moved towards JIT production. Through industry cooperation, individual component companies were placed in a superior position to compete for overseas contracts to supply parts to non-local customers, and so assist them in gaining a potential competitive advantage directly from their adoption of EDI.

**March 1991 Motor Vehicle Industry Statement**

On 12 March 1991 the Australian Government announced that the objectives of the Button Car Plan, first enunciated in 1984, were on track and needed no fundamental change in policy direction. However, the March 1991 Statement accepted the advice of the Industry Commission for a 15 per cent tariff by the year 2000 at an annual rate reduction of 2.5 per cent. The intention of the further tariff reductions is echoed by the AIA (1992:7) report, which was to

> encourage the continued development of a more efficient industry capable of surviving at lower levels of Government assistance and able to provide more affordable and better quality cars for consumers.

The March 1991 Statement re-emphasised the initial Button Car Plan objectives and strategies, in particular, the continued reduction in the level of tariff protection. The Statement sent a clear message to the industry that in order to survive, the industry must become internationally competitive, which could only be achieved through committed improvements in overall efficiency, product quality and price.

The biggest contributor to achieving the government’s policy objectives set in train in the 1984 Button Car Plan was undoubtedly the continued introduction of lean manufacturing, with its focus on JIT manufacturing practices, and incorporating major investments in new manufacturing technology, revised work practices and reformed management policies.

One of the industry’s responses to the Button Car Plan was the establishment in November 1985 of an EDI subcommittee composed of representatives of the car assemblers, the FCAI (Federal Chamber of Automotive Industries) and component suppliers, the FAPM (Federation of Automotive Products Manufacturers).
Before discussing the actual implementation of EDI in the Australian automotive industry, the following section outlines a working definition and provides a framework for understanding the organisational impact of EDI on the automotive industry.

### 2.2 DEFINITIONS AND CONCEPTS

Monczka & Carter (1988:2) define EDI as ‘the direct electronic transmission, computer to computer, of standard business forms between two organisations’; Kimberley (1991c:13) prefers the definition that EDI ‘involves the electronic transmission from one computer system to another of any common business information, for example, orders, invoices, payment instructions, schedules and manifests’; Sokol (1989:12) states that EDI ‘is the inter-company, computer-to-computer communication of standard business transactions in a standard format that permits the receiver to perform the intended transaction’; finally, Emmelhainz, (1987:2) defines EDI simply as ‘computer-to-computer transmission of standard business data’. Most of these definitions capture some of the elements of EDI, but the definition preferred for this study is:

*EDI is the paperless transmission of business documents between independent trading partner application systems, via a computer and communications network, in an agreed standard message format.*

The key focus of the above definition is that EDI does not directly involve any use of paper, uses a computer (and telecommunication facilities) for access between trading partner application systems, and messages are in a pre-agreed, preferably internationally agreed, standard formats.  

Benjamin et al. (1990) provide a taxonomy to examine the range of electronic communication technologies that are classified as interorganisational systems (IOS). This divides IOS into one of four classes depending upon the cell which best explains the main focuses of that system. Exhibit 2.2 summaries the taxonomy of Benjamin et al. (1990).

#### Exhibit 2.2 Interorganisational Systems

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6 The term trading partner is used here in its broadest sense, to include commercial information exchanges, as between customers and suppliers, and exchanges between organisations and regulatory bodies, such as government customs services, and intra-firm exchanges between subsidiaries.
<table>
<thead>
<tr>
<th>Transaction Processing</th>
<th>Electronic Hierarchies</th>
<th>Electronic Markets</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cell 1</td>
<td>American Hospital Supply</td>
<td>Cell 2</td>
</tr>
<tr>
<td></td>
<td></td>
<td>American Airlines SABRE System</td>
</tr>
<tr>
<td>Cell 3</td>
<td>CIGNA’s Risk Info Services</td>
<td>Cell 4</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Planning Research Corporation’s Reality Systems</td>
</tr>
</tbody>
</table>

Cell 1 is the classification into which EDI falls. It is characterised by automated, routine transactions between trading partners. A well-known example is American Hospital Supply and Baxter Health Care).

Cell 2 characterises an information technology that supports electronic market place trading with routine purchases being made from a range of options. The best known IOS in this category is SABRE—American Airlines reservation system.

Benjamin et al. (1990) differentiate Cell 3 from Cell 1 (EDI) on the grounds of non-routine, task-related IOS systems. CIGNA’s Risk Information Services allow their corporate customers access to their computer for the purposes of ad hoc data analysis.

Finally, Cell 4 describes IOS systems that create a marketplace for many buyers and sellers involved in non-routine transactions. Planning Research Corporation’s real estate system is an example of a marketplace IOS that allows member agents access to a range of services including listings and sales analysis searches.

Benjamin et al. (1990) make the distinction based on the above taxonomy because too often non-EDI interorganisational systems are classified as EDI, leading to misleading conclusions. Benjamin et al. (1990) conclude that EDI applications are the most common form of IOS and are a natural outgrowth of existing ways of working.

In their review of literature on EDI and system integration, Swatman and Swatman (1992:200) point out that EDI is ‘the pre-eminent example of a cooperative information system that can still provide competitive advantage.’ EDI has the ability to enhance cooperation between organisations as well as provide a platform for use as a competitive weapon. Swatman and Swatman (1992:183) state that:
One of the most outstanding differences between the type of strategic IOS referred to by the majority of academic authors and EDI systems is that EDI gains its major leverage from cooperation between organisations to their greater benefit, rather than providing an immediate competitive weapon to the using organisation.

It is worth noting what EDI does not include. EDI is not electronic mail, simple data file transfers or remote data entry. The key difference that distinguishes EDI from these three types of telecommunications systems is that EDI uses standard formats which have been agreed between two or more trading partners, and documents exchanged are usually integrated with either or both users’ internal application systems. However, these three systems may be used in conjunction with the EDI process.

Healy (1991) suggests that customers withdrawing cash from their financial institution’s automatic teller machine (ATM) are in fact participating in an EDI transaction. The application behind the scenes actually sends back a standard document that is read by the ATM.

Throughout the world there are in excess of one hundred EDI documents currently being used in document exchanges or undergoing standards development. Among the more common electronic documents are purchase orders, invoices, payment orders, requests for quotation, ship notices, receiving advices, shipping schedules, status reports, bills of lading, and planning schedules (Data Interchange Standards Association Inc, 1990).

Diagrammatically, the essential elements of an EDI system are summarised in Exhibit 2.3, using the automotive industry as the particular example. Exhibit 2.3 illustrates the key elements involved in communicating production requirements between two trading partners: Ford Australia (customer) and Hella Manufacturing, a key first-tier supplier to Ford Australia of headlamp assemblies.

Exhibit 2.3 Elements of an EDI System
Data from Ford’s MRP (materials requirements planning) application system is translated by EDI software (called Tradelink) supplied by Telstra Multimedia, into an agreed *standard* format (ANSI X.12: 830 document called a materials release schedule or MRS). The information is deposited into Ford’s *electronic mailbox* located in a Telstra Multimedia computer. This message is electronically transferred into Hella Manufacturing’s *electronic mailbox* where it is available to be read by Hella’s computer system for retranslation and ultimate direct entry into Hella’s sales order/entry application system for further processing.

When Hella is ready to transport the ordered parts to Ford, the above process is reversed. Hella sends Ford an ANSI X12: 856 electronic document called an Advance Shipment Notice (or ASN) notifying Ford of the details of delivery. Upon arriving at Ford’s receiving gate, the EDI message will have preceded the transport vehicle, allowing it to directly proceed to the assembly line to unload its contents without delay.7

There are three essential elements which support the interchange of information between trading partners in the manner described above. They are: (a) agreed standards (generally ANSI X.12 or EDIFACT), (b) translation software such as Telstra’s

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7 Before EDI and timed deliveries, it was not uncommon for suppliers’ trucks to wait up to three hours before unloading could commence.
Tradelink software and (c) a mailbox system, of which Telstra Multimedia’s value added network service is merely one example of a number of available services.

The following section briefly reports the known extent of EDI overseas, as a precursor to discussing EDI within Australia, and especially EDI’s introduction into the Australian automotive industry.

2.3 SURVEY OF PREVAILING BELIEFS OF EDI

The first use of EDI in the world is reported by Baker (1991) as originating during the Berlin Airlift. Facing a massive logistical problem in flying in relief supplies to the blockaded city, Edward Guilbert, traffic director for US operations, developed standardised forms and documents which he communicated between forwarding and receiving centres using telex facilities.

Well after the war, Guilbert continued developing the techniques he started during the airlift, founding the Transportation Data Coordinating Committee. One of the committee’s principal roles was the development and publication of standard computer formats for data exchange between companies. This committee, which later became known as the Electronic Data Interchange Association (EDIA), assisted in the establishment of over 150 different types of data communication transaction sets. The ANSI X12 (American National Standards Institute) standard is one of the most significant outcomes of the association’s efforts. This standard is currently the principal standard for EDI communications in North America and Australia. Europe has primarily adopted the United Nations sponsored EDIFACT (EDI for Administration, Commerce and Transport) standard, and has recently gained the cooperation of ANSI for the UN/EDIFACT standard to ultimately replace the more restricted ANSI X12 standard for all new EDI documents.

Indications are that EDI is used as the primary form of electronic commerce in most advanced countries of the world. The USA appears to be the single largest user of EDI. Most European countries are also utilising EDI services in inter-European trade and in direct trade with the USA. The rapidly growing Asian-Pacific economic region has also taken significant steps towards adopting EDI as the primary method for facilitating international trade.

Reliable estimates of EDI adoption are difficult to confirm. However, Kimberley’s (1991b:11) research provides consistent estimates claiming a worldwide total of about
20,000 EDI users in 1989. In 1993, Kimberley (1993a) estimates 120,000 users of EDI covering three trading blocks, comprising:

<table>
<thead>
<tr>
<th>Region</th>
<th>Users</th>
</tr>
</thead>
<tbody>
<tr>
<td>North America</td>
<td>60,000</td>
</tr>
<tr>
<td>Europe</td>
<td>30,000</td>
</tr>
<tr>
<td>Asia-Pacific</td>
<td>30,000</td>
</tr>
<tr>
<td>Total</td>
<td>120,000</td>
</tr>
</tbody>
</table>

At anticipated growth rates, by 1998, Kim berley estimates a total of 540,000 users of EDI worldwide, comprising:

<table>
<thead>
<tr>
<th>Region</th>
<th>Users</th>
</tr>
</thead>
<tbody>
<tr>
<td>North America</td>
<td>200,000</td>
</tr>
<tr>
<td>Asia-Pacific</td>
<td>200,000</td>
</tr>
<tr>
<td>Europe/E. Europe and South Africa</td>
<td>130,000</td>
</tr>
<tr>
<td>Other areas</td>
<td>10,000</td>
</tr>
<tr>
<td>Total</td>
<td>540,000</td>
</tr>
</tbody>
</table>

The following survey of EDI global practices includes the United States of America, Europe, the Asian-Pacific region (particularly China, Singapore, Japan, and Hong Kong), concluding with the present experience in Australia.

### 2.3.1 EDI IN UNITED STATES OF AMERICA

Many authors on the subject of EDI, including Sokol (1989), Kimberley (1991c), Baker (1991), Keen (1991) and others, begin by concluding that EDI is either becoming, or has become, an accepted way of transacting business between trading partners. Estimates from Emmelhainz (1990:3) put the number of US firms using EDI in 1988 at about 5,000. Recent estimates place the number of US firms using electronic trading at approximately 50,000, as EDI becomes accepted as a more efficient alternative to paper-based methods of information exchange (personal communication with EDI Council of Australia).

Emmelhainz (1990) reported that in 1988, just over a third of all Fortune 1000 organisations were using EDI. The Gartner Group estimated that there were between 8,000 and 11,000 EDI users in 1989 alone (Baker 1991:9), providing support for Emmelhainz’s estimate of EDI users.

The principal industries using EDI in the USA include the transportation, automotive, chemical, retailing, grocery, and healthcare sectors, including the US Federal Government and its many agencies. Sokol (1989) predicted that by 1993, 70 per cent of
all companies in the USA would have made significant use of EDI as the primary method of inter-firm exchange of trading documents (Sokol, 1989:xi). The recent impact of the world recession in the USA has understandably reduced the growth in EDI adoption.

The only conclusion that may be drawn from the statistics reported above, is that EDI in the USA is being used by a number of firms in many industries and that more organisations are likely to adopt the communication and information technology that writers claim will revolutionise the way business is transacted. The reliance on the participant work referenced above reflects, to some degree, the state of empirical research in the field of electronic commerce until the early 1990s.

**Early Developments in the US Automotive Industry**

One of the earliest industries to adopt EDI was the US automotive industry. This pioneering work followed the partnership between General Motors (GM) and PPG Industries (a major supplier of windshields, paints, adhesives, fibreglass and body parts to the automotive industry) in the early 1960s, and is credited with facilitating the growth of EDI in the automotive industry, eventually flowing on to other industries (Baker 1991).

By the mid-1970s GM incorporated transport consolidators into the EDI process. During the same period, GM attempted to incorporate the banking sector into the payments side of its business through a modified electronic funds transfer (EFT) process. In essence, this completed the ordering-delivery-payment loop that many industries are still striving for today.

The EDI process, started in the automotive industry, launched GM into the EDI business itself. A GM subsidiary, called Electronic Data Systems (EDS), was established to provide all GM’s electronic trading requirements. The magnitude of the traffic is illustrated by Baker (1991), and includes more than 6,000 customers in 26 countries; 730 million transactions per month; 12 million long distance calls every month; connections to 280,000 data terminals; and by the end of 1992, an additional 2,000 European suppliers were expected to be added.

EDI links between Chrysler Corporation and its suppliers began in the 1970s, slightly after GM. As giants of the automotive industry, each followed their own independent design and document standards. The consequence of such an approach (and unlike that ultimately followed in the Australian automotive industry) was the requirement for each
supplier to purchase and use different software, apply varying standards of data communications, and to follow differing business rules for each customer. It was not until the establishment of the Automotive Industry Action Group (AIAG) in 1981 that a standard method of EDI communication was established throughout the US automotive industry.

In addition to the standard use of EDI for electronic trading, Ford uses EDI during the process of the design of component parts to be manufactured by its suppliers. Instead of sending error-prone out-of-date paper-based blueprints, Ford engineers are able to electronically transmit their designs to their selected supplier for confirmation and modification, in the knowledge that both customer and supplier are working on the same version of the plans.

Baker (1991) suggests that much of the move toward using EDI in the automotive industry is due to one word—Japan. In meeting the Japanese challenge, EDI was one of the applications used by the US automotive industry to improve the quality, efficiency and competitiveness traditionally found in Japanese automotive factories.

Kimberley (1993) outlines what he considers is the current status of EDI in North America: in the USA, there are approximately 60,000 users of EDI services; in excess of 10 organisations provide network services (mailbox facilities with the ability to provide direct connect and interconnect to competitor networks); and around 60 software suppliers providing the necessary EDI software for translation and interchange, primarily based on the ANSI ASC X12 standard, but incorporating available UN/EDIFACT documents.

The major industries presently using EDI in North America include: automotive industry/manufacturing; retail and distribution; railways; banking (via the North American Clearing House Association); government and health.

Throughout the USA, the principal standard is still the ANSI ASC X12 standard. Where documents are used for international trade, especially with Europe, the UN/EDIFACT standard is slowly being adopted. Clearly, the trading power of the USA keeps it in a dominant position to dictate standards, but the USA is now committed to supporting the development of the EDIFACT standard for all new documents. In Canada, there are about 10,000 users, split between 4,000 government users and 6,000 individual organisations.
A number of countries in South America and Central America are beginning to use EDI. They include Mexico, Colombia, Chile, Brazil and Argentina.
2.3.2 EDI IN EUROPE

Early Beginnings

It is difficult to be precise as to when EDI began in Europe. Kimberley (1993b) believes the early, but restricted, *EDI-like* systems such as SITA (1947) and SWIFT (1973), impacted the early development of EDI in Europe. Both these systems were designed to interchange information electronically between participating organisations (airlines and banks). The networks acted like cartels exerting strong barriers to entry, preventing outsiders from using their networks.

A number of other important events brought about the adoption of EDI in Europe, particularly for international trade. The first event can be traced back to 1961, when the United Nations Economic Commission for Europe (UN/ECE) committee on Development of Trade attempted to standardise international trade procedures and documentation (Sokol 1989).

A second significant event which took place in 1968 in the USA, saw the establishment of the TDCC (Transportation Data Coordinating Committee) under the auspices of the US Department of Defence. TDCC developed messaging standards for interorganisational communication of business transactions. These standards were the first developed in the USA for inter-company EDI transactions. However, it wasn’t until over a decade later, in 1979, that the American National Standards Institute (ANSI) officially chartered the ASC (Accredited Standards Committee) X12 to develop a standard for all inter-industry EDI transactions. The resulting standards assisted all industries and organisations in developing consistent electronic documents (Sokol 1989).

Further developments in 1983 saw the major European automotive manufacturers from the United Kingdom, Italy, France, Belgium, Sweden, the Netherlands and Germany form a committee to develop EDI standards for their industries. This committee, called ODETT EDI Standards Committee, represented the largest group of EDI users in Europe (representing the major 25 European automotive manufacturing companies).

A further initiative in 1982 saw the United Kingdom Article Numbering Association (ANA) let a tender to the British computer company ICL to develop an EDI network service for the food and wholesale/retail distribution industries throughout the UK. The network was later implemented as the TRADACOMS document standard.
In 1984, the JEDI (Joint EDI) Committee was formed to consolidate the data directories of the two competing standards in the USA, namely TDCC and ANSI X12. In the following year, it was the turn of the two automotive industry groups, one in the USA (Automotive Industry Action Group) and the other in Europe (ODETTE) to form an association that ultimately resulted in the establishment of a standard message format for the European automotive industry.

A further development in the UK was the design of a range of forms and procedures for Her Majesty’s Customs and Excise by SITPRO (the UK Department of Trade and Industry’s Simplification of International Trade Procedures). Kimberley (1993) recounts how SITPRO took a pro-active role in developing the TDI (Trade Data Interchange) document standards in response to the increased transborder flow of EDI transactions during the 1980s. This standard was later to become the UN/GTDI (United Nations General Trade Data Interchange), a precursor to the final establishment of a single international standard called EDIFACT.

In November 1985, both North American and European EDI communities representing over 20 countries met to discuss the potential of establishing a truly international EDI standard for international trade. In April 1987, following a series of subsequent meetings, the EDIFACT standard was born, and in September of the same year all voting countries unanimously declared EDIFACT a full international standard. In 1988, EDIFACT received further support when the US Custom Service announced it would fully back development of the EDIFACT standards for international business transactions.

The formation in 1992 of an economically unified Europe has opened up many opportunities for EDI. As Baker (1991:178) describes (in anticipation of a unified Europe):

> The volume of trans-border traffic will increase as companies increasingly locate facilities outside what used to be their home markets. ... companies will cross borders to compete in each others’ markets. Some analysts even expect more transoceanic competition for this business from Japan and the US.

Following the US Custom Service’s support for EDIFACT, both the UK and Australian governments announced their support for this truly international EDI standard.

The significance of the European markets for engaging in EDI is exemplified by Baker’s (1991) summary of population and trade. Baker states that Europe ultimately offers the
potential for a much larger market than the USA, with a combined population larger than the US or Japan, and an international trade three times that of the USA and five times that of Japan.

Emmelhainz (1990:212) quotes the commissioner responsible for high technology within the European Community as saying: “new technology developments are leading to cross-border information services such as EDI, which play an increasingly important role in our economic competitiveness”. Further, the European estimates made in 1990, suggested that 80 per cent of European retailers would be using EDI by 1992, an estimate not able to be confirmed, but indicative of the significance that Europeans are placing on EDI in their new, more competitive unified environment.

Webster (1993:2) concludes that ‘EDI is seen as a key tool in the management of international supply chains and in the conduct of international trading relationships’. Particularly, EDI is seen as a means of simplifying and harmonising international trade (including payments). Webster stresses, however, that such a movement involves a change in approach and a move away from competitive strategies amongst organisations to a more cooperative network of trading partners, including network providers and industry associations. Through cooperation between organisations within the trading community, EDI is seen by Europe as critical in the development of a regional competitive advantage.

Webster (1993:13) stresses the significance of developing common EDI standards in an international trade setting:

*The development of EDI standards can therefore be seen as representing a move towards an ‘international system of innovation’, in which industry and the polity form a unified constituency with a common objective, in which structures and processes are set up for collaboration between the two in developing technology and in which government explicitly provides resources and support for these development efforts.*

While an international standard is essential for trade facilitation, Kimberley (1993a) stresses that, in reality, most of all EDI transactions will remain within national boundaries, the remainder will be for trade facilitation. Until the EDIFACT standard becomes completely accepted in all electronic exchanges, national, industry and private standards will proliferate, with ANSI X12 having more users, but giving way to EDIFACT for trade facilitation.
Kimberley (1993a) estimates that the number of EDI users in Europe is around 14,000, of which at least 6,000 are in the United Kingdom. In addition, there are about 100 EDI software suppliers (including 25 in the UK) providing EDI services. The principal groups making use of EDI include manufacturing (particularly automotive), retail and distribution, with strong interest being shown by health industries. For trade facilitation, the travel, tourism and mining industries are currently the major users. Through the European Commission’s Telematique initiative, Northern Ireland was to receive funding of £800,000 for 100 companies to become EDI-enabled during 1993 (Sarson and Harris 1993).

2.3.3 EDI IN THE ASIA-PACIFIC REGION

Kimberley (1991, 1993) categorises the Asia-Pacific region’s use of EDI on the basis of those countries which have a common interest (or problem) in a particular form of EDI messaging. The four categories include the following countries:

(a) Chinese language EDI: China, Hong Kong and Taiwan
(b) Japanese type icons EDI: Japan and South Korea
(c) South-East Asian group: Singapore, Malaysia, Thailand, Indonesia and Philippines
(d) English language EDI: New Zealand and Australia

This study has chosen to review one country from each category as an illustration of the inherent common interest in EDI adoption.

CHINA

China, the world’s most populous country, has probably the greatest potential for the development of EDI. The National Coordinating Group for Promoting EDI Applications (CEC) was established in September 1991 to provide the infrastructure necessary to support the spread of EDI both locally within China and for international trade facilitation.

The major problem facing China’s adoption of EDI is the translation of international trading documents to and from the Chinese character set. For international trade, China has adopted the UN/EDIFACT standard, having successfully translated a number of ISO (International Standards Organisation) documents into Chinese.
Through ChinaPac, the necessary communications structure is expected to be in place to support 30 central switches and 6000 access points by 1995 (Kimberley 1993:8). The recently launched videotex service supports X.400 and X.500 for the provision of EDI services. However, while the infrastructure is rapidly developing, only a few EDI pilot schemes are in operation.

JAPAN

At a recent international conference in Australia, Kubota (1993), a member of the Japanese contingent, announced the growing awareness of the importance of EDI to furthering Japanese trade. Kubota’s statement would appear to be an understatement when one considers the recent historical record of Japanese business. Kimberley (1991b:23) points out that

*Japan is a country full of contradictions. It has the world’s largest telecommunications company [NTT] (also the largest company of any kind by capitalisation), and a society more concerned about information, its collection and transmission more than anywhere else in the world, but a remarkably small telecommunications market. Intensely keen in the outside world, international telecommunications services and procurement have, traditionally, been much less developed than domestic facilities.*

Following the deregulation and privatisation of NTT during the 1980s, VAN feba (VAN fever) resulted in the establishment of over 900 VANs. By the end of 1990, there were about 3,000 EDI users, all based on private or industry standards (Kimberley 1993a). Most of the applications were concentrated in the industries of machine tooling, automotive manufacturing, retailing (chain stores), shipping and transportation.

With the appointment in 1990 of a joint Japan–Singapore EDIFACT WP4 rapporteur by JASTPRO (Japanese Simplification for Trade Procedures), it was believed Japan would finally decide to adopt a truly international EDI standard for all trading documents. Kimberley (1993a) believes the tardiness in adopting international standards will cause Japan fundamental problems in facilitating international trade. Kimberley believes the root cause of the reluctance to accept international EDI standards is due to the extent of vertical integration exhibited in most large corporations known as keiretsu or corporate family.

By establishing their own proprietary networks and message standards, the keiretsu companies have in effect violated the most important feature of EDI networking—that of mutual cooperation. These companies, by locking their trading partners into their own *family* communities and out of their competitors’ trading communities, have directly
contradicted EDI principles which thrive on open systems and shared benefits. As Kimberley (1993b:12) notes: ‘we see the same principles in place with Japanese word processors and pc. operating systems’. With increasing international trade, ultimately corporations maintaining proprietary standards will face major trade facilitation difficulties.

Ultimately, it appears the keiretsu culture will penalise Japanese supply chains. Kimberley (1993a) estimates there are about 20,000 Japanese proprietary standard EDI users across a range of supply chains, with a small but growing number of around 150 or so export-oriented EDIFACT users. In trading with the rest of the world, in particular with the USA and Europe, Japan will have to adopt the two major standards—ANSI and EDIFACT—but are expected, as Kimberley calls it, to gateway overseas transactions into their own keiretsu philosophy networks.

Through the Ministry of Industry and Trade, the Japanese government has assisted in the recent creation of an Asian EDIFACT Board, comprising Japan, China, Hong Kong, Taiwan, Singapore, Malaysia, South Korea and India. The formation of a Japanese EDI Council in 1992 should assist Japanese businesses in fully adopting international EDI standards.

**SINGAPORE**

As a relatively small island-city with few natural resources, Singapore’s survival depends almost exclusively on its ability to promote trade with the rest of the world. Singapore ranks about 17th in the world as a trading nation. In order to further expand and develop its volume of trade, Singapore has devoted significant attention to removing impeding trade barriers. It was out of this desire to improve trade that EDI was so readily embraced as one of the significant technologies that would assist in achieving their goal. The initiative for EDI can be traced back to the early 1980s and the establishment of the National Computer Board (NCB) of Singapore in 1981.

The NCB’s principal focus was the creation of an educational infrastructure to rapidly increase the supply of computer professionals and to accelerate the widespread computerisation of the civil service. The number of IT professionals—systems analysts programmers and telecommunications specialists—grew from 850 in 1980 to approximately 10,000 by 1990 (Melody *et al.* 1990).

The NCB’s thrust in promoting the use of information technology in the public and private sectors has emphasised both the intraorganisation and interorganisation
applications of information technologies. This is manifested in concerted efforts to identify and develop industry-wide applications which provide EDI and other related network services to facilitate electronic linkages between organisations.

The NCB is responsible for systematically reviewing each industry sector to identify the potential for EDI applications. Some of the factors considered for each industry include the frequency and information intensity of interorganisation transactions, industry structure, regulatory requirements, extent of current computerisation and experience of similar EDI applications overseas.

Once a project has been identified, the NCB works closely with other government agencies, private sector industry groups and other key organisations in the industry to conceptualise the network applications, study its feasibility and specify functional requirements including data and document standards. Various implementation strategies are then considered and the most cost-effective means to develop and operate the network is selected.

Among the most developed EDI applications in Singapore is TradeNet and PortNet. TradeNet, which began operation in January 1989, facilitates the electronic submission of trade documents by the business community with the twenty or so government agencies which require the submission of trading documents. An EDI response from the agency is sent back to the trading party confirming the status of the approval of exports, imports and cargo clearances. The agencies also use the information generated to compile statistics to assist in decision making, and for the monitoring of Singapore’s port operations.

With TradeNet, the trading community is now able to gain approval for imports/exports within 15 minutes, compared to half a day or much longer previously. Agencies can submit applications 24 hours a day. The agencies have indicated productivity increases of between 20 per cent and 30 per cent being realised in documentation handling alone. Labour reductions have, in some cases, been as high as 50 per cent (Chan 1990).

PortNet is run by the Port of Singapore Authority and complements TradeNet. The system provides many one-stop information services to port users including: processing of container shipment, trans-shipment, delivery and cargo shipment documents; request for port services such as berth, pilot, tug and water; and access to information on shipping arrivals, berthings and departures and the whereabouts of vessel, container and cargo in port.
At a recent international conference in March 1993, one delegate told the audience that Singapore customs has moved from no EDI (i.e. totally paper-based clearances before 1989) to a mixture where EDI was encouraged, to a full implementation requiring all importers or exporters to be EDI capable or be granted no clearances.

The number of trading companies is in excess of 1,500, with the number of government agencies in excess of 20. A significant number of airfreight companies have become members of the service network.
Standards

Singapore has primarily accepted the United Nations EDIFACT standard for all EDI documents. The Singapore EDIFACT committee was set up in 1990 to coordinate message development, assess technical standards, provide maintenance, documentation and promotion of the standard messages used throughout Singapore. The committee has member representatives from the government, network operators, EDI software vendors and specific user groups.

In 1991, Singapore joined with Japan to form a joint Japan–Singapore EDIFACT Board (JSEB) to promote the role of EDI internationally. The building of industry-wide and international EDI networks is a major part of Singapore’s infrastructure development effort to create an efficient network of electronic data highways. Clearly, these EDI developments are intended to help increase the competitiveness of local companies and the economy as a whole.

According to Lee (1991:9), it has been estimated that Asian economies will control 42 per cent of the world’s trade by about the year 2000. Singapore is certainly proposing to be in the position to take full advantage of this growth and development in trade by having an efficient electronically-based method of communication.

AUSTRALIA

Most industries have been affected in some way by the introduction of EDI in Australia. The first use made of EDI in an Australian industry was the retailer, K-Mart, a division of the Coles Myer Group, who established an EDI pilot scheme with a small number of their suppliers. The network provider was GEIS. In mid-1990, General Electric Information Services (GEIS) became the main network provider to the whole of the Coles-Myer group.

Some of the major industries adopting EDI within the last ten years or so include:

Automotive industry: all four local manufacturers, including over 92 per cent of the 280 or so component suppliers;

Airlines: Qantas airlines claim to have established the first, and maybe only, interactive EDI facility in Australia;

Chemicals: ICI;
Clothing: Levi Strauss;

Australian Government: including Australian Customs and the Australian Tax Office;

State Governments: including Western Australia, Victoria, New South Wales and South Australia;

Local governments: including the Brisbane and Melbourne City Councils;

Retail/wholesale distribution: includes the largest retail company in Australia, Coles-Myer and Woolworths, Mitre 10 and McEwans hardware;

Steel: BHP have moved into EDI in a significant way through their development of a sophisticated computer and communications facility called a corporate gateway; at present, BHP IT provide EDI services to the Australian Government.

Engineering and heavy manufacturing: BHP Slab & Plate;

Mining/banking: CRA and the ANZ bank; Comalco and the Commonwealth Bank in financial EDI systems; the State Bank of NSW; other banks have not officially announced their intentions, but appear to be actively pursing financial EDI with some of their major customers;

Insurance: Colonial Mutual;


Transport: Brambles, TNT in association with the automotive industry in their role as freight consolidators; and

Media: television channels 7, 9 & 10 with five advertising agencies.

In 1986, an industry-sponsored body called EDICA (Electronic Data Interchange Council of Australia)8 was established to provide education and advice to its members on the implementation of EDI. Its primary role has been to provide a forum for the discussion and development of standards and policies for EDI implementation.

Australia adoption of EDI standards has generally followed those of the United States (ANSI X12 and associated X400) and more recently the developing European standard—UN/EDIFACT.

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8 In late 1994, EDICA decided to change its name to Electronic Commerce Australia (ECA) to reflect a more general emphasis on electronic commerce rather than just EDI.
EDI’s growth in Australia is partly reflected in the growth of third party value added network providers, which include: Telstra Multimedia (formally Telecom Enhanced Services following the merger of Telecom Plus and OTC Edge); BHP IT; GEIS; National Electronic Interchange Systems (NEIS); AT&T; IBM Advantis (IBM/IN); ICL; AAP Communications; Bull HN; McDonnell Douglas; T-Net (Telecom/P&O Australia joint venture); InfoNet (internationally owned consortium of providers, including MCI, Telstra Multimedia and a number of European service providers).

The current number of users of EDI services in Australia is difficult to determine, as reliable information is generally only available from the EDI vendors themselves, who classify such information as commercially sensitive and not available for publication. In 1993, Kimberley (1993a:18) estimated there were 4,000–5,000 organisations trading electronically using EDI in Australia.

The users are dominated by the notably large corporations such as Coles-Myer (12,000 food and produce suppliers of which about 150 K-Mart suppliers are using EDI with their major customer) and Woolworths, together with the NSW Government (5,000) and Australian Customs (1,500). Since 1992, the Australian Government and its associated agencies have become major EDI users (Clarke 1993). The EDI Council of Australia estimate that in 1995, there were 7,500–8,000 firms using EDI (personal communication).

2.4 EDI IN THE AUSTRALIAN AUTOMOTIVE INDUSTRY

The Australian Automotive Industry

In 1992, the Australian Automotive Industry was characterised by a range of producers, principally made up of five local manufacturers (Ford, GMH, Mitsubishi, Nissan and Toyota); approximately 300 component parts manufacturers, and a number of motor vehicle importers and assemblers.

In February 1992, Nissan Japan announced that it will no longer manufacture cars in Australia, but rather will concentrate solely on importing vehicles from Japan. As a consequence, the number of local manufacturers was reduced from five to four in October 1992. If GMH and Toyota are grouped together (because of their strategic alliance in joint product design, engineering and production), then one might claim that
the Button Car Plan has in effect achieved one of its principal aims of reducing the number of local manufacturers from five to three.

An understanding of the Button Car Plan is an important component in an understanding of the reasons for the introduction of EDI in the Australian automotive industry. It puts the reasons for adoption into context. Details of the Button Car Plan and its importance for EDI adoption in the automotive industry were discussed in section 2.1.2.

Each of the major manufacturers have well-established distributor networks responsible for the delivery of motor vehicles to customers, together with the settlement of any warranty claims on behalf of the original equipment manufacturer.

The distributor network is not directly affected by EDI, in that most car companies have direct computer links with their distributors, and so do not trade with them directly using EDI. They are therefore outside the scope of this study.

### 2.4.1 THE INTRODUCTION OF EDI

The Australian automotive industry is credited with being the first Australian industry to introduce EDI on an industry-wide basis. As indicated in Robert Copley’s address quoted earlier, there is much scope for EDI to assist the automotive industry in achieving economies in communicating material requirements between trading partners.
Early History

The motivation to use EDI in the Australian automotive industry began in about November 1985. The impetus came from a desire by the FCAI to improve the scheduling of the materials procurement process in response to the pressures imposed by the Button Car Plan. It was apparent to FCAI members (the five car manufacturers) that communications between trading partners took far too long, and the formats of documents sent to each supplier were different, even when sent to the same suppliers.

In November 1985, the first initiatives to develop EDI in the automotive industry were taken by GEIS who were keen to introduce the American package Software Express into Australia. GEIS spoke to each car company independently about introducing EDI into their organisation. Communication with the mainframe-based service in the USA was to be accomplished using GEIS Express as the communication medium.

By early 1986, a joint industry proposal assessed the feasibility of using EDI through an examination of projected costs and benefits. The examining committee consisted of the car company materials managers and three supply representatives (Pacific BBA, ACL and BTR).

Colin Hill, Mitsubishi MIS Manager, recounts that progression with GEIS was slow and less than satisfactory, and in particular, estimates of implementation costs were not forthcoming. GEIS wanted to know what the likely volumes would be, while the industry couldn’t provide such estimates until it knew the likely costs. As Colin Hill recounts, ‘it became something of a Mexican stand-off’ (personal interview).

The GEIS service involved using *time windows* on the US mainframe computers in the middle of the night. It was found from earlier trials that because the computer system only updated the mainframe about once every hour, the sending trading partner could not get confirmation that the transmission was received and technically correct for at least one hour. If an error was made, the *document* had to be retransmitted, with a wait of a further hour for reconfirmation.

Additional problems surrounded the issue of security of the proposed network, and overall network management, which ultimately led the industry to consider *rolling their own*. The first steps to achieving this end was the building of an industry EDI service called *Autolink*. 
Autolink was designed and built by the technical sub-committee of the industry’s EDI committee (composed of the technical support managers of the five car manufacturers).\footnote{Ford still use Autolink (basically a file transfer process) to communicate with their former joint venture partner Nissan, and ACI Computer Services (now Ferntree), who provided a file translation service between Ford and Telecom’s network for communication with Ford’s suppliers.} However, the EDI committee quickly realised that the major problem with Autolink was the point-to-point communication method employed to communicate between trading partners. In other words, there was no central mailbox facility (as used currently) which all users could access.

One of the local car manufacturers offered to run a central mailbox system on behalf of the whole industry, but this offer was firmly rejected principally on grounds of security.

It soon became apparent to the automotive industry that EDI would become important to other industries, including those in which it had trading partners. Telecom had already been involved with the industry about running Autolink over Telecom’s X.25 network. This development provided the EDI committee with an opportunity to discuss with Telecom the provision of EDI translation software using a central mailbox facility. By this stage, the GEIS involvement in EDI with the automotive industry had been terminated.

By Christmas 1986, the industry seemed convinced that Telecom should be contracted as the industry’s VAN supplier. A Heads of Agreement (HOG) was signed in September 1987 committing Telecom, the FCAI and the FAPM to a development, including a financial arrangement, to supplying EDI to the automotive industry. Unlike the American automotive industry, its Australian counterpart had achieved a unified industry approach to the provision of EDI services using a central mailbox facility.

Telecom, in their search for appropriate standards and software translators, approached the American Industry Action Group (AIAG). The standards they employed were based on a version of the ANSI standard. This effectively was the birth of Tradelink, and led to the creation of the Telecom business arm, Telecom Plus (now Telstra Multimedia).
Heads of Agreement

Through the Heads of Agreement, both Telecom and the industry bodies were obligated to provide certain functions. On Telecom’s part, these functions were:

(a) coordination and oversight of Tradelink development within Telecom to ensure the product meets the needs of the FCAI and FAPM;
(b) addressing network charging policies;
(c) providing the focal point for resolving network operational difficulties and for implementation of the network;
(d) evaluation of operational performance of the network;
(e) reporting to the FCAI/FAPM Committee as reasonably required;
(f) arranging for connection and training of new users;
(g) preparation and publication of user documentation; and
(h) publishing network data standards as prepared by the FCAI and FAPM.

For their part, the FCAI and FAPM obligations included:

(a) defining document data standards;
(b) formulating policies as required by the FAPM and FCAI regarding development and use;
(c) conducting reviews;
(d) defining requirements;
(e) receiving reports from the Project Manager; and
(f) providing a focus for feedback of problems within the automotive industry.

The first EDI pilot involved the five local car manufacturers, together with each of two nominated suppliers and the transport consolidator TNT. The suppliers included were Borg Warner, Yazaki Australia, Brake and Clutch, Bridgestone, Sacobell, Rainsford, Nylex Industries, ACL, Ajax, and one other firm which has since ceased production.

Following a tour of the USA and UK by two industry representatives (Colin Hill, Mitsubishi and John Warner, Telecom), a recommendation was accepted to establish a body similar to industry associations formed overseas which would oversee the development and coordination of EDI standards in Australia. Following a meeting of eight people over dinner one night, the EDI Council of Australia (EDICA) was established. The first AGM was held sometime later in June 1988.
The Australian automotive industry has been using EDI since the first *live* electronic data transmissions commenced on the 1st October 1988, to communicate the production requirements of the five car manufacturers to their component suppliers in order to meet the demands of the Australian motor vehicle market.

EDI was acknowledged by the automotive industry, in particular the FCAI and FAPM, as one of a number of technologies that would assist it in its restructuring plans following the conditions placed upon it in 1984 by the Button Car Plan. It seems reasonable to conclude that the Button Car Plan created the incentive within the automotive industry to promote competitive strategies, including EDI.

### 2.4.2 Document Flows in the Australian Automotive Industry

Exhibit 2.4 illustrates the principal flow of EDI documents in the Australian automotive industry (Hill 1989b:9).

### 2.5 Electronic Integration at Ford

Henry Ford established the Ford Motor Company in 1903. The following year, Australia saw the first Ford car, a Model A, imported into the country. To overcome high Australian tariffs on imported vehicles, Ford of Canada decided to establish production facilities for the Model T in Geelong, Victoria, in 1925. The following year, manufacturing and assembly plants opened in Geelong, Fremantle, Adelaide and Brisbane (Ford Australia 1993).

It was not until 1956, however, that Australia witnessed the first signs of major expansion by its Canadian owners. The purchase of 162 hectares at Broadmeadows, Victoria, the present site of Ford Australia’s principal assembly operations, became the home of the Ford Falcon and Ford Capri. The success of GMH’s locally produced Holden, launched in 1948, was
Exhibit 2.4
Explanation of Exhibit 2.4 EDI Document Flow Diagram

1. Planned vehicle production is calculated from orders and forecasts.
2. Long-term Material Release Schedule (MRS) is calculated, including daily schedules.
3. Using EDI, MRS data is converted into standard international format and deposited in the Tradelink electronic mailbox.
4. Using EDI, the supplier takes the MRS from the mailbox and converts data into in-house format.
5. MRS data is then used by suppliers computer systems to process and order, and plan production of warehouse parts and advise dispatch of shipping requirements.
6. Dispatch department prepares Advance Shipping Notice (ASN) message, prints bar-coded cartnote and ships material.
7. ASN message is processed by suppliers accounts receivable system.
8. Using EDI, the ASN message is deposited in the Manufacturer’s mailbox.
9. If an interstate shipment is involved the ASN message is sent to the transport consolidator who will consolidate the ASNs to represent the truckloads and deposit the consolidation ASN in the manufacturer’s mailbox.
10. The manufacturers take the supplier and consolidation ASNs from the mailbox and compares by computer ASN shipment details (parts, quantity and ETA) for variation from the MRS—takes necessary actions for variations.
11. Material arrives, labels/cartnotes are read by bar-code reader and receipt is confirmed against ASN data already in the computer system files.
12. ASN data (Receipt) is processed into the inventory management (stock control) system.
13. ASN data is processed into the accounts payable system.

Note: The ASN data is the same as that raised by the supplier dispatch clerk.

Source of Exhibit 2.4 & Explanation: Hill (1989)
considered by observers as one of the prime movers for Ford to increase its Australian content (Acutt et al. 1991). Simultaneously, the original assembly plant in Geelong was converted to produce engines, panels and other components. In 1959 the Broadmeadows plant was opened, producing the Australian-built Fairlane 500, and the following year, the first Falcon XL sedan came off the new assembly line.

Henry Ford is accredited with the development of mass production techniques, adopted by many manufacturers throughout the first half of this century. With its emphasis on standardised product design, flow-line production and minute division of labour, Ford was able to significantly reduce production costs and deliver cars at more affordable prices. By 1987, Ford was second only to GM and ahead of Toyota of Japan with 12 per cent of the world automotive market (Acutt et al. 1991). In Australia, it is the leading manufacturer of passenger motor vehicles with 23 per cent market share, followed by GMH with 21.5 per cent and Toyota with 16 per cent (see Exhibit 2.1). In a global context, Australia accounts for 2 per cent of Ford’s total worldwide factory sales, and 7 per cent of total sales outside of the USA and Canada (Ford Motor Company 1994).

Since Henry Ford’s retirement in 1945, his distinctive influence over the company has declined. However, the basic features he instilled in mass production techniques of hierarchy, tight rules, division of labour and alienating assembly-line work remained basically intact until the early 1970s. With the growing global influence of the Japanese car companies, exhibited in Australia by increasing Japanese imports, Ford and the other US-based manufacturers decided to change their emphasis on mass production and focus instead on the principal features of the successful lean manufacturing approach led by Toyota of Japan (Womack et al. 1990).

The influence of the growing Japanese domination of world car production, combined with the objectives of the Button Car Plan described earlier, assisted Ford Australia, its four competitors and the industry’s 300 or so local component suppliers to consider how the industry should respond to this new challenge. One of the industry responses was adoption of EDI.

Ford Australia was one of the first automotive companies in Australia to adopt EDI. It did so as part of an industry-wide response to the Button Car Plan. With GMH and Mitsubishi, Ford has one of the most developed EDI networks with approximately 93 per cent of its 220 trading partners (principally component suppliers) both sending and receiving electronic documents.

At Ford, EDI is integrated with four application systems:
(a) assembly plant receiving (original equipment for new car assembly);
(b) parts and accessories (primarily to support dealer requirements);
(c) accounts payable (for financial settlement with suppliers); and
(d) CMMS (new material requirements management system based in the USA).

The integration of EDI with each of Ford’s application systems is discussed in the context of both the impact on Ford and the implied impact on its 220 suppliers.

Assembly Plant Receiving (Original Equipment Manufacturing)

Ford Australia’s principal assembly plants located at Broadmeadows in Victoria, are essentially run on a JIT inventory management system. Inventories are maintained at under two days supply, compared with 11.5 days supply before JIT was introduced. The component sector, including Ford’s Geelong engine assembly plant, receive regular EDI messages from Ford’s material planning system called MATCON. The Geelong-based engine assembly plant receives three JIT messages daily, while most other component suppliers regularly receive weekly or monthly MRS documents, as material forecasts and confirmation of the required assembly-line requirements.

EDI was first introduced into the assembly operations of the plant by Ford in early 1990, when the first MRS document was exchanged with a small number of key component suppliers. By February 1991, 80 suppliers were using EDI to receive MRS documents, with 10 suppliers sending ASNs to Ford (Ford Supply Manager).

Ford Australia management state that the decision to introduce EDI into the Broadmeadows factory was not directly influenced by its parent Ford Canada (or its parent Ford US), but rather was a direct stimulus triggered by the policy objectives set in train by the Button Car Plan and the Ford US imperative to become more efficient if local assembly operations were to continue in Australia.

In December 1993, 93 per cent of parts were ordered using EDI, representing about 75 per cent of all suppliers. With the introduction of EDI to Ford, the 30 people originally handling the 7,000 paper-based schedules (the MRS) to suppliers within Ford was reduced to 12 persons. With the introduction of the ASN (from suppliers to Ford), the

10 Ford’s inventory is valued at approximately $3 million per day, with process inventory valued at around $140 million (Ford Supply Manager). While the savings flowing from JIT inventory management are important to Ford, the significantly reduced inventory level has meant a refocus by senior management on industrial relations. For example, a strike in a component supplier’s plant for more than one day would close the Ford assembly line.
number handling both the 4,500 ASN and MRS documents fell to four persons. At the two Ford assembly plant receiving stations, the number of persons required fell from five to two, with waiting hours for suppliers who send an accurate ASN to Ford reduced from up to three hours down to 20 minutes at most (Ford Supply Manager and field observation).

Integration of EDI into the assembly-line procurement system has allowed Ford to achieve a number of efficiencies, although not all can be credited to EDI’s introduction alone. Among the benefits claimed by Ford following EDI’s introduction are: increased accountability of suppliers (suppliers who fail to meet JIT schedules are required to pay the cost of installation of the delinquent parts at Ford, including any required overtime); immediate corporate benefits of reduced staff (30 down to 4); inventory savings of over $15 million; data integrity leading to increased reliance on accurate information; timely flow of information eliminating the JIC or just-in-case inventory scenario; a significant reduction in shortages as the timely flow of information from receiving the ASN has allowed the material planning system to assign locations for components directly onto the production line, so avoiding double-handling of inventory.

Internal managers at Ford have cited a number of organisational impacts from EDI adoption on current work practices. The reliance on computer technology has enhanced the need for multiskilling of both production line and clerical employees. The virtual elimination of paper-based records has caused some insecurity amongst employees as they adjust to the new methods of trading with suppliers without the ability to examine paper records. The encouragement to undertake additional training, including university degrees and diplomas, has been an attempt by Ford to overcome some of the anxieties experienced by staff with the introduction of new information technologies such as EDI.

One of the claimed benefits to flow from EDI integration with MATCON, is the reduced possession of information by different sections within Ford. The almost total dependence on the new way of doing business has meant that information is now shared via the computer screen, so that no one section or division is seen to own the information, but rather be both joint contributors and users.

The assembly operation was the first division in Ford to experience EDI, and consequently has had greater experience with the way EDI has impacted relationships with its suppliers. All five managers contacted for this study reported perceived improvements in trust between trading partners. The degree of informal discussions (or as one manager described it, informal chatter) taking place had increased, with suppliers...
and customer seemingly to be getting on and doings things cooperatively for a change since EDI was introduced.

Toward the end of the study period in December 1993, the assembly division was preparing itself for the second stage of EDI implementation, the integration of EDI into its Evaluated Receipts System which would allow payment of suppliers directly using financial EDI.

**Parts and Accessories (P & A)**

At the end of 1993, approximately 160 local suppliers, representing 40 per cent of total suppliers, were trading with Ford P & A electronically, and were increasing at the rate of about six per month. All 160 suppliers received MRS documents at the rate of 10,000 transactions per month, representing 80 per cent of parts by value. Additionally, 56 per cent sent ASNs to Ford at the rate of 2,000 transactions per month.

Ford management claim the introduction of the ASN (which did not have a paper counterpart before EDI) has helped identify specific problems in the daily ordering system before they fully impact P & A inventory. Of the 103,000 parts and accessories kept in stock, about 50,000 originate from Japan (see Exhibit 2.5 showing the origin of key parts for Ford assembly and
Exhibit 2.5
Ford P & A divisions). Introducing EDI to the P & A division has allowed lead times in international ordering to be reduced from a monthly to a weekly basis, facilitating a move closer to JIT ordering of parts and accessories. The customs clearance document created by Ford from the ASN is used for entry into the Australian Customs EXIT system.

The P & A manager reports inventory savings evidenced from a reduction in value from $67 million in 1990 with a 92 per cent fill rate, down to $52 million with a 94 per cent fill rate.11 The importance of reduced inventory should become apparent as Ford resources an increasing number of parts from suppliers in Japan. Reducing tariffs has been one of the catalysts in a continuation of this trend.

In summary, EDI, particularly through the use of the ASN document, has enhanced inventory management through a transition toward JIT practices, incorporating both local and international suppliers of parts and accessories, and has contributed to a significant lowering of inventory costs.

**Accounts Payable**

The accounts payable division of Ford Australia is not a direct user of EDI, but rather feeds off the EDI system through the information supplied in the ASN. Eventually, direct links to the four major Australian banks, coupled with the EDI document *Remittance Advice*, will complete the business loop between the customer sending a supplier an MRS document requesting parts; the supplier sending the customer an ASN prior to shipment; and finally, the supplier receiving a remittance advice that its bank has received payment. Exhibit 2.6 illustrates the supplier payment system incorporating the information provided by the ASN electronic document.

Financial management reports improved relationships both within Ford and between Ford and its suppliers. The use of the information supplied by the ASN has enforced a greater discipline on all systems and encouraged the resolution of common problems, once deemed the province of the *owners* of the information. The Manager, Office Services and Disbursements, stated that before the ASN information was available, queries initiated by staff in

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11 The per cent fill rate is a measure of how efficiently the P & A division can meet customer requirements (i.e. the Ford dealers) when an order for parts is initially placed with Ford P & A.
2.6 Integration of EDI with Ford’s Evaluated Receipts System
accounts payable to staff in receiving and control caused considerable conflict. Receiving always felt blamed for any errors and subsequent requests for further information. Now that the information is cooperatively shared, the quality of relationships has improved markedly, as has the resolution of those problems.

**Common Manufacturing Management System (CMMS)**

The fourth division in which EDI impacts Ford operations is the new common manufacturing management system or CMMS. CMMS is a computer-based application system located in the USA to provide Ford’s own component manufacturing plants with the same ability for ordering parts for manufacturing as does the local assembly plants. The key element of CMMS is EDI.

CMMS was established by Ford USA at a cost of US$275 million. Ford Australia became the 62nd plant to install and launch CMMS on 31 December 1993, at a cost of US$2.8 million. The system uses a combination of international fibre optic cable links and satellite telecommunications facilities between Australia and the USA. Three EDI documents are integrated with CMMS, the ANSI X12: 830 MRS, 856 ASN and the 861 RC (Receipt Confirmation). Each supplier to Ford manufacturing requires the ability to receive and to send six transactions. Exhibit 2.7 shows where information from the three EDI documents is integrated into the CMMS system.

The primary benefit of the CMMS system to Ford manufacturing is the application of the information provided by the ASN. As the system has only been in operation since early 1994, Ford management expect similar benefits to flow from EDI’s integration into CMMS as for the assembly operation.

**2.6 CHAPTER SUMMARY**

This chapter has provided a contextual framework for this study by first presenting an overview of the automotive industry’s industrial setting in Australia, including the policy initiatives of the Australian Government which

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12 Principally Ford Plastics Plant (Broadmeadows), Basic Manufacturing Operations Plant (Geelong), Broadmeadows Sub Assembly Plants and Castings Plant (Geelong).
2.7 Integration of EDI with CMMS
engendered change in the industry. Second, EDI was defined and placed in the context of interorganisational systems. Third, the scope of EDI use in the three major trading blocs of the USA, Europe and the Asia-Pacific region was briefly outlined. Fourth, the introduction of EDI to the Australian automotive industry was outlined. Finally, the nature of EDI integration at Ford Australia, and between Ford and its component suppliers, was presented as the particular case for this study.

The next chapter outlines the conceptual model and research propositions used in testing the principal research question outlined in Chapter 1.
Chapter 3

Research Propositions and the Conceptual Model

After establishing the theoretical foundation for this study, the conceptual model and the fundamental research questions to be tested are outlined. The importance of the conceptual model in the diffusion of EDI both within an organisation and an industry sector, such as the components sector, is highlighted.

3.1 CONCEPTUAL MODEL

3.1.1 THEORETICAL FOUNDATION

Research performed during the late 1980s and early 1990s describes the type of benefits an organisation can expect to gain from adopting EDI (see Kimberley 1991c; Sokol 1989; Baker 1991; Emmelhainz 1990). The thrust of most of this research was that benefits automatically flow from adopting EDI. However, there is little evidence to support this assertion. The purpose of this current research is to establish a conceptual model that describes a number of fundamental relationships which it is proposed affect the degree of benefit an organisation may receive following EDI adoption.

Chapter 1 introduced the problem of using traditional classical and neoclassical theories of the firm which basically view the internal operations of firms as if they were a black box (Holmstrom and Tirole 1989). Inputs went in at one end of the process while outputs appeared at the other. The processes which occurred during the transformation of the inputs into outputs within the firm are seldom given more than passing consideration. Eliasson (1994:173) goes further in suggesting that ‘standard neoclassical theory has no place for the entity called a firm’.

Contributions to unravelling the black box have emphasised transactions cost, principal-agent, and property rights approaches to the theory of the firm (see Coase 1937;
Williamson 1985, 1989, 1990; Aoki 1990; Barney and Ouchi 1986; Langlois 1984; Langlois and Everett 1992; Schmalensee and Willig 1989; and Tirole 1989). However, Lamberton’s (1992) challenge for researchers is to go beyond these basically theoretical approaches. Lamberton suggests that empirical studies should include observation of information flows that include an examination of information linkages and their costs, the nature of changing boundaries of the firm, and how the application of new information and communication technologies impact the internal (and external) operation of the firm.

Chapter 2 located EDI within Benjamin et al.’s (1990) taxonomy of interorganisational systems. As a natural outgrowth of the ways firms work, particularly large organisations, Benjamin et al. state that EDI is the most common form of interorganisational system. Indeed, it is an application of information and communication technologies that companies have used in the process of re-engineering their business processes.

Swatman and Swatman (1992) stress that the EDI is the pre-eminent example of cooperative interorganisational systems with the ability to provide a degree of competitive advantage depending upon the way it is used—especially depending upon the way it is integrated into an organisation’s internal application systems and organisational structure.

In taking up the challenge issued by Lamberton (1992)—to go beyond the transactions cost, principal-agent, and property rights approaches, and to incorporate the role of EDI as a subset of interorganisational systems—the next logical step is to consider the contribution of theorists in the field of information economics and the economics of internal organisations. The contributions of three inter-related theories provide a theoretical foundation for extending the research outlined in this thesis beyond interorganisational systems. First, the general theory of exit and voice, originally formulated by Hirschman (1970) as responses to decline in firms, organisations and states, and reinterpreted by Helper (1993); second, the theory of the experimentally organised economy (Eliasson 1994, 1995); and third, the theory of corporate coherence (Teece 1988, Teece et al. 1994).

Helper (1993) extends the original theory of responses to decline in firms, organisations and states, formulated by Hirschman (1970), to include responses by firms in resolving problems that may arise between customers and suppliers. Hirschman (1970) postulated that a firm would respond to a particular problem by either exiting to a better alternative, or voicing its objection to the present objectionable state of affairs, rather than to escape
from it. Helper (1993:142), in considering problem resolution between customer and supplier, extends Hirschman’s original theory and identifies exit as ‘where the customer firm’s response to problems with a supplier is to find a new supplier; and voice, where the customer’s response is to work with the original supplier until the problem is corrected’.

This study extends the theory to include the customer response in terms of multisupplier response to a more widespread general problem. In the case under study, Ford Australia has on at least two occasions threatened to close its manufacturing plants in Australia (Victoria) and instead, to fully import all parts or vehicles. The problem for Ford (and the other four vehicle assemblers), was how best to respond to the problems imposed on it by the Button Car Plan—in particular, to adjust to the reducing level of Australian tariffs. A second associated problem was adjusting to the increasing competitiveness of the Japanese manufacturers.

For Ford, many of the Australian suppliers were not as efficient or quality-minded as their overseas counterparts. Additionally, lower tariffs meant that imported parts were relatively cheaper than those parts produced locally. Ford’s exit strategy then, was the threat to leave Australian shores unless suppliers improved their quality and reduced their price. Ford had already used the exit strategy with individual firms by substituting one supplier for another when that particular firm failed to perform on quality or other grounds. Of course, as Helper (1993:143) is quick to point out, the ‘use of the exit option requires the continued availability of suppliers who are close substitutes’—or to produce the parts inhouse. The exit strategy is only possible if the customer’s demands (e.g. for lower prices, improved quality and timely deliveries) are seen by suppliers as credible.

In contrast to the exit strategy, the voice strategy involves what Helper (1993:144) calls the ‘let’s work things out’ approach. Essentially, this strategy involves creating a communications system that will facilitate the mutual exchange of information. In part, this facilitation involves some degree of administrative coordination in the type and volume of information that flows between producing agents. Both suppliers and customers should be in a position to gain benefits from such mutual exchange. For its success, the administrative coordination process must rely on a degree of trust between both parties, a point stressed by Brousseau (1994).

In outlining the nature of EDI, Brousseau (1994:4) describes EDI as composed of two elements—a telecommunications technology and a language technology. As a telecommunications technology, EDI is characterised by positive network externalities,
and as a language, ‘it deals with the transmission of intent through a set of formal codes that the two parties must produce, and interpret, and to which they have to be able to respond’. This leads to what Brousseau terms a demonstration that the actual messages sent between trading partners actually embody the specificities of business practices. Further, that the messages are designed to exchange information that is required by the coordination process—for example, to facilitate a JIT production mode of operation. This embodiment of technologies (of telecommunications and language) enables the firm (e.g. Ford) to extend their boundaries to include all external relationships formally managed within the boundaries of their firm.

The voice response by Ford and their competitors GMH, Mitsubishi, Nissan and Toyota, was to establish EDI as a coordination (and perhaps control) technique. EDI was established in conjunction with three compliant core suppliers. Helper (1993) concluded that while the exit strategy maximises customer bargaining power, the voice response maximises many types of technical change. Inevitably, there exists a trade-off between the two strategies. However, in the case of Nissan, the initial cooperative voice response was ultimately replaced, in 1992, by an exit strategy as Nissan terminated its manufacturing involvement in Australia.

While positive network externalities may flow from EDI adoption, both Sweeny (1987) and Macdonald (1992) warn of the problem of reducing informal contact. As far as EDI reduces (or indeed eliminates) the need for customers and suppliers to communicate informally, such as through the use of telephone calls to resolve specific purchasing problems, Macdonald (1992) stresses that this situation may lead to a breakdown or failure to communicate because of a lack of informality. Sweeny (1987) proposes that this lack of informality can lead to extreme difficulties for small firms who are particularly dependent both on their [large] customers, and their informal contacts for diffusion of best practice, innovation and technical prowess.

The second theory that has influenced this research is that espoused by Eliasson (1994, 1995) as the experimentally organised economy (EOE). The essence of the EOE relies on accepting what Eliasson (1994:173) calls the dynamics of a profoundly imperfect competition process. In this experimental economy, Eliasson sees firms as experimentally learning machines that operate in imperfect markets (product, labour and financial). The ability of these firms to remain competitive, says Eliasson, is determined by their capacity to upgrade their competence through organisational learning. In addition, these organisations so organise themselves to exploit commercial and technological opportunities of the global business opportunity set. Essentially this means
coping with the unpredictable nature of the market environment—or of uncertainty and bounded rationality (Eliasson 1995).

To the extent that Ford Australia and their competitors exploited the opportunities afforded by EDI, their activities fit within Eliasson’s EOE. Some of their learning activity was facilitated by reference to their parent company (Ford Canada and Ford US) who had already been using EDI to coordinate their economic activities. The learning activity included not only the potential for improving efficiency in production (e.g. through improved coordination of the production process) but also in raising overall enterprise performance and improved product quality (e.g. through a commitment to all suppliers becoming Q1-suppliers).

The third theory contributing to this study is the theory of corporate coherence (Teece et al. 1994, Teece 1988). Firms are considered coherent if their businesses are related in some way, such as through joint operations and/or ownership—whether total ownership or partial ownership.

Like Eliasson (1994), Teece et al. (1994) place emphasis on the ability of the firm to learn (enterprise learning) and on the development of competences—the firm’s ability to solve organisational problems and technical problems. Organisational competence involves three aspects: first, allocative competence—essentially deciding what to produce and how much to charge customers; second, transactional competence—the make or buy decision, and whether to produce independently or enter into partnerships or joint ventures; third, administrative competence—how to improve performance through a redesign of business structures. Technical competence is more related to the design of new products and processes and the more efficient operation of facilities.

Teece et al. (1994) include the notion of path dependencies in establishing their theory of corporate coherence. Essentially, path dependency suggests that history matters—that what a firm did in the past, including its previous investment history and other related activities, will actually influence (and perhaps constrain) its future behaviour. The implications for this theory are summarised by Teece et al. (1994:23) as implying

that firms can be thought of as integrated clusters of core competences and supporting complementary assets and that the degree of coherence one would expect to observe among the parts at a particular point in time depends on the relationship between learning, path dependencies, opportunities, inherited complementary assets, and selection.
This theory assists in explaining the coherence between firms in the Australian automotive industry, especially the notion of the network firm described by Teece et al. (1994) and Antonelli (1992b). This coherence has resulted in the cooperative establishment of EDI for the coordination of production and the improvement in global competitiveness—a response to government policy following the initiatives imposed on the automotive industry by the Button Car Plan (and the Japanese automotive industry). The theory also has implications for the circumstances under which various organisational forms within the industry may remain (or become) viable.

The model developed in this study does not attempt to directly implement the theories of exit and voice, the experimentally organised economy, and corporate coherence. However, the research model does adopt elements of each of these theories to build relationships between model constructs detailed in the next section.

The essential argument proposed in this thesis is that an organisation adopting EDI is capable of receiving both direct and indirect benefits from its adoption. These net benefits may be achieved through a process of diffusion of that technology from within that organisation, within the automotive industry and within other industries with which the organisation trades. As Macdonald (1992) concludes, EDI is the innovation that binds—it is little wonder that large firms are attracted to this approach—including both customers and large suppliers.

The conceptual model outlined in the next section of this thesis proposes that EDI benefits are affected by a number of interrelated factors. These factors include: the size of the organisation; the amount of trade the organisation undertakes with the automotive industry (its concentration or dependence on the industry), the level of senior management commitment to establishing EDI, and the extent of EDI integration with other application systems within the organisation.

The impact of the industry sector itself (the components sector) is more difficult to articulate. However, over time, industry networks (both between component suppliers and between customers and suppliers) are likely to have a consequent effect on the organisation which may be measured.

3.1.2 OVERVIEW OF THE MODEL

The research model proposes that net benefits arising from the diffusion of EDI within an organisation result from a number of internal and external factors. Internal factors
include the extent of integration of EDI within the organisation’s information systems, and the level of commitment from senior management.

External factors include the size of the company and the amount of trade that a component supplier has with its automotive customers. Each of these relationships is outlined in the next section.

The model depicted in Exhibit 3.1 describes the following relationships:

(a) organisations with a positive commitment from senior management, which have integrated EDI with their internal information and application systems, receive net benefits following EDI adoption;

(b) the size of the company and amount of trade it transacts with both its automotive customers and other automotive suppliers, both directly
and indirectly, influences the level of commitment from senior management and the extent of system integration; and

(c) over time, the influence of other industry-wide factors, such as industry seminars and local supplier-interaction with other suppliers who have adopted EDI, has a positive effect on the extent to which an individual organisation may achieve benefits from EDI adoption.

3.2 RESEARCH PROPOSITIONS

Each of the relationships shown in the conceptual model in Exhibit 3.1 can be described as an individual research proposition. Exhibit 3.2 outlines each proposition and the direction of causality controlling for other factors in the model. This section defines the model components and articulates the relationships between them, resulting in the nine research propositions.

3.2.1 EDI Net Benefits

Most of the literature relating directly to the use of EDI in electronic trading identifies benefits and costs of using this form of information technology as savings in paper, postage, labour, improved data accuracy and integrity and so on. In the automobile industry, studies from overseas (Kimberley 1991:6) indicate savings of US$200 per finished vehicle as a direct result of using EDI; in the UK, similar savings of £200 have been claimed. So far, there is little evidence to support these assertions. As Benjamin et al. (1990:29) state:

"Most of the literature to date in this field has relied on anecdotal data to draw conclusions about the conceptual development of inter organisational systems [including EDI] and their effects."
### Exhibit 3.2 Research Propositions

<table>
<thead>
<tr>
<th>Research Propositions</th>
<th>Description</th>
<th>Direction of Linkage</th>
</tr>
</thead>
<tbody>
<tr>
<td>RP1</td>
<td>The level of senior management commitment has a direct effect on the achievement of net benefits from EDI.</td>
<td>Positive</td>
</tr>
<tr>
<td>RP2</td>
<td>The degree of system integration has a direct effect on the achievement of net benefits from EDI.</td>
<td>Positive</td>
</tr>
<tr>
<td>RP3</td>
<td>The level of senior management commitment has a direct effect on the extent of system integration achieved.</td>
<td>Positive</td>
</tr>
<tr>
<td>RP4</td>
<td>Company size directly affects the level of senior management commitment to EDI.</td>
<td>Inverse</td>
</tr>
<tr>
<td>RP5</td>
<td>Company size has a direct effect on the achievement of net benefits from EDI.</td>
<td>Positive</td>
</tr>
<tr>
<td>RP6</td>
<td>Company size directly affects the extent of system integration.</td>
<td>Positive</td>
</tr>
<tr>
<td>RP7</td>
<td>The concentration of trade an organisation achieves with the automotive sector has a direct effect on the level of senior management commitment to EDI.</td>
<td>Positive</td>
</tr>
<tr>
<td>RP8</td>
<td>The concentration of trade an organisation achieves with the automotive sector has a direct effect on the achievement of net benefits derived from EDI.</td>
<td>Positive</td>
</tr>
<tr>
<td>RP9</td>
<td>The concentration of trade an organisation achieves with the automotive sector has a direct effect on the extent of system integration.</td>
<td>Positive</td>
</tr>
</tbody>
</table>

As a leap in faith, or as Weill and Olson (1989) prefer to call it, *blind faith*, Ford Australia introduced EDI without any specific evaluation being performed (such as an internal benefit/cost analysis). It was believed that EDI made good business sense, and for a minimal investment of about $100,000, was expected to return savings of many millions of dollars over ensuing years [Ford, personal contact]. At best, it may be assumed that an implicit benefit/cost analysis was performed. On this basis, as the benefit/cost ratio appears so large, the consequential risk of failure was considered to be very small.
Although references to EDI adoption overseas were examined, especially with Ford Australia’s parent in the USA, the decision to implement EDI in Australia was made at the local level. Its implementation in Australia was quite different to that of its American parent. While it may be evident to a large car manufacturer that the expected gains would be quite large, and the risks relatively small, it cannot be concluded that all (generally smaller) suppliers will achieve the same net gains from its adoption.

Malone et al. (1987) develop a theory that applications of information technologies (such as EDI) ultimately give rise to three sets of effects:

– *electronic communication effect*: where the real costs of communication are falling, the reach (of time and distance) is expanding;

– *electronic brokerage effect*: where there is an increase in the number and quality of considerations of alternatives associated with a decreasing cost of transactions; and

– *electronic integration effects*: increasing the degree of interdependence between the group of participants involved in the particular delivery process.

They then relate their theory to a particular case of the insurance industry where they conclude that, had all companies adopted a common network platform for delivery, then the three sets of effects would have been observed. This would ultimately have led to what the authors call an *electronic marketplace* (Malone et al. 1987; 1989).

In contrast to the insurance industry example of Malone et al., the motor vehicle industry has basically adopted one common network platform. If Malone et al.’s theory holds, one would expect to observe all three effects. The empirical evidence from the motor vehicle industry is expected to shed some light on this theory.
Stated Benefits

The most common benefits cited by authors (see Sokol 1989; Emmelhainz 1990 and Baker 1991) can be divided into three main categories:

Direct Benefits, including:
- reduced postage
- increased data accuracy
- reduced administration costs
- reduced clerical staff levels
- reduction in document matching and transactions
- reduced telephone usage

Indirect Benefits, including
- increased productivity
- reduction in inventory levels (move to a JIT inventory management system)
- improved control of purchasing and distribution
- better cash management
- improved control over transport and distribution
- improved quality of product

Strategic Benefits, including:
- improved (closer) relationships with trading partners
- creation of more flexible buying strategies

The first two categories provide straightforward examples of where EDI may provide an organisation with advantages. Essentially they are economic in nature.

The third category, Strategic Benefits, have potentially the greatest scope for providing benefits to an organisation. Traditionally, customers and suppliers have always dealt at arm’s length, wishing only to share as little information as possible to reach an agreement and sign a contract. One of EDI’s most significant expected benefits can come from a reversal of this approach where trading partners work together and share information in order to achieve outcomes such as improved quality of product (e.g. longer-lasting parts, improved paintwork), reduced transactions costs, and earlier solution of joint problems (e.g. in ordering and delivery)

An advantage EDI has over other forms of communication and information technologies is its ability to perform as a facilitating technology. By its very nature it is (and needs to
be) a cooperative technology that may lead to competitive advantages. One of the primary benefits cited for adopting EDI is the gaining of some degree of competitive advantage in the market place. A question examined in this thesis is whether or not EDI does provide an organisation with such an advantage. Even if it does, it may be no more than a short-term gain without sustained (long-term) advantages.

In summary, direct benefits are positive gains the organisation has received, directly caused by the introduction of EDI.

**Indirect Benefits**

The weight of evidence examined to date suggests that the adoption of EDI by trading partners produces some benefits, including those listed above (see Mackay 1993b, Swatman and Swatman 1992, Swatman 1993, Sokol 1989). For some organisations the benefits will be substantial, while for most the benefits may only be modest, or non-existent. While direct savings (e.g. saving paper, reducing mail and telephone expenses) may result in some savings to the organisation, it is not until the EDI adopter actually integrates EDI into the firm’s own internal systems that the real benefits can be achieved (Swatman and Swatman 1992).

These indirect benefits can be categorised as those that affect the supplier (e.g. component suppliers such as Hella and Pacific BBA) and those that affect a buyer such as Ford Australia (Benjamin *et al.* 1990).

In their study of supplier impacts, Benjamin *et al.* (1990) outline the results of three case studies which included examining eight different applications and the effect the adoption of EDI had on the three firms and their systems. Their results show that relatively small savings were achieved by staff reductions (i.e. few staff were laid off), and insignificant other cost savings were made. In general they conclude that whatever gains are made tend to be intangible and only short-lived unless EDI is fully integrated into the firm’s internal application systems. Once this is achieved, greater gains are possible.

However, once other competitors react by adopting EDI themselves, any competitive advantage the supplier may have gained as an efficient innovator, has the potential for being quickly whittled away unless the firm is in a position to maintain the momentum by further information technology investments.

In assessing customer impacts, Benjamin *et al.* (1990) stress that customers (or buyers) tend to be the receivers of the most significant benefits from adopting EDI. They gain
the more immediate and measurable benefits and cost savings, simply because of their structural position in the market place. This is enhanced by a generally superior materials management handling system necessitated by the introduction of EDI.

One of the primary benefits claimed for EDI is the significant reduction in inventory levels. In order to achieve this saving, the customer (e.g. Ford) must be able to pass the holding of inventory onto their first tier suppliers (e.g. Hella). In turn, to reap any inventory savings themselves, the first tier suppliers must be able to pass on their inventory costs to their suppliers, and so on up the supply chain. This is one of the reasons for the claim that significant gains to the customer and only minimal gains to suppliers are evident in the early days of an industry adopting EDI.

**Implementation Costs**

The costs of EDI fall into a number of categories, which include, first, *fixed costs*—generally once-only costs such as hardware purchases, EDI translation software (including development costs), decision support (e.g. purchase of consultant time) and initial personnel training; second, *variable costs* which are transaction or volume-dependent, specifically communication or network-related services, and ongoing training and software support.

Hardware costs include the purchase of a suitable computer system and associated peripherals, and/or the upgrading of an existing facility, such as a mainframe, to handle the new system function. For most small to medium organisations which have already implemented EDI, an existing personal computer (PC) is often used. If an additional computer needs to be purchased, a cost of $2,000–$3,000 must be met. Additionally, a modem suitable to communicate with the value-added network provider’s mailbox would cost around $500–$900.

A growing trend among major users of EDI is the establishment of *corporate gateways*—sophisticated telecommunication and computer systems for the exchange of EDI documents. Swatman (1994) describes BHP Steel’s implementation of a corporate gateway, allowing users throughout the company to utilise the existing internal networks, providing internal electronic mailbox services and a platform for corporate X.400 and X.500 facilities. BHP Steel’s facility effectively allows all company users to centralise their exchanges of information with trading partners from existing application systems without the need to perform individual translations.
The necessary EDI software is generally of two types. It includes translation software for translation of a company’s electronic document data to and from an agreed document standard (e.g. EDIFACT or ANSI ASC X12). Indicative pricing is available from published rates by Telecom Plus and GEIS as Australia’s two major EDI software providers.

The relatively small Australian market for EDI software has meant that prices (and transmission charges) are not as competitive as their much larger overseas counterparts. The cost of PC software from Telstra Multimedia (Tradelink) was as high as $8,000 for purchasers in the pharmaceutical’s industry, and $5,000 in the automotive industry. In early 1993 the price for the new release of Tradelink software dropped to $2,500 (including installation and training) to encourage customers to become EDI enabled. The latest release includes all available document standards (ANSI and EDIFACT).

Coles-Myer suppliers purchasing software from GEIS pay about $3,500, although a low entry level is available at $1,500 (plus training) for the cost of their EDI software for a package comparable to Tradelink. With installation and training, a typical PC-based EDI package for a medium sized K-Mart supplier (which provides the user with the ability to integrate the data from the electronic documents into their internal application system) is around $6,000. For additional document standards or for enabling a supplier wishing to send messages to a customer or supplier on another network, GEIS charge $295 for each document and have a once-only fee of $200.

The second aspect of EDI software involves providing the organisation with the ability to integrate the mail messages from their trading partner (that is, data which forms the basis of a normal business document such as a purchase order or invoice) with their own internal application systems—such as order/entry and inventory. Because there is a dearth of application software, typically accounting information systems and materials resource planning (MRP) systems with EDI capability, most application software must at present be modified. A typical PC application could be modified for as little as $1,500, whereas upwards of $100,000 would be needed for a mainframe modification (Emmelhainz 1990:173).

Costs of employing a consultant to advise on the best way to implement EDI within an organisation will clearly depend on the complexity of the implementation. A PC implementation may not require the services of such a person, but reliance on the value-added service provider may be sufficient to perform the initial installation. A company with inhouse data processing staff may also not need to use outside consultants.
Depending upon the complexity of the installation, training could take from as little as half a day to two days or more. Cost of training courses are generally around $350 per person/day. Additional costs of training include payment for the training of employees as they are replaced within the organisation.

Both Telecom and GEIS charge about $0.32 per kilo-character for all transactions, plus a monthly mailbox rental fee which for Telecom is $85.00. Following an agreement between Telecom and GEIS, customers on either network can exchange messages with one another. The practical implication of this means that an automotive supplier using Tradelink software on Telecom’s network does not need to purchase additional GEIS software to become a supplier to K-Mart.

Value-added service providers normally include the cost of providing software upgrades in their annual maintenance fees. Such upgrades relate to improved enhancement of the software itself (e.g. development of a Windows version of the package from a DOS version) and ongoing maintenance of the published standards as they are modified by international agreement.

Although averages can be misleading, Kimberley (1991a) listed what he considered as typical annual cost averages for small, medium and large volume users: small user: US$12,000; medium user: US$32,000; large user: US$73,000.

In the context of this study, net benefits is defined as gross benefits minus gross costs.

### 3.2.2 SENIOR MANAGEMENT COMMITMENT

**Definition**

The role played by senior management in information systems planning and development is a recurring theme in the information systems literature. For example, Sokol (1989:92) states quite categorically: ‘without the support of upper management, EDI cannot happen.’ As it is senior management which generally has the delegated authority to commit both financial and human resources to information technology projects, having both their support and involvement is highly desirable—or as Sokol believes, it is essential.

Tinsley and Power (1990) believe that in order to have successfully executed information system strategies, the CEO must not only see information systems as a
strategic part of what their business does, but must ultimately be prepared to support the venture with more than words. That is, it must finance it, and require measurable benefits to be demonstrated.

Torkzadeh and Xia (1992) use the word *recognition*, in addition to the words support or involvement. Recognition should be taken as the lowest level of commitment, in that a Board of Directors, the CEO or Senior Management Group might recognise the project, but without actual support, both financial and human, or active involvement, the commitment will not be nearly as complete.

For the purposes of this research, senior management commitment is defined as the level and degree of involvement in an information technology project that the organisation is prepared to make to ensure the project is a success. By level of involvement is meant the seniority of the person appointed to manage the EDI project (e.g. a corporation may appoint anyone from the chief executive officer down). In the case of a partnership or sole trader, it may well be an owner of the business.

The degree of involvement is the extent to which the appointed person actually supports the project (e.g. delegated support in terms of written support for a project through the commitment of funds, or actual involvement as a member of a project’s steering committee (Lederer and Mendelow 1993).

**Path Linkages**

There is considerable evidence in support of the role that senior management must play for the successful achievement of benefits from information systems and information technology projects. One of the early contributors was Ginzberg (1981) whose research identified six *generic* factors which contributed to the difference between success or failure of MIS projects. Two of the key factors were *commitment to the project* and *commitment to change*. Ginzberg (1981:55) concludes:

> Thus, the probability of success in implementing an MIS could likely be increased if special attention were paid to 1) gaining commitment to the project, 2) gaining commitment to any changes necessitated by the new system.

Earl (1993) in examining the experience of 27 companies with strategic information systems planning methods, identified top management commitment as ranked third in importance. Both direct support and direct involvement ranked in the top five criteria as necessary for achieving benefits from strategic information systems. Earl (1989:118)
enunciates the point that ‘In the past lack of top management support and involvement has impeded the successful exploitation of information technology.’ Often this has been brought about by the lack of senior executive awareness of the importance of information technology projects to the organisation. Earl’s conclusions concur with Doll (1985), who sees a necessary bond between top management, MIS management and system development activities.

Lederer and Mendelow (1993) supported Earl’s findings by demonstrating that if an organisation only involves its low-level managers in information systems planning, then one or both of two things are likely to occur. First, because of their non-involvement in top level decision making, it may be difficult for them to see the big picture, that is, the impact the information technology project may have on the whole business. Second, top management may change the business priorities which may impact the priorities set by lower-level managers, and consequently affect the outcomes of the project.

In addressing the issue of information technology investment and performance, Weill and Olson (1989) discuss the issue of conversion effectiveness, or the effectiveness of how investment in information technology conversion to the productive outputs of the firm depends on a number of key factors. One of the most important factors for maximising performance was the level of top management commitment.

A number of researchers, including Galliers (1987), Konsynski and McFarlan (1990), and Runge and Earl (1990) discuss the role of champions within an organisation. Galliers work, based on empirical research in the United Kingdom and Australia, confirmed the expected role of senior management regarding their participation in information systems planning. He demonstrated that not only should top level management be involved, but they should direct the [project] team’s efforts. The role of the senior executive champion in this context, should be to ensure the smooth implementation of the information systems plan, for example, the implementation of EDI into the organisation, ensuring that sufficient resources (both financial and human) are made available.

Konsynski and McFarlan (1990) share Gallier’s view, in stating that at the top, there needs to be a shared view which must be communicated throughout the organisation. This can best be done using a champion within senior management.

Runge and Earl (1990:136) discuss work at SPRU (Science Policy Research Unit, UK) which defined a champion (in the case of SPRU, called a product champion) as ‘any individual who made a decisive contribution to the innovation by actively and
enthusiastically promoting its progress through critical stages.’ They found that such champions had a high degree of authority and responsibility, and were generally at or above director level. Further, they possessed four general attributes: first, a vision of the nature of the company’s markets—especially those that are under change, development or threat; second, be able to secure and commit the necessary financial and human resources to the project, sometimes against the odds; third, be able to defend the project by demonstrating the benefits likely to be obtained from the development; and fourth, actively promote the system during implementation, especially to users of the system but also to customers and suppliers.

Strassmann (1985:47) highlights the importance of leadership within the organisational context of new applications of technology:

*By leadership I do not mean only inspired messages from top management published in the employee newsletter, but also the acting out of intentions by personal demonstrations of new computer applications under working conditions.*

The implementation of EDI into component organisations by some firms, may be regarded as an unnecessary imposition. Many of the firms introducing EDI did so in response to customer demands (e.g. from the five Australian car companies). They did so with little management commitment. Indeed, the FAPM EDI Project Manager reports numerous cases of firms initially agreeing to introduce EDI, but doing so by treating it as an expensive facsimile machine (personal communication). In other words, they printed out the EDI message and rekeyed the information back into their own computer systems. This point is amply supported by Konsynski and McFarlan’s (1990) research which related incompatible information system standards and the failure to resolve consequential partnership conflicts.

Firms with little top management support are unlikely to gain many of the potential benefits from adopting EDI. Those firms that have top management support and involvement are expected to gain the most.

This discussion leads formally to the first research proposition:

*RP1: The level of senior management commitment has a direct positive effect on the achievement of net benefits from EDI.*
3.2.3 EXTENT OF SYSTEM INTEGRATION

Definition

In defining the term integration, Hall (1991) identifies two perspectives from which to view the nature of how integration may be most usefully applied within an organisation. First, there is the strategic perspective, which tends to concentrate its focus on improving organisational goals such as increased market share or profit. This perspective stresses the development of new or innovative information systems to improve the organisation’s strategic position. The emphasis on integration from a strategic perspective focuses on the decentralisation of data and systems.

Second, and in contrast, is the technical perspective, which is aimed at achieving productive efficiency, with an emphasis on system centralisation, principally for reasons of technical efficiency, and system interfacing. EDI systems tend to be related more to the second perspective than to the first.

Bergeron and Raymond (1992) briefly discuss a further dimension of EDI integration—internal and external integration. EDI is internally integrated to the extent that EDI transmissions are directly linked with the firm’s internal applications—order/entry, inventory and so on. It is externally integrated to its various types of trading partners, which may be represented by both customers and suppliers. Indeed, for an internationally-oriented firm, an externally integrated party would be the Australian Customs Service.

This study defines integration in terms of the extent to which an EDI document, for example, a MRS, ASN or JIT document, is seamlessly connected to its related application in the organisation’s information system. For example, upon receiving an EDI message from its customer Ford, a component supplier is able to directly communicate Ford’s requirements into its own internal application system without human intervention in the form of rekeying the transmitted data. In this respect, integration follows Hall’s (1990) technical perspective definition. To the extent that the same component supplier may communicate its own needs to that of one or more if its own suppliers, then it is externally integrated following Bergeron and Raymond’s (1992) interpretation. Either interpretation is dependent not so much on who the component supplier trades with, but whether or not its own internal systems are integrated with the incoming messages.

Path Linkages
Rochester (1989) estimates that 70 per cent of business data manually entered into an organisation’s computer, is rekeyed into another organisation’s computer. This process has been the common method of transferring business requirements between customers and suppliers using paper-based methods of document transfer. Computer-generated purchase orders initially entered by customer staff are re-entered by supplier staff into their firm’s computer-based order/entry system. A seamless method of transferring data between trading partners must, at the very least, relieve one trading partner of the need to rekey their trading partner’s requirements.

In their discussion of information partnerships, Konsynski and McFarlan (1990) stress that most strategic system applications are based on an integration of computer and telecommunications technology. This is especially true of EDI.

The Swatman and Swatman (1991b, 1991c, 1992) and Swatman and Clarke (1990) broad-ranging studies have focused particularly on the issue of integration and the benefits to be achieved from full integration of EDI into organisations’ internal application systems. On the issue of achieving competitive advantage from EDI and the significance of system integration to its achievement, Swatman and Swatman (1992:185) point out that:

There are competitive advantages to be obtained from the use of EDI, but these are in the integration of EDI into the organisation’s internal structure and systems. ... while EDI per se is not a competitive weapon (except in the very short term), there is immense scope for competitive advantage to be gained from the way in which EDI is integrated into the organisation’s structure.

In discussing the economics of EDI standardisation, that is, the need for trading partners to adopt a common language of communication, Brousseau (1994) correctly identifies two significant features of the telecommunications aspect of EDI. First, that it is characterised by positive network externalities, and second, by increasing returns to adoption. He further states that EDI standards are a mechanism which constitutes a language enabling two information systems to understand each other.

Brousseau (1994:5) also stresses the need for system integration in that:

The aim of EDI standards is indeed that a received message can be correctly interpreted by the intended recipient information systems and therefore integrated into internal applications software such as inventory or
production management systems. The aim is thus to transmit intent, not just data.

Fowler et al. (1994:49) quote the work of Boucher who suggests that interfacing EDI processes with internal applications software should be approached as if it were like a jigsaw puzzle. In essence Boucher suggests:

The most crucial piece of the puzzle, however, is actually the software which will provide a seamless connection between the outside world and applications such as purchasing, order entry or accounting—and between these applications themselves.

The importance of EDI integration to the achievement of net benefits from EDI leads to the following proposition:

RP2: The degree of system integration has a direct positive effect on the achievement of net benefits from EDI.

In deciding the primary forces acting to bring about a successful EDI implementation, Rochester (1989) suggests that the role of middle and lower-level management cannot be ignored. Often these managers are the technical specialists with the necessary knowledge to design and implement the connection between EDI and the firm’s internal applications. Rochester also argues that while the roles played by middle and lower level management are certainly important, it is senior management that commits the funds and the human resources to their project.

It is primarily the top level executives that have a greater awareness of the company’s goals and often a vested interest in their achievement. In supporting what he describes as a total EDI strategy, Rochester (1989) says that information systems are an ideal medium for promoting the strategy throughout the organisation, provided it has top management support. The total strategy involves complete integration of all information systems with the EDI processes.

Earl (1989) relates his own research (with Feeny and Edwards) which distinguished between organisations with either high or low levels of integration. Eight features stood out for those organisations with high levels of integration, and were absent in those with low (or non-existent) levels of integration. Three of the outstanding features include: first, business unit management perceived that future exploitation of information technology was of strategic importance; second, an information technology executive was established as part of the executive team or board for the business concerned; and
third, there was a top-down planning process for linking information systems strategy to business needs.

Earl’s (1989) focus on top management, organisational goals and information systems strategy are very much related to Rochester’s (1989) conclusions from a study conducted at DEC (Digital Equipment Corporation) following the company’s introduction of EDI. In essence they learnt three things: first, EDI creates changes in business practices (that must directly involve senior management); second, not only does EDI directly contribute to greater efficiencies in production and manufacturing through reduced costs, but by its very nature, EDI reinforces interdependencies between trading partners; and third, conventional methods of introducing (including integrating) EDI into existing application systems will not usually work—instead, alternative and flexible methods must be employed.

In improving the coordination between organisational functions, Torkzadeh and Xia (1992) suggest that telecommunication technologies (such as EDI) need the establishment of steering committees. Steering committees with organisational support, such as senior management involvement on the committee in the position of chairman, generally implies that the organisation is recognising the telecommunications role (EDI) as a corporate resource rather than a support role.

In pointing out the original support role for information technology, in terms of support for specific functions like procurement, finance, human resource planning, and so on, Beng (1994) takes the link between commitment and integration a step further. Beng suggests that many of the new technologies (including EDI) are being used to enable automated information exchanges for company-wide and worldwide functions and locations.

Beng (1994) concludes that these technologies are indeed a business integration which links four important elements, namely: strategy, people, processes and technology (see also Carter 1994). He observes that there are two distinct themes in the adoption of most information technologies—they are either value-adding market-driven activities, or they are coordinating and infrastructure-based with an emphasis on cost reduction.

EDI is generally regarded as falling into Beng’s latter category, although as Swatman and Swatman (1992) point out, EDI is a cooperative technology with the ability to provide significant scope for achieving competitive advantage. However, they are quick to point out that EDI’s usefulness as a competitive weapon is only possible once it is fully integrated into the organisation’s internal systems and structures. To achieve the
degree of integration required for competitive use, Swatman and Swatman (1992:199) state that:

*EDI is essentially a facilitator of organisational change and, as such, will not provide its most effective benefits when implemented in a piecemeal fashion by middle-management IT professionals.*

Beng (1994) supports Swatman and Swatman’s conclusions in stating that true benefits will not immediately flow from simply introducing information technology. What must happen is that the introduction of any application of information technology must be managed properly, a message amply supported by Bessant (1993).

The implication for top management is clear and leads to the third research proposition:

**RP3:** The level of senior management commitment has a direct positive effect on the extent of system integration achieved.

### 3.2.4 COMPANY SIZE

**Definition**

Company size, or firm size, have received frequent attention from both economists and organisation theorists in their attempts to explain the characteristics of structure that assist in the determination of economies of scale and the complexities associated with organisational structure (Milgrom and Roberts 1992; Harris and Katz 1991). To the economist, firm size (through increases in scale of operation), leads to reductions in unit costs of production. In the market place, larger firms are generally in a superior bargaining position with respect to both suppliers and customers in maintaining their market dominance (or market power) in both purchasing and selling activities.

Organisational theorists, while not necessarily agreeing on the exact relationship between the size of an organisation and its structure, do generally agree that the study of firm size is a most significant variable in influencing the structure of organisations and its use of technology (e.g. Child 1987; Bedeian and Zammuto 1991; Robbins and Barnwell 1994).

In defining organisation size, Robbins and Barnwell (1994:135) determined that ‘over 80 per cent of studies using organisation size as a variable define it as the total number
of employees’. In addition, their basic proposition points to the logical relationship between size and structure—that is, size causes changes in organisation structure.

For the purposes of this study, firm size is defined in two ways—the number of employees and annual turnover, a similar definition adopted by Tavakolian (1989) in his assessment of the influence of size on information technology structure.

**Path Linkages**

Organisational size both affects and is affected by the adoption of technology and the associated benefits that an organisation would hope to gain from its introduction. While there is some dispute as to whether size causes changes in structure or is the result of such changes in firms, (see Robbins and Barnwell 1994:137), there is little doubt that it is a variable that must be included in any study of the type being undertaken here.

The nature of the size imperative is discussed by many organisation theorists (see especially Child 1987b; Daft 1992; Evan 1993; Robbins and Barnwell 1994). Most of the discussion focuses on the attributes of firms that become larger. Essentially, these theorists describe the differences between large and small organisations that are related to size and structure. Daft (1992) lists four characteristics that differentiate large from small firms. They are *formalisation, decentralisation, complexity* and *personnel ratios*. In the context of this study, only the first three are addressed.

Small organisations are often characterised by centralisation of decision making where most of the decisions are taken by the owner, manager and principal employee, who may well be one and the same person. Formally, small organisations have flat structures with very shallow, if any, hierarchy. In contrast, the larger the organisation becomes, the greater the desire to take advantage of the economic benefits of specialisation, inevitably leading to increased horizontal differentiation (Robbins and Barnwell 1994).

In order to manage the new functional groupings, management will normally put in place rules, regulations and formal procedures to control the new structure, as personal surveillance is now not always possible because of the increased organisational complexity. In order to manage the now more horizontally differentiated organisation, senior management needs to expand the levels in the hierarchy, and so vertical differentiation increases. This is part of the formalisation process characteristic of large organisations and replaces the personal observation and involvement of senior management found in smaller organisations (Daft 1992).
Changes in vertical differentiation are often accompanied by decentralisation of decision making. As senior management discover they can no longer take all the decisions, they pass them down the hierarchy to lower level management. As Daft (1992:158) concludes, ‘the research on organization size indicates that larger organizations ... permit greater decentralization.’

Complexity’s influence over size exists in two dimensions—horizontal and vertical. An organisation growing larger, becomes more complex as both the number of levels in the hierarchy increases (vertical complexity) and the number of functional areas (departments or jobs) increases (horizontal complexity). The need to specialise most often occurs in larger organisations (Daft 1992). To manage these specialisations, departments or functional groups are created. As the number of employees rise, additional problems of delegation and control arise. Consequently, management is forced into developing ways of maintaining control over the growing numbers of departments and people. Unlike smaller organisations, the chief executive officer is unable to maintain the centralised control usually seen as desirable.

Vertical complexity occurs from additional levels being made in the hierarchy in order to ‘keep spans of control from becoming too large’. (Daft 1992:129). Child (1987), however, states that increasing use of information technology will reduce the number of levels of management required for a given scale of operation, so modifying the extent of vertical complexity.

Smaller companies are generally less complex, with more centralised decision making where formal structures are unnecessary compared with their larger counterparts. Both Harris and Katz (1991) and Child (1987) conclude that the chief executive officer is more likely to be in a superior position to effect change quickly, in response to an external pressure, within a small organisation because of the reduced complexity (flatter structure) and tendency to be closer to the day-to-day operations of the business. In his discussion of the benefits obtainable from telecommunications-based (information) networks, Macdonald (1992:60) notes the savings possible in the automobile industry from computer to computer ordering. On the question of firm size, he states that:

*Perhaps the main competitive advantage of the small firm is that its informal interactive information network allows every employee to know what is going on, and permits the firm sufficient flexibility to adapt to changing circumstances.*
In the context of this study, smaller organisations are therefore more likely to have senior management involvement (especially the chief executive officer) and commitment directly in the EDI project than are larger organisations. Formally stated:

**RP4:** *Company size has a direct inverse affect on the level of senior management commitment to EDI.*

Pfeiffer’s (1990) survey of EDI adoption in European and North American companies noted that in at least three areas of strategic benefits attributed to EDI diffusion, medium-sized companies received a greater positive impact than smaller ones.\(^1\) The three positive benefits assessed by Pfeiffer were improved *customer service*, greater *responsiveness* in areas such as JIT manufacturing, and improved *control*—the maintenance of an accurate corporate information system.

Research by Harris and Katz (1991) into information technology investment by life insurers, suggested that larger firms are more likely to realise the economic benefits from their information technology investment than smaller firms. They conclude that seldom are these benefits adequately realised without pro-active management of the information technology. Their conclusion includes the way the organisation adapts to the business process changes required to sufficiently take advantage of the investment. Their conclusion suggests that benefits from information technology investment (including EDI adoption), are both directly and indirectly attributable to the structural attribute of company size.

A recent study found a direct relationship between firm size and the adoption of information systems technologies (Harris and Katz 1991). Larger organisations are also more likely to have a range of expertise amongst senior managers who understand the strategic importance of information technology to the firm. It is through these investments in information technology that larger firms realise the economic gains. Because of their size, large companies are usually in a superior position to take account of economies of scale, have greater access to financial resources, and better able to forge value chain alliances with their customers or supplier (Kettinger *et al.* 1994).

In assessing the important organisational attributes associated with increasing effectiveness of information systems in general and decision support systems success in particular, Udo and Davis (1992) concluded that organisational attributes (such as company size) were significant in explaining the achievement of benefits from the

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\(^1\) In the context of this study, large component manufacturers in Australia generally fall into Pfeiffer’s medium-sized classification of 200 to 2000 employees.
introduction of decision support systems. Their research showed a mixture of both positive and negative relationships between both tangible and intangible benefits and organisational attributes.

It is often the larger companies that process the greater volumes of EDI transactions. Pfeiffer (1990) found that it was the high volume users of EDI that gained the most from EDI and consequently received the larger cost savings. Some benefits were apparent in reduced transactions costs and clerical staff savings.

In discussing the ‘slow and often ineffective take-up of manufacturing innovation ... in Australia,’ Lowe and Sim (1993:245) concluded that their empirical research demonstrated support for the importance of size in the adoption process of certain manufacturing innovations. Their research focused on the adoption of two manufacturing innovations—JIT and MRPII\(^2\) (manufacturing resource planning)—by firms in New South Wales. They concluded that it was generally the smaller firms that were either slow to adopt or non-adopters of either technologies. It was generally the larger firms that were the early adopters of the innovative techniques. It was unclear from their study as to the precise reasons why small firms were slow or non-adopters. Lowe and Sim speculated that the ability to appropriate benefits may have been a possible cause, but so may have been other external factors.

While the evidence presented is not conclusive, there are sufficient grounds to suggest that there is a positive causal relationship between organisational attributes such as size, and the benefits expected from EDI adoption. This leads then to the formal statement of the research proposition that:

\[ \textit{RP5: Company size has a direct positive effect on the achievement of net benefits from EDI.} \]

Large companies generally employ information technology specialists. Larger firms tend to have a MIS department with a range of expertise to handle most programming requirements. The range of information systems required by large organisations will generally require constant maintenance by information systems professionals. These specialists (e.g. analysts and programmers) will be in a position to implement the integration of EDI into existing application systems.

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\(^2\) MRPII ‘is the process that links strategic planning and management control in the area of manufacturing. It includes demand forecasting, manufacturing/production planning, material requirements planning (MRP) and control of manufacturing activities’ (Lowe and Sim 1993:247).
Harris and Katz (1991:347) state that:

large firms enjoy increased benefits from their information technology investments, due especially to economies of scale in software production—is consistent with the findings that hardware represents an increasingly large fraction of the technology budgets for large firms.

Smaller firms, on the other hand, will usually not have information technology professionals as full-time employees. They will generally be relying on off-the-shelf packaged software to meet their manufacturing needs. An example of this software in the automotive sector is MRPII software. Until recently, EDI has not been integrated with MRP software. Such software is also more costly to purchase, or to have existing applications modified by software suppliers.

In summary, small organisations generally find the integration of EDI software relatively more costly because they do not have the information technology specialists nor the desire or ability to proceed with the integration inhouse. This leads to the formal statement of the proposition that:

RP6: Company size has a direct positive effect on the extent of system integration.

3.2.5 CONCENTRATION OF TRADE

Definition

Component manufacturers who trade exclusively with the automotive industry are dependent upon this industry for their continued existence. This degree of dependency is reduced as component suppliers trade with other industry sectors, not directly connected with the automotive industry.

This study defines concentration of trade as the degree of dependence an organisation is said to have, based on the volume of trade it achieves within the automotive industry compared with the total volume of trade it undertakes.
Increasing dependence on the automotive industry appears to flow from component suppliers becoming locked-in to longer-term relationships with their major customers, the four multinational vehicle assemblers. Component manufacturers that only trade with the automotive industry are in essence totally dependent on this industry for their continued existence. In their study of Australian component suppliers, Marceau and Jureidini (1992) found more than a quarter of firms relied extremely heavily on one customer for their business, in which they sold over 50 per cent of their core product to that single customer.

The decision by Nissan Japan to close its Australian assembly plants in October 1992 caused varying responses from their local suppliers. Webb and Wood (1992) concluded that a number of their major suppliers had either been reducing their exposure to Nissan or believed they would increase their sales to other former Nissan competitors. On the other hand, sole first tier suppliers to Nissan and their second tier suppliers unable to negotiate new contracts with other customers would suffer severe setbacks to their business, estimated by Webb and Wood (1992:5) at a loss of 6,000 workers.

The mandatory adoption of EDI in the Australian automotive industry also resulted in varying responses (Mackay 1992c) from suppliers. Generally, the larger (usually multinational) companies saw EDI adoption as a relatively trivial exercise in response to the industry’s call to become more competitive. The cost, relative to their industry revenues, was comparatively negligible. However, many of these large suppliers were dependent on their customers for expected long-term contracts. Their commitment was necessary given the significant design and tool costs involved in responding to customer requirements. The added pressure of increased competition from international component suppliers, following the continued decline in level of tariff protection in the late 1980s and early 1990s, no doubt contributed to greater compliance.

Galliers (1987:234) points to a different type of organisational dependence, one that is based on ‘information systems and of information systems diffusion within the organization’. The consequence of this dependence for larger organisations is a reliance on their information systems in contributing to gains such as cost savings. To the extent that EDI contributes to costs savings, dependent organisations are likely to introduce EDI through an already identified commitment by senior management.

To the degree that EDI facilitates JIT inventory management, Marceau (1992:5) points out that ‘tight control of the production process is necessary, both inside and outside the

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central manufacturing plants in the chain’. In mandating the adoption of EDI, organisations with greater reliance on the automotive industry for their business are logically more likely to adopt EDI in response to their major customers’ demands. As Marceau (1992a:28) describes, the affect of such requirements does not end here:

*Any major new technologies, both physical equipment and managerial strategies, affect firms in other places in the chain. Those associated with computer related technologies [e.g. EDI] and JIT/TQC may be expected, a priori, to have particularly strong and far-reaching effects on the operating strategies of others in the chain. The internal logic of the system suggests that to work effectively others in the chain must adopt the same strategies.*

The study reported by Marceau and Jureidini (1992) concluded that other than for a few very large companies, the majority of suppliers were small organisations who were up to 80 per cent reliant on their few (up to five) exceedingly larger customers. This dominance suggests almost instant compliance with the *requests* of these customers.

To the extent that suppliers are dependent on the automotive industry, senior management commitment should be a positive characteristic of these organisations. This leads to the proposition that:

*RP7: The concentration of trade an organisation achieves with the automotive sector has a direct positive effect on the level of senior management commitment to EDI.*

Firms that are less dependent on the automotive industry for their main business and uncertain of the potential benefits to be achieved from EDI adoption, are unlikely to embrace EDI voluntarily—to them it appears to be simply an additional and unnecessary cost of doing business. Many of these firms, coerced into using EDI, will not necessarily use the technology other than to satisfy their customer demands. Mackay (1992c) showed that such firms had little senior management commitment to EDI, and certainly had not integrated EDI into their internal application systems. In essence, they merely used EDI as an *expensive fax machine*, by simply printing out the electronic orders and rekeying them into their own order/entry system.

While this use of EDI may not have been the most appropriate, the fact that these organisations did use it, does not preclude them achieving some net benefit. For example, reduced postage and telephone usage combined with improved data accuracy from their customer, may achieve some net gain. Organisations that use EDI in this *minimalist* way leads to the proposition that:
RP8: The concentration of trade an organisation achieves with the automotive sector has a direct positive effect on net benefits derived from EDI.

The automotive industry’s move toward the Japanese-led lean production technique of manufacturing (Womack et al. 1990) brings with it certain requirements. Bordone (1993) stresses that in order for component manufacturers to react to the demands of its customers, the old order processing procedures need to be fully revised. Logistically, the pressures on the organisation are to achieve three things: to be able to take quick decisions; to be able to take a global perspective on product costs; and be fully integrated. Bordone (1993:76–77) adds:

The first step is to move towards a full integration inside the company and with the external suppliers: this is necessary to increase the service to the customer, minimizing the costs. ... Integration means co-operation: the supplier must become a partner and the objective is to maximize the performance of all the elements of the supply chain together.

To achieve full integration, Bordone stresses that instruments like EDI are needed, combined with appropriate standards (e.g. ANSI ASC X12 and EDIFACT) allowing fast inter-company transfer of information to be achieved at minimal cost.

The need for fast, efficient and reliable information exchange in response to changing markets is emphasised by Cash and Konsynski (1985:135) in stating that:

The combination of decreasing costs and increasing capability has resulted in a broader range of internal computer applications. As more and more data are stored in computers, the natural next step is to transmit these data in machine-readable form wherever they are needed. This prevents redundant encoding of data and makes information readily accessible. Both the money and the time saved easily justify such data and resource sharing.

The rising trend in the global automotive industry, including Australia, is for car manufacturers to deal with fewer parts suppliers. There is a developing reliance on sub-assembly techniques where smaller suppliers (typically second tier suppliers) provide components to larger first tier manufacturers, who then assemble the components before sending them just-in-time to the car manufacturers (Marceau 1992a; Marceau and Jureidini 1992). While there is an obvious mutual dependency between supplier and customer (Marceau 1992a) in this exchange, success depends very much on the successful integration of facilitating technologies such as EDI.

This leads to the final research proposition of this study that:
RP9: *The concentration of trade an organisation achieves with the automotive sector has a direct positive effect on the extent of system integration.*

### 3.3 CHAPTER SUMMARY

This chapter has outlined the fundamental research propositions to be tested in this study. In essence, the propositions state that the two exogenous variables—company size and concentration of trade—both directly and indirectly influence the level of net benefits received by adopters of EDI, through their effect on senior management commitment and extent of system integration.

The next chapter describes the research method used and instruments developed to test these propositions.
Chapter 4
Research Method

The previous chapter described the nine principal research propositions to be tested in this study. This chapter outlines the research method used to test those propositions.

The chapter is divided into five sections. Section one details the research design; section two, the research environment (including the research setting and key participants); section three, the procedure followed in developing the research instruments to be used in the testing phase, and the method and sources of all data collected; section four outlines development of the research instrument including validity and reliability testing; finally, section five summarises the chapter.

4.1 RESEARCH DESIGN

Research design may be defined as ‘the plan and structure of investigation so conceived as to obtain answers to research questions’ (Kerlinger 1986:279). In seeking to provide answers to the research questions, the research design must endeavour to control both extraneous and error variance inherent in the research method. Adequately planned and executed, Kerlinger concludes that research design provides a framework that suggests (rather than tells) the direction the researcher should proceed in observation-making and analysis.

A number of authors have classified research methods into categories that allow an assessment of their individual strengths and weaknesses. The classifications often appear as opposites. For example, Galliers (1991) lists research categories and approaches under two main headings—scientific and interpretivist. Under the former he includes surveys, case studies and field experiments, while the latter embodies action research, futures research and reviews. Cooper (1992) highlights the debate over the value and contributions of quantitative versus qualitative research in the social sciences. The debate often leads to the conclusion that the two are necessarily opposed, rather than complementary.
Case study methods have been criticised on grounds of poor controllability, deductibility, repeatability and generalisability (Gable 1992). Yin (1989:21) responds to such criticisms by concluding that ‘case studies, like experiments, are generalizable to theoretical propositions and not to populations or universes.’ In essence, a case study should not be seen as a sample (as in survey work), but rather the goal of the researcher is in the expansion and analytic generalisation of theories. Yin suggests four different applications for using case study methods in evaluation research: firstly, in explaining the causal links in real-life intervention situations; second, in describing the real-life context in which the intervention occurred; third, in providing an illustration of the intervention itself; and finally, as a tool to explore the situation following the environment in which the intervention occurred, where outcomes are unclear.

In answering their own question as to who does qualitative research? Strauss and Corbin (1990) conclude that this style of research is undertaken by researchers in both the social and behavioural sciences in studying organisations, groups and individuals, and may be performed by persons alone or in a team. Strauss and Corbin (1990:19–20) further state:

> When qualitative methods are combined with quantitative ones, the qualitative aspect is usually subsidiary to the larger research project and is likely to be carried out by individuals or a small team of specialists.

Gable (1992) reports a classification by Emory who enumerates seemingly opposing research design paradigms. These paradigms include case study versus statistical methods, field versus laboratory experiments, and observational versus survey. While these design methods may appear to represent competing research designs, they can be used to complement each other, for example, following the integrated approach adopted by Gable (1992).

As Warwick and Lininger (1975) observe, all methods of collecting data are only approximations to knowledge. Whatever method or methods are finally chosen, the researcher is only provided with particular (and varying) glimpses of reality. In making their methodological decision, Warwick and Lininger believe that researchers will need to consider questions relating to cost, time, experience, qualifications and available facilities. To this should be added cooperation from the subject under investigation.
The research design chosen for this study is an integrated case study which incorporates both cross-sectional and longitudinal data collection methods. The case study design incorporates features proposed by Yin (1989):

A case study is an empirical inquiry that:

- investigates a contemporary phenomenon within its real-life context; when
- the boundaries between phenomenon and context are not clearly evident; and in which
- multiple sources of evidence are used.

The integrated case study is the primary method chosen for this study, and other methods of analysis are used to supplement and assist where grounds were believed to exist for the enhancement of the case study approach and to avoid some of its claimed criticisms (see Lee 1989; Myers 1994). This approach bears resemblance to a modified case study approach where not only are multiple sources of evidence used, but other research strategies (individual surveys) are employed to assist in providing an insight into the extent of net benefits received from using EDI in the Australian automotive industry. This research approach fits into the field research method described by Kerlinger (1986) and Fidel (1992).

In choosing the longitudinal approach, the researcher was influenced by reasons which can best be summed up by Menard (1991:5): ‘Longitudinal research serves two primary purposes: to describe patterns of change, and to establish the direction ... and magnitude ... of causal relationships.’ It was also chosen because a search of the information systems literature failed to unearth anyone else who has attempted to measure EDI benefits in this way, a deficiency identified by Clarke (1991) and Bergeron and Raymond (1992).

A repeated cross-sectional design method of data collection was used for the longitudinal approach. According to Menard (1991) this method may be appropriate where data are collected on the same set of variables, and cases are comparable between periods. As essentially the same group of Ford suppliers was used in each survey period, both of Menard’s criteria are fulfilled. In addition, and to assist in overcoming any potential limitations imposed by the method of repeated cross-sectional design (Menard 1991:27), it was possible to identify a representative group of respondents participating in both surveys. This group was used to aid in the further analysis and interpretation of results using a modified conceptual model described and reported in the next chapter.
The research design chosen for this study closely mirrors that of Gable (1992). In essence, it was chosen to provide a contextual framework for the variables chosen for the study; as a source of quantitative data providing detail of firms’ experience with EDI; as a means of triangulation in blending the case study experiences of a few firms with the quantitative data obtained from a survey of the whole industry sector (that is, ‘as a repeated experiment,’ Gable 1992:702); to develop meaningful relationships with a small number of firms to assist in pilot testing the questionnaire responses; and finally, to provide a method of cross-checking survey responses to assist in validating research instruments of measurement.

4.2 RESEARCH ENVIRONMENT

In assessing the most appropriate research design, the researcher was influenced by the work of Warwick and Lininger (1975) who suggest six criteria that should be considered.

The appropriateness to the objectives of the research deals with which method will best provide the type of data needed to answer the research propositions posed in the study. In testing the research propositions outlined in Chapter 3, quantitative data were considered the most appropriate primary source of data. This was supported by case study material in two ways: first, in developing the initial survey questionnaire, and second, in providing an additional means of triangulation in supporting the quantitative-based results from the two surveys.

The accuracy of measurement refers to the generalisability of the measurements adopted by the study in question, making a judgement as to the most appropriate method from other possible related measurements that may have been chosen. Accuracy of measurement includes such factors as quantification, replicability, qualitative depth and control over observer effects, which if not taken into account in choosing the most appropriate method, may result in reducing the accuracy of the variables being measured. The choice of measurement used in this study attempted to follow the work of related studies. Where a measurement had not been developed, the researcher constructed his own.

The generalisability of the results refers to the extent to which the results obtained may be generalisable to a broader universe or population, making it imperative that the researcher knows how representative the chosen sample is of the population about which conclusions are to be made. By surveying the whole industry sector of
component suppliers, an attempt was made to reduce any variability caused in adopting sampling methods. The size of the sector made a census possible. In choosing the research method, the researcher was aware of the need to consider the generalisability of the results outside the present context of the Australian automotive industry.

*Explanatory power,* refers to the power of the chosen method which will assist in an analysis of causation. As Warwick and Lininger (1975:7) state, ‘The question then becomes not only *who* or *what,* but also *why*.’ Structural equation modelling, the method of data analysis outlined in the next chapter, allows conclusions about the direction and strength of causation to be made. This is based on the conceptual model described in Chapter 3.

*Administrative convenience* is achieved if the chosen method is performed at minimum cost, with rapid speed and with few, if any, demands on management. The authors stress the importance in obtaining the correct balance between high accuracy, generalisability and explanatory power with the appropriate degree of administrative convenience. Both the chosen method and selected context (the Australian automotive industry) satisfied this criterion. Cooperation was sought from within the Australian automotive industry, most of which is based in Victoria—the resident State of the researcher.

*Avoidance of ethical and political problems* can occur in one or both of two ways. First, problems that are unavoidable which the researcher must address during the conduct of the research; and second, those problems which are avoidable given proper planning and judgement. Essentially, this issue addresses the problems arising from relationships with respondents (including ethical notions of privacy and confidentiality) and sponsorship (e.g. avoidance of controversy and claims of bias toward sectional interests). Potential ethical and privacy problems for this study were minimised through appropriate planning. Such planning involved obtaining Deakin University’s ethics committee approval for the surveys. The researcher offered to sign a confidentiality agreement for Ford Australia’s management, although ultimately this was not required by Ford. Further, a printed statement on the surveys indicated that all information provided by component sector respondents would not be individually divulged, and all questionnaires would be appropriately stored at the completion of the study.

In summary, the chosen integrated case study and survey method described earlier, sought to include the complementary advantages of both quantitative and qualitative research methods, while minimising the disadvantages of each, with the intent to complete the study in a rigorous and timely manner.
4.2.1 RESEARCH CONTEXT

Chapter 2 described EDI adoption in Australia, reporting that it had been a relatively slow and spasmodic process across most industries adopting the technology. The first Australian industry sector to pilot EDI was K-Mart, a business unit of Australia’s giant retailer, Coles-Myer. K-Mart trialed EDI with a handful of suppliers before committing itself (and ultimately its suppliers) to a full implementation. The only other industry to have embraced EDI to anything beyond a pilot stage was the Australian automotive industry.\(^1\)

At the commencement of this research project (mid-1990), the automotive industry had been using EDI for about two years, following its initiation and subsequent development by the automotive industry and Telecom (the chosen network provider) in 1986. The final selection of the automotive industry was appropriate for a number of unique reasons. First, it was the inaugural industry to adopt EDI as an industry, rather than as individual organisations within an industry (e.g. K-Mart). Second, it was the only industry that had had anything approaching a maturing period of experience with EDI. This experience would assist in any measurement of the diffusion process of EDI during 1991–94. Third, the network provider, Telecom, and the automotive industry itself, were most willing to cooperate in providing assistance with this research.

Initial contact with the automotive industry was made with the assistance of Telecom during its national Automotive EDI Conference held in Melbourne on 5th and 6th of July 1990. The conference, sponsored by the FCAI (representing the five vehicle manufacturers), the FAPM (representing the component suppliers) and Telecom Plus (the EDI network service provider), provided a forum for the dissemination of information about EDI. Sixty-two delegates were present, including seven representing the vehicle manufacturers, the remainder being drawn primarily from component suppliers and the transport sector. During this conference, initial contact was made on the researcher’s behalf by Telecom’s EDI manager with Ford Australia and GMH, as potential contenders for the research project.

Following the EDI conference, Ford Australia, through its EDI Supply Systems Planning Manager, expressed Ford’s interest in the proposed research, and asked the researcher for a letter outlining the extent of Ford’s involvement in the project, which

\(^1\) It should be noted that the government sector, particularly the State Government of Western Australia, was an early non-industry user of EDI in Australia (see Government of Western Australia 1990), but was not considered for investigation by this study.
was forwarded to Ford’s Director of Supply for approval. On the 29th October 1990, approval for Ford’s involvement and cooperation was confirmed.

In summary, gaining the necessary cooperation to conduct the study initially involved securing the cooperation of both Telecom and Ford Australia, through a process of negotiation involving a detailed explanation of the project, the extent of each participant’s involvement, and potential benefits which might accrue to the industry as a result of the findings of the project. Interviews held with senior personnel in both organisations confirmed the timeliness of the study.

The basis of the agreement with Ford allowed the researcher frequent contact with the Manager, Supply Systems Planning, a detailed tour of the main assembly plant at Broadmeadows, Victoria (setting the context for EDI at Ford), and access to Ford’s list of component suppliers, including their EDI status. In addition, it was agreed by Ford and Telecom that the researcher should attend the monthly automotive industry EDI sub-committee meetings at which all aspects of the industry’s EDI implementation were proposed prior to enactment by the individual companies. The committee consisted of two representatives from each of the five vehicle assemblers, three representing the component sector, one from the FCAI, Telecom’s automotive industry EDI account manager and the FAPM’s EDI project manager.

Attendance at the automotive industry EDI committee meetings proved to be a most valuable source of information to the research project, and enabled the researcher to rapidly become aware of the changes proposed by the industry in their pursuit of full EDI implementation. Following the initial meeting attended by the researcher, the appropriateness of selecting Ford Australia for the case study became abundantly clear. There was little doubt that, compared with the other four assemblers, Ford Australia had shown a degree of industry leadership in the implementation of EDI with its own suppliers, not apparent amongst its four competitors.

For example, both Toyota and Nissan were initially not in a position (until late 1991) to use EDI between their assembly plants and their suppliers. The interim procedure adopted was to rekey data from their mainframe computer’s MRP system into a standalone PC for sending MRS documents to their suppliers. Receipt of ASNs followed the same route, but in reverse. Mitsubishi, the automotive industry EDI pioneer, had fallen behind both Ford and GMH in its implementation plans since the
recent retirement of Colin Hill, Mitsubishi’s MIS manager.\(^2\) It was difficult to discover the extent of GMH’s EDI implementation, but discussions with the FAPM project manager confirmed GMH was second only to Ford in EDI development.

In the early stages of this project (late 1990 to early 1991), it became clear that the proposed case study should not focus so much on Ford Australia, but on Ford’s component suppliers. While Ford had initially invested about $100,000 directly into developing an integrated EDI within its recently enhanced MRP system (personal communication), it was the component suppliers who were really feeling the major impact of the industry’s decision to adopt EDI. Further, it was the component suppliers who spent most of the second day of the July 1990 national conference asking their vehicle assembly customers, \(\text{what’s in it for us}\)? Many at the conference openly stated their belief that the five assemblers were simply pushing EDI implementation solely for their own benefit, with little consideration of the likely impact it would have on component suppliers.

4.2.2 PROJECT PARTICIPANTS

The change in focus for this study led the researcher to modify the design of the project, to include methods that would provide satisfactory answers to Warwick and Lininger’s (1975) six questions outlined earlier. The most appropriate method chosen was a combination of survey research and participant observation.

Survey Research

Warwick and Lininger (1975:9) state that survey research methods are generally a useful means of collecting information under three conditions:

\[
\text{when the goals of the research call for quantitative data, when the information sought is reasonably specific and familiar to the respondents, and when the researcher himself has considerable prior knowledge of particular problems and the range of responses likely to emerge.}
\]

As little was known about the status of EDI adoption or its impact amongst component manufacturers, the researcher decided that quantitative data were necessary in order to

\(^2\) Shortly after his official retirement from Mitsubishi, Colin Hill was employed as an EDI consultant to Telecom Plus, to work primarily with the automotive industry.
classify information about the industry sector’s response to their customers’ pressures to become EDI enabled.

In an attempt to minimise any inherent compounding factor variance in the survey (see Kerlinger 1986), the participants chosen for this study were confined to component suppliers of Ford Australia’s vehicle assembly plants at Broadmeadows, Victoria. Ford provided a list of about 230 suppliers who were identified as PMV (passenger motor vehicle) suppliers of parts to the Victorian manufacturing plants and spare parts division. Of these suppliers, 80 were using EDI, representing about 36 per cent of all suppliers, but approximately 80 per cent of all parts supplied.

The Ford EDI manager noted that the list provided to the researcher was accurate at the time of printing, but within a year or so, Ford expected to reduce its number of suppliers from 230 to about 180. It was anticipated that EDI would be a contributing factor in this reduction, as suppliers unwilling to adopt EDI were replaced with more compliant ones, including encouraging diversification from amongst existing Ford suppliers. Where a replacement supplier was not available, every effort would be made to encourage that supplier to become EDI enabled. Additionally, even without the influence of EDI, suppliers are both added to, and deleted from, Ford’s preferred supplier list according to the vagaries of the industry’s market forces.

Discussions held between Ford’s supply manager, the FAPM project manager and Telecom, concluded that all surveys should be sent direct to the EDI coordinators identified on Ford’s supplier list. They were confident that the questions specifically related to EDI should be familiar to them. The experience gained from observation at the industry EDI sub-committee meetings, discussions with Ford and the FAPM, provided the researcher with sufficient background knowledge to identify particular problems and assess the likely range of responses gained from the two surveys. The FAPM’s experience of the industry proved invaluable in the development of the survey and construction of the instrument discussed later in this chapter.

**Participant Observation**

On the question of participant observation, Warwick and Lininger (1975:10) see its relevance

*when the study requires an examination of complex social relationships or intricate patterns of interaction; [and] when a major goal of the study is to construct a qualitative contextual picture of a certain situation or flow of events.*
It was important to use participant observation in two ways: first, as a means to identify appropriate questions to ask in the surveys; and second, to discern more closely, through semi-structured interviews, the specific context for the impacts EDI was having on suppliers. Initially, twelve suppliers were chosen to assist in the survey design and pilot testing stages. The selection procedure of firms was also influenced by the research of Straub (1989), whose basis for selection of interviewees included various expertises, organisational roles and geographical regions, designed to provide maximum feedback from a range of expertise in designing a valid research instrument.

The twelve suppliers chosen represented what the industry calls high-end, middle-end and low-end EDI user suppliers. The three categories represent the range of EDI use with Ford Australia from high-volume through medium to low-volume suppliers. Typically the three categories also represented large, medium and small suppliers to Ford.

Selection was made in consultation with Ford, the FAPM project manager and Telecom, based on the criteria of length of experience with EDI, volume of EDI transactions, size of the organisation and potential cooperation exhibited from past experience with Ford and the FAPM (to provide maximum feedback as described by Straub 1989). Appendix C provides additional details about each of the companies. Their related responses are summarised in Appendix D.

From the initial list of Ford suppliers, the following twelve automotive supplier organisations were chosen:

<table>
<thead>
<tr>
<th>High-end Users</th>
<th>Middle-end Users</th>
<th>Low-end Users</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hella Manufacturing</td>
<td>L R Alderson</td>
<td>Watsford (Aust.)</td>
</tr>
<tr>
<td>Pacific BBA (PBR)</td>
<td>BTR Kennon</td>
<td>CPC Auto Components</td>
</tr>
<tr>
<td>Yazaki Australia</td>
<td>Bostick (Aust)</td>
<td>K &amp; K Fastners</td>
</tr>
<tr>
<td>Hendersons</td>
<td>South Pacific Tyres</td>
<td>Plastic Component</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Painting</td>
</tr>
</tbody>
</table>

Finally, semi-structured interviews were conducted with Ford’s senior managers who had direct knowledge of the impact of EDI’s integration at the Broadmeadow’s plants. The four areas of EDI integration at Ford were discussed in Chapter 2.

4.3 RESEARCH PROCEDURE
This section discusses the procedure used in the construction of the research instrument and the method used in data collection. The principal sources of data used in this study are the two surveys, the first conducted between late November 1991 and January 1992 (the 1992 survey) and the second between the same months in 1993 and 1994 (the 1994 survey). The formation of the instrument is used to test the nine research propositions outlined in the previous chapter. The supplementary sources include the twelve case studies conducted during the period of the 1994 (second) survey. Additionally, semi-structured interviews were conducted at Ford in November and December 1993.

4.3.1 CONSTRUCTING THE RESEARCH INSTRUMENT

Exhibit 4.1 graphically outlines the research procedure followed throughout this study. A flow diagram illustrating each of the stages performed and important information flows between the stages is shown. The diagram highlights the inputs and outputs flowing between the particular phases in the formulation of the surveys and case studies.

During the year immediately preceding the first survey, an extensive review of the EDI literature focused on the components that made up the research model, in particular, the benefits attributed to EDI. Following the review, a list of potential net benefits was compiled which ultimately led to the construction of a scale to measure the result variable, net benefits. The other key components of the research model were identified with the assistance of the FAPM project manager. These components focused on the question of EDI integration and organisational commitment.

In gaining the full cooperation of the FAPM, supplementary questions to those required for this particular research study were added at their request. These questions focused on suppliers who had not signalled their intention to adopt EDI, issues the suppliers believed were of major concern to their organisation for its continued use, and other non-automotive industry use of EDI (e.g. for customs clearance purposes).

4.3.2 THE EXPLORATORY STUDY AND PILOT SURVEY

There were essentially three reasons for conducting an exploratory case study and pilot survey. First, to assist in the identification of the key variables and items component sector organisations deemed important; second, to provide an assessment of the
readability of the questionnaire in terms of its general layout and the organisations’ cognition of the questions asked; and third, to test the reliability of the instrument in the context of its real-world setting.
Exhibit 4.1 Research Procedure

1. Define Research Agenda
2. Review Related Literature
3. Research Propositions
4. Develop Pilot Case Study
5. Research Context
10. Potential Variables & Relationships
27. Document Pilot
20. Survey Instrument
13. Develop Conceptual Model
18. Determine Variables & Instruments
22. Pilot Test Survey 1
32. Industry Tested Instruments
33. Conduct Survey 1991–92
37. Produce Descriptive Statistics
39. Descriptive Statistics
44. Conduct Validity & Reliability
47. Validated Constructs
38. Survey 1991–92 Data
Exhibit 4.1 Research Procedure (cont'd)
Exhibit 4.1 Research Procedure (cont'd)

1. Validated Constructs

2. Test Model 2 & Research Propositions

3. Analyse & Interpret Findings

4. Report Findings 2

5. Develop Longitudinal Model

6. Analyse & Interpret Findings

7. Finalise Multiple Case Studies

8. Conduct Multiple Case Studies

9. Analyse & Interpret Results of CS

10. Report Results of Case Studies

11. Use Cases to Support Survey

12. Documented Structured Questions

13. Document Findings

14. Hypothesised Relationships

15. Model Results

16. Model Findings

17. Documented Interviews
Following the identification of potential key variables for inclusion in the study, an initial draft case study questionnaire was developed. Three of the twelve component sector organisations identified earlier were asked to participate in this essentially exploratory phase. Feedback from the three cases ultimately led to a draft of the first survey questionnaire. In addition, Ford Australia, the FAPM CEO (based in Canberra) and the FAPM project officer, were invited to provide a detailed assessment of the draft questionnaire. At all stages in the development of these questionnaires, reference was made to a number of experienced academics skilled in research methods. In concert with the development of the questionnaire, the conceptual model was formalised and documented.

This stage in the evolution of the questionnaire led to the development of a Likert-type scale of net benefits. Feedback from the three case studies in particular, and industry experts, provided particularly useful input into the final list of items perceived to be identifiable by component manufacturers following EDI adoption. Their feedback also led to the scale of net benefits being redesigned.

Changes suggested by the various participants included changes to the layout and wording of some questions. Several supplementary questions requested by the FAPM were included. Why was EDI adopted (as an indicator of the extent of coercive adoption)? What were issues of concern in continued use of EDI? What further EDI developments would the sector like to see occur? What was supplier assessment of EDI’s impact on the total automotive industry? Additional questions were related directly to those manufacturers not EDI enabled were added to the questionnaire. The questions used were tailored to reflect the use of EDI in the Australian automotive industry, and to reflect the originality of the survey. They could be applied to other industries following appropriate modifications.

Given the sensitivity of the information requested from component suppliers, confidentiality was to be strictly adhered to by the researcher. However, in order to provide identification of suppliers for the conduct of the longitudinal study (following the second questionnaire), suppliers were invited to record their name, position, company name and telephone number as they completed the questionnaire. Approximately 80 per cent of respondents completed the requested identifying information.

4.3.3 THE FIRST SURVEY 1992
Surveyed Population

The first questionnaire was mailed to 226 Ford Australia component suppliers identified from a list jointly provided by Ford and Telecom Australia in late November 1991. Two groups of automotive industry suppliers were represented: EDI capable suppliers who were trading electronically with Ford Australia, and who were registered with Telecom Plus as Tradelink (auto) users; and those suppliers who were not EDI capable at the time of answering the questionnaire.

The Telecom registered group consisted principally of original equipment (OE) manufacturers who in aggregate supplied between 72 per cent and 92 per cent of component parts (depending upon which automotive customers they supply) to the passenger motor vehicle assembly lines, and spare parts divisions of the automotive industry. The total number of industry respondents was 51 per cent of actual EDI users and 34 per cent of non-EDI users. This represented an overall effective response rate of 47 per cent.

All EDI capable respondents were registered with Telecom as users of the proprietary EDI software called Tradelink (auto). To ensure anonymity, Telecom provided the mailing facilities for the questionnaire, which included an accompanying letter from the FAPM explaining the reason for the survey and seeking their full cooperation. Suppliers were asked to respond within three weeks of receiving the questionnaire. All survey questionnaires were addressed to the EDI Coordinator, the person identified from Ford and Telecom’s mailing list as the person responsible for EDI facilitation within the organisation. Ford, Telecom and the FAPM all agreed that the EDI Coordinator for each firm would be the person best equipped to respond on behalf of the company. Generally, the EDI coordinator was at least a middle-manager, frequently a senior manager, and sometimes the CEO (particularly in small companies).

The coding system used for monitoring the questionnaires allowed a follow-up letter to be sent, via the Telecom facility, to organisations not responding to the initial request. Further compliance was assisted through visits by the FAPM EDI project manager to member organisations during the survey period. Both these methods assisted in achieving the high response rate not normally associated with mail questionnaires.

3 Telecom Plus was the EDI division of Telecom Australia which provided all EDI services to the Australian automotive industry; Telecom changed its corporate name to AOTC in 1992 following its merger with OTC, and was renamed Telstra in 1993. Telecom Plus became Telstra Enhanced Services; recently it was renamed Telstra Multimedia, having assumed responsibility for pay TV and teleconferencing.
Organisations who had agreed to supply a contact name and telephone number for response clarification purposes were contacted if there was missing information, or responses to open-ended questions required clarification. This procedure resulted in only one returned questionnaire being deemed invalid (no name or telephone number provided). In all, 106 suppliers responded, 105 proved usable responses.

The First Questionnaire

Respondents were asked to complete 39 questions, including six open-ended questions. Most of the questions asked respondents to circle or tick a response. Two questions asked for specific data based on establishment and running costs of EDI. Instructions were provided at the beginning of the questionnaire to assist participants in completing the requested task with an assurance of confidentiality and requested completion date. A self-addressed envelope (addressed directly to the researcher) was provided with each questionnaire.

The questionnaire is divided into seven sections (see Appendix A). Section one asks questions about the nature of the organisation; section two asks EDI specific questions; section three relates EDI experience to inventory changes; section four asks about changes to supplier trading relationships with their customers; section five concerned Ford suppliers alone; section six related specifically to other non-automotive manufacturers which suppliers traded with using EDI; and section seven was completed only by respondents who had not adopted EDI.
4.3.4 THE SECOND SURVEY 1994

Following an analysis and dissemination of the results from the 1992 survey, a review of the first questionnaire was undertaken in preparation for the second questionnaire exactly two years later. Two years was chosen as an appropriate period of time between surveys, keeping in mind the criteria outlined by Warwick and Lininger (1975). Industry observers also deemed the period as one in which many component suppliers were continuing to experience identifiable impacts from EDI adoption, including a period when a number of larger first-tier suppliers had commenced integrating EDI into the second supplier tier (see Svinicki 1988). The two-year period also coincided with the closing of Nissan Australia’s assembly plant in Victoria towards the end of 1992.

The Second Questionnaire

Minor changes were required to the first questionnaire before it was redistributed to the original group of Ford suppliers. The second questionnaire was expanded by a net two questions, added to the minor redrafting of a number of questions to improve the wording (see Appendix B). For example, responses from the first survey allowed a checklist to be prepared for the original Q14 (difficulties of integration) to be categorised. Inventory-related questions (Q21 and Q22) were redesigned to aid understanding. An additional question asked respondents if they believed they had received strategic or competitive advantages from EDI. An open-ended question followed, inviting participants to elaborate their answer.

Other than minor wording changes to Q22 concerning *net benefits*, none of the questions directly related to the repeated cross-sectional design variables used to test the conceptual model were amended. Exhibit 4.2 provides a comparison of questions between the two surveys for the five key model components, to assist in matching variables from both questionnaires.
Exhibit 4.2 Questionnaire Matching 1992–94

<table>
<thead>
<tr>
<th>Variable</th>
<th>1992 Survey</th>
<th>1994 Survey</th>
</tr>
</thead>
<tbody>
<tr>
<td>Company Size</td>
<td>Q1</td>
<td>Q1</td>
</tr>
<tr>
<td></td>
<td>Q2</td>
<td>Q2</td>
</tr>
<tr>
<td>Concentration of Trade</td>
<td>Q3</td>
<td>Q3</td>
</tr>
<tr>
<td>Management Commitment</td>
<td>Q15</td>
<td>Q18</td>
</tr>
<tr>
<td></td>
<td>Q16</td>
<td>Q19</td>
</tr>
<tr>
<td>Extent of System Integration</td>
<td>Q13</td>
<td>Q16</td>
</tr>
<tr>
<td>Level of Net Benefits</td>
<td>Q19</td>
<td>Q22</td>
</tr>
</tbody>
</table>

The complete questionnaires are included as Appendix A and Appendix B

Conduct of the 1994 Survey

The original list of Ford suppliers (incorporating new suppliers and the loss of others—a source of what Menard (1991) calls panel attrition) was reassembled by Telecom for administering the second survey. Identical procedures to the first survey were adopted by Telecom. A total of 207 component manufacturers were sent the questionnaire, of which N=114 responded, providing a response rate of 55 per cent. In addition, 44 suppliers were able to be identified as having completed the 1992 survey. This information is used in the formulation of what Menard (1991) calls pure longitudinal research, whereby data for the same subjects or cases are collected.

Multiple Case Studies

The final stage of data collection involved the design of a semi-structured questionnaire to assist in the conduct of interviews of the original 12 component manufacturers identified in 1991 (see Appendix E). During the second survey collection period, interviews with all 12 case suppliers were scheduled and completed. Interspersed with supplier interviews were cognate meetings (using a similar semi-structured questionnaire) with four key management executives at Ford Australia’s Broadmeadows assembly plant (see Appendix F). All interviews were recorded and later transcribed. In addition to providing assistance with the design of the original questionnaire, the 12 case studies were used in providing a further degree of triangulation in presenting the results of this study.

4 In reality there would have been additional matching companies, but as in the first survey, some suppliers did not provide contact details, and therefore could not be identified.
4.4 THE RESEARCH INSTRUMENT

Section 4.3.3 described the questionnaire used to provide the data required in testing the first stage of the conceptual model. This section describes the variables used to represent the various components of the model outlined in Chapter 3, and the procedures used to test scale reliability and construct validity.

4.4.1 MODEL COMPONENTS

Exhibit 4.3 summarises the five components of the conceptual model developed in Chapter 3, and the nature of the variables used in estimating each component.

<table>
<thead>
<tr>
<th>Conceptual Model Component</th>
<th>Measured Variable</th>
</tr>
</thead>
<tbody>
<tr>
<td>Company Size</td>
<td>Annual Turnover; Number of Persons Employed.</td>
</tr>
<tr>
<td>Concentration of Trade</td>
<td>Percent of Trade with the Auto. Industry.</td>
</tr>
<tr>
<td>Level of Commitment</td>
<td>Highest Level of Management Involvement; Position of EDI Coordinator.</td>
</tr>
<tr>
<td>Extent of Integration</td>
<td>EDI Documents Integrated with Application Systems.</td>
</tr>
<tr>
<td>Net Benefits</td>
<td>Perceived Net Benefits Scale.</td>
</tr>
</tbody>
</table>
Company Size

In developing a scale to measure company size, cognisance was given to the organisational theory literature in which many of the reported studies used number of employees. For example, Robbins and Barnwell (1994:135), in defining organisational size, state that: ‘Over 80 per cent of studies using organisation size as a variable define it as the total number of employees.’ The authors allude to some of the difficulties with the measure, in particular that measuring full-time employees ignores organisations in which part-time employees predominate.

In order to overcome the difficulty in measuring full-time and part-time employees, participants were asked to estimate the total number of full-time equivalent employees, explicitly incorporating all employed persons within their organisation. Robbins and Barnwell (1994) also conclude that total number of employees appears to be closely related to other measures of organisation size, for example, net assets. For consistency and comparison with other studies of size, this study chose number of persons employed (full-time equivalent) as the measure of organisation size (see Appendix A, Q2). With the assistance of automotive industry experts familiar with the size of component sector organisations, a seven-point Likert-type scale was developed to measure number of persons employed. The scale ranged from organisations with fewer than 20 full-time equivalent employees to in excess of 1,000 employees.

While number of persons employed appears to be an accurate and consistent measure of organisation size (Robbins and Barnwell 1994:135), the researcher decided to test a further measure of size, namely annual turnover. Respondents were asked to state the annual turnover contribution (in $million) their organisation receives from supplying the automotive industry. Once again, a seven-point scale was used in developing the measure (see Appendix A, Q1). The scale ranged from less than $1.0 million to greater than $200 million.

Concentration of Trade

In determining a measure of dependency, the researcher developed a scale measuring the percentage of trade each organisation was engaged in with the automotive industry (including overseas trade). The industry experts concluded that it would be difficult for any individual firm to make a precise measurement of the percentage, so a ten-point scale was developed (see Appendix A, Q3) covering less than 10 per cent trade to 90–100 per cent trade.
Level of Commitment

The theory underpinning the construct commitment was described in Chapter 3. In developing a measure of commitment, two scales were developed by the researcher, namely, the highest level (or position) of active management participation in the implementation of EDI, and the position of the person responsible for the day-to-day (continuing) coordination of EDI within the organisation. Once again, the industry experts provided confirmation of the position titles that respondents would be most familiar with in responding to the two questions (see Appendix A, Q15 & Q16).

Extent of System Integration

At the time of administering the first survey, two principal EDI documents were being exchanged between automotive trading partners—the MRS and ASN (see Hill 1991). GMH continued to trial a third electronic document, the JIT document, with a limited number of their suppliers. At the time of developing the initial questionnaire, two other electronic documents, namely the remittance advice and receiving advice, were proposed for adoption by the industry EDI sub-committee in electronic trading (see Hill and Ferguson 1989). Subsequently, however, the industry decided not to adopt the receiving advice, while the remittance advice was delayed until early 1994.

The scale developed by the researcher sought to identify the EDI documents each supplier used in trading with their automotive industry customers (see Appendix A, Q11). Subsequent questions (Q12 & Q13) sought to determine the extent of EDI integration with specific internal application systems. Essentially, the measure of integration identified whether or not EDI had been fully integrated with the organisation’s internal application systems, including sales order/entry, inventory and finance.
Net Benefits

The operational definition of net benefits outlined in Chapter 3, sought to measure the difference between perceived benefits and costs received by firms adopting EDI. One approach suggested by Emmelhainz (1990) is to directly quantify all direct and indirect benefits and costs attributable to EDI adoption. Ives and Olson (1984) agree that an ideal indicator of MIS success would be an aggregate organisational benefit measure. Although it is theoretically attractive and economically simple to determine organisational benefits, it is in reality quite difficult to assess such frequently arbitrarily applied measures of benefits. The problems associated with using formal benefit/cost analysis are outlined by Awad (1985). For example, Awad concludes that in assessing intangible benefits and costs, management tend to ignore them, and by implication they receive a value of zero. Further, if assessment is made, there will be considerable inconsistency in their financial valuation. Still further problems are encountered in selecting a method of evaluation that would be consistent and reliable across all participant organisations.

Early discussions with the component suppliers chosen for the multiple case studies, confirmed Emmelhainz’s (1990) view that few companies have assessed the value of benefits and costs resulting from EDI adoption. The principal reason given by Emmelhainz is that recent survey research of EDI users in the USA, indicates that cost reduction was not the main reason for organisations adopting EDI. Other reasons including improved information management, customer service and customer demand were often cited as the principal reasons for adoption. For these reasons, a traditional benefit/cost analysis was deemed inappropriate in the context of the conceptual model outlined in Chapter 3.

However, there is sufficient evidence that conventional benefit/cost analysis would be an appropriate method for individual organisations seeking to justify to senior management the commitment of funds required for EDI adoption (see Emmelhainz 1990; Kimberley 1991; Hornback 1994). It is worth noting that of the 12 organisations chosen for the case studies, only one had attempted a benefit/cost analysis. Ford Australia’s decision not to conduct a benefit/cost evaluation lends support to a participant’s response from recent research conducted by Emmelhainz (1990:169):

*EDI hits at the heart of our business. The benefits are so obvious that cost/benefit documentation is not a worthwhile expenditure of resources.*
In designing a scale of measurement for net benefit, this study was influenced by the range of benefits claimed following EDI adoption. Chapter 3 outlined the nature of three particular categories of benefits—direct, indirect and strategic. The five-point Likert-type scale developed to measure the construct net benefit, consisted of 15 identifiable items incorporating all three categories of benefits (see Appendix A, Q19). The scale ranged from significant net benefit through no change to significant net cost. Ives and Olson’s (1984) review of measures of system success describes a similar approach adopted by Vanlommel and DeBrabander in 1975 who used both a seven-item and five-item Likert-type scale in their assessment of economic benefits and operational advantages to the organisation from user involvement in MIS projects.

4.4.2 INSTRUMENT VALIDATION AND RELIABILITY

Two important criteria are generally considered important in determining the quality of research results, namely validity and reliability (Glazier and Powell 1992). The importance of these criteria in testing an instrument used in measuring a construct such as net benefit, is amplified by a number of researchers, including Cook and Campbell (1979), McCroskey and Young (1979), Kerlinger (1986), Straub (1989) and Messick (1994). When the relationship between observable responses (empirically grounded indicators) and underlying unobservable concepts is strong, (statistical) analysis of the observed responses may provide useful inferences to be drawn in testing theoretical propositions (Carmines and Zeller 1979).

Following a review of 117 articles from a number of scholarly MIS publications, Straub (1989) found that less than 20 per cent used any form of validity or reliability testing procedures. Recent studies have sought to redress this situation by applying appropriate validation and reliability tests to their instruments of measure (see Boynton et al. 1994; Barki and Hartwick 1994). This present study draws upon the work of a number of methodologists in testing the instruments used to measure the constructs developed in this investigation.

Validity

Messick (1994:1) defines validity as:

*an integrated evaluative judgement of the degree to which empirical evidence and theoretical rationales support the adequacy and appropriateness of interpretations and actions based on test scores or other models of assessment.*
Validity is traditionally divided into three components, namely content, criterion and construct validities (Carmines and Zeller 1979; Messick 1994). Carmines and Zeller (1979) stress that unlike construct validity, both content validity and criterion-related validity have limited usefulness in assessing the quality of social science measures. Messick (1994:1) believes that this traditional view of validity is fragmented and incomplete, because it fails to take account of ‘the value implications of score meaning as a basis for action and of the social consequences of test use’. Messick further states that both content and criterion-related evidence are subsumed as aspects of construct validity. Instead, Messick proposes a new unified concept of validity that integrates appropriateness, meaningfulness and usefulness of score-based inferences.

The very foundation of Messick’s new concept, adopted by the American Psychological Association reflecting current definitions of validity, is construct validity. This is the method chosen to test the net benefit instrument developed in this study. The test uses principal components factor analysis as the basis of testing the instrument net benefits (see McCroskey and Young 1979; Kerlinger 1986; Straub 1989). Kerlinger (1986:569) describes factor analysis as the ‘queen of analytic methods ... because it serves the cause of scientific parsimony’. Factorial validity assists in determining the extent to which the set of measures used to construct net benefits do or do not reflect the latent construct—the research instrument.

Exhibit 4.4 summarises the results of factor analysis applied to the set of measures used to test validity. Carmines and Zeller (1979) state that for a set of items to measure one set of phenomenon (unidimensionality), some of the following criteria should be met:

1. the first extracted factor should explain a significant proportion of the variance (>0.4);
2. subsequent components should explain fairly equal (but decreasing) variance;
3. most of the items should have substantial loading on the first factor (>0.3); and
4. most of the items should have higher loadings on the first factor than the second or subsequent factors.

Although items Q19.6 and Q19.12 (marked with an *) represent borderline items for inclusion in the first factor, the factor analysis in Exhibit 4.4 confirms that measures of
net benefit used in the first questionnaire are highly interrelated and constitute a latent construct.\textsuperscript{5}

**Exhibit 4.4 Factor Analysis of Net Benefits for Survey 1992**

<table>
<thead>
<tr>
<th>Item No.</th>
<th>Factor 1</th>
<th>Factor 2</th>
<th>Eigenvalue</th>
</tr>
</thead>
<tbody>
<tr>
<td>Q19.1</td>
<td>.6014</td>
<td>-.5150</td>
<td>4.50</td>
</tr>
<tr>
<td>Q19.2</td>
<td>.5983</td>
<td>-.1359</td>
<td>1.45</td>
</tr>
<tr>
<td>Q19.3</td>
<td>.7211</td>
<td>.0151</td>
<td>1.13</td>
</tr>
<tr>
<td>Q19.4</td>
<td>.7443</td>
<td>-.0765</td>
<td>.93</td>
</tr>
<tr>
<td>Q19.5</td>
<td>.7185</td>
<td>-.3914</td>
<td>.84</td>
</tr>
<tr>
<td>*Q19.6</td>
<td>.4375</td>
<td>.4765</td>
<td>.75</td>
</tr>
<tr>
<td>Q19.7</td>
<td>.5969</td>
<td>.4431</td>
<td>.65</td>
</tr>
<tr>
<td>Q19.8</td>
<td>.6515</td>
<td>.3042</td>
<td>.55</td>
</tr>
<tr>
<td>Q19.9</td>
<td>n/a</td>
<td>n/a</td>
<td>–</td>
</tr>
<tr>
<td>Q19.10</td>
<td>n/a</td>
<td>n/a</td>
<td>–</td>
</tr>
<tr>
<td>Q19.11</td>
<td>.5544</td>
<td>.1278</td>
<td>.43</td>
</tr>
<tr>
<td>*Q19.12</td>
<td>.2071</td>
<td>.3954</td>
<td>.33</td>
</tr>
<tr>
<td>Q19.13</td>
<td>.5859</td>
<td>-.5006</td>
<td>.25</td>
</tr>
<tr>
<td>Q19.14</td>
<td>n/a</td>
<td>n/a</td>
<td>–</td>
</tr>
<tr>
<td>Q19.15</td>
<td>.7256</td>
<td>.2588</td>
<td>.17</td>
</tr>
</tbody>
</table>

*n/a*: Three items were excluded from the first survey analysis because most respondents failed to include them in their list of net benefits. For consistency, they were kept for the second survey.

**Reliability**

Messick stresses that validity alone is not sufficient. Validity needs to be systematically addressed along with other assessment notions as reliability, comparability and fairness. Fidel (1992:39) defines reliability as:

\begin{center}
the extent to which repeated employment of the same research instrument, under conditions taken to be constant, produces the same result.
\end{center}

Essentially, reliability is about testing for internal consistency, and is ultimately an evaluation of measurement accuracy (Straub 1989). One of the most commonly used\textsuperscript{5}

\textsuperscript{5} McCroskey and Young (1979:380) state that ‘if a relatively small proportion (as a rule of thumb we use 10 per cent) of the variables does not have the highest loading on the first unrotated factor, the single-factor solution still may be the best interpretation’.
forms of testing the reliability of an instrument is the *Cronbach alpha test*. Coefficient alpha is derived as a correlation between the actual test performed and a hypothetical alternative form of the same test. A special case of Cronbach’s alpha is coefficient *theta* (Carmines and Zeller 1989). It is simpler to calculate and returns a similar value. For this study, the theta coefficient was used and calculated as:

\[
\vartheta = \left( \frac{N}{N-1} \right) \left( 1 - \frac{1}{\lambda_1} \right)
\]

where \( \vartheta \) is the coefficient to be estimated; \( N \) the number of items; and \( \lambda_1 \) is the largest (that is, the first) eigenvalue. Being a special case of Cronbach’s alpha coefficient, theta has exactly the same interpretation as alpha. High theta (or alpha) coefficients (usually >0.8) are indications that the measures are reliable (Straub 1989). For the first survey, theta was estimated to be 0.85 for the scale used to measure net benefits.

Exhibit 4.5 presents the validity and reliability tests for the second survey.

The results presented in Exhibit 4.5 confirm that the instrument used to measure net benefits in the second questionnaire represents both a valid construct and a reliable instrument measure. However, for the sake of comparison between surveys one and two, Exhibit 4.6 presents the results of a third factor analysis performed to test the loadings on the same 12 items used in survey one.
### Exhibit 4.5 Factor Analysis for Net Benefits for Survey 1994

<table>
<thead>
<tr>
<th>Item No.</th>
<th>Factor 1</th>
<th>Factor 2</th>
<th>Eigenvalue</th>
</tr>
</thead>
<tbody>
<tr>
<td>R22.1</td>
<td>.5920</td>
<td>−.4684</td>
<td>5.04</td>
</tr>
<tr>
<td>R22.2</td>
<td>.3265</td>
<td>−.1009</td>
<td>1.86</td>
</tr>
<tr>
<td>R22.3</td>
<td>.6513</td>
<td>−.2536</td>
<td>1.16</td>
</tr>
<tr>
<td>R22.4</td>
<td>.8463</td>
<td>−.2349</td>
<td>1.10</td>
</tr>
<tr>
<td>R22.5</td>
<td>.7109</td>
<td>−.4184</td>
<td>1.01</td>
</tr>
<tr>
<td>R22.6</td>
<td>.5094</td>
<td>.5028</td>
<td>.79</td>
</tr>
<tr>
<td>R22.7</td>
<td>.5935</td>
<td>.3269</td>
<td>.76</td>
</tr>
<tr>
<td>R22.8</td>
<td>.4417</td>
<td>−.1078</td>
<td>.59</td>
</tr>
<tr>
<td>R22.9</td>
<td>.5280</td>
<td>.4289</td>
<td>.55</td>
</tr>
<tr>
<td>*R22.10</td>
<td>.4496</td>
<td>.6640</td>
<td>.48</td>
</tr>
<tr>
<td>R22.11</td>
<td>.6025</td>
<td>−.0769</td>
<td>.42</td>
</tr>
<tr>
<td>R22.12</td>
<td>.5303</td>
<td>.2714</td>
<td>.41</td>
</tr>
<tr>
<td>R22.13</td>
<td>.5621</td>
<td>−.2626</td>
<td>.32</td>
</tr>
<tr>
<td>R22.14</td>
<td>.5321</td>
<td>.3938</td>
<td>.29</td>
</tr>
<tr>
<td>R22.15</td>
<td>.6363</td>
<td>−.1813</td>
<td>.20</td>
</tr>
</tbody>
</table>

Theta = 0.86

### Exhibit 4.6 Factor Analysis for Net Benefits for Survey 1994

**Twelve Item Scale**

<table>
<thead>
<tr>
<th>Item No.</th>
<th>Factor 1</th>
<th>Factor 2</th>
<th>Eigenvalue</th>
</tr>
</thead>
<tbody>
<tr>
<td>R22.1</td>
<td>.6651</td>
<td>.4506</td>
<td>4.46</td>
</tr>
<tr>
<td>R22.2</td>
<td>.3236</td>
<td>−.4623</td>
<td>1.22</td>
</tr>
<tr>
<td>R22.3</td>
<td>.6741</td>
<td>−.1158</td>
<td>1.12</td>
</tr>
<tr>
<td>R22.4</td>
<td>.8771</td>
<td>−.0789</td>
<td>1.03</td>
</tr>
<tr>
<td>R22.5</td>
<td>.7843</td>
<td>−.2599</td>
<td>.91</td>
</tr>
<tr>
<td>R22.6</td>
<td>.4096</td>
<td>.4603</td>
<td>.68</td>
</tr>
<tr>
<td>R22.7</td>
<td>.5379</td>
<td>.5074</td>
<td>.58</td>
</tr>
<tr>
<td>R22.8</td>
<td>.4655</td>
<td>.3572</td>
<td>.54</td>
</tr>
<tr>
<td>R22.11</td>
<td>.6156</td>
<td>.0996</td>
<td>.48</td>
</tr>
<tr>
<td>R22.12</td>
<td>.4879</td>
<td>.2096</td>
<td>.42</td>
</tr>
<tr>
<td>R22.13</td>
<td>.5895</td>
<td>−.1891</td>
<td>.34</td>
</tr>
<tr>
<td>R22.15</td>
<td>.6629</td>
<td>.1821</td>
<td>.21</td>
</tr>
</tbody>
</table>

Theta = 0.85
The results presented in Exhibit 4.6 confirm that the more parsimonious 12-item model results in no loss of reliability when compared with the original 15-item model.

4.5 CHAPTER SUMMARY

This chapter outlined the research method and described all sources of data used in this study. The development and testing of the research instruments used was also presented. The next chapter presents an analysis of the collected data, and tests each of the research propositions outlined in Chapter 3. A discussion of results concludes the chapter.
Chapter 5

Research Results

Chapter 4 outlined the research method used in testing the propositions developed in Chapter 3. This chapter describes the primary tool of analysis used and presents the results of that analysis.

This chapter is divided into six sections. Section one summaries the characteristics of the data collected for each of the variables developed from the conceptual model. Section two identifies the primary statistical tool of analysis used in analysing the data. Section three reports the results for the repeated cross-sectional longitudinal model (1992 to 1994). Section four discusses the results and tests each of the nine research propositions of Chapter 3 for degree of support. Section five reports the results of the pure longitudinal model. The chapter concludes with a summary.

5.1 STATISTICAL ASSESSMENT OF MODEL DATA

Before choosing the method of statistical analysis, an assessment of the characteristics of the data used in forming the measurement scales for each of the components outlined in the conceptual model was made. A total of five constructs were proposed in the conceptual model which together composed 24 observed components. A summary of the characteristics of each of the 24 components is presented in Exhibit 5.1a for the 1992 model and in Exhibit 5.1b for the 1994 model. Additionally, frequency distributions for each of the three exogenous components are presented in Appendix H.
A necessary condition for most parametric statistical testing requires the data to be normally distributed. An examination of the summary statistics presented in Exhibits 5.1a and 5.1b indicates that most of the observed variables are not normally distributed. Confirmation of the lack of normality in the research data is provided by an examination of the normal plots\(^1\) and assessment of the Lilliefors statistical test.\(^2\) Normal probability plots were created for the 15 components of the result (dependent) variable *EDI net benefits*, on the assumption that violation of normality on the result variable would be sufficient reason to adopt a statistical tool that does not require the restrictive assumption of normality.

Normal probability plots, detrended normal plots and the Lilliefors test statistic for each of the 15 components of EDI net benefits are presented in Appendix G. An examination of the normal plots and Lilliefors test statistic confirms that the research data does not constitute grounds for assuming normality.

### 5.2 THE STATISTICAL ANALYSIS MODEL

The statistical tool chosen to analyse the data collected for this study was partial least squares (PLS) based on the PLS algorithm developed by Wold (1980). PLS is one of a family of structural equation modelling (SEM) and path modelling techniques applied by researchers in psychology and sociology (Duncan, Featherman and Duncan 1972; Alwin and Hauser 1975; Bollen 1989; Agho, Mueller and Price 1993), in education (Duncan 1989; Banks and Rosier 1990), and more recently in the general domain of management, organisational behaviour and information systems (Stumpf and Hartman 1984; Brownell and McInnes 1986; Igbaria and Greenhaus 1992; Florkowski and Schuster 1992; Ferguson and Nevell 1994; Ferguson 1994; Boynton, Zmud and Jacobs 1994).

Wold (1980) notes that econometricians have been using a version of path models based on directly observable variables (manifest variables) since the early 1930s, while sociologists have reported using the technique from around 1960 with indirectly observed variables (latent variables). PLS incorporates both approaches.

---

\(^1\) Normal probability plots provide a visual basis for assessing the extent of normality. A sample from a normal population should cluster around a straight line. A detrended normal plot should cluster around a horizontal line through zero and there should be no pattern (Norusis 1990:114).

\(^2\) The Lilliefors test for normality is based on a modified Kolmogorov-Smirnov test. The null hypothesis assumes normality, the alternate hypothesis non-normality (Norusis 1990:115).
Falk and Miller (1992) summarise the three contributions that psychology, economics and sociology have made to the contemporary use of path analysis in the social sciences. First, from psychology, researchers suggest that a valid construct should not rely on a single measure alone. Second, economics contributes the strength of theory required for the estimation of parameters. Third, sociology contributes the notion of ordering of theoretical variables and their decomposition into types of effects (direct, indirect and common cause). Taken together, the three contributions have merged under the title of latent variable structural equation modelling.

Path analysis, a technique originally invented by geneticist Sewall Wright, may be used to assist the social scientist in the analysis of causal research propositions. They are not causal in the strict scientific or deterministic sense, but are causal in indicating the direction of change, or causal order (Davis 1985). The basis of the logic of causal systems is that arrows representing a connection or relationship between variables indicate potential flows of causation, not necessarily actual flows, used to analyse the chain of predicted relationships simultaneously. Essentially, causal order is an empirical problem which researchers attempt to solve using data and statistical tools grounded in their knowledge of how the real world works (Davis 1985).

Wold (1980) stresses that there are few occasions, particularly in economics, when the researcher can assume normality of data. The researcher may have compiled a list of causal variables and their likely effects, but is often confronted with the problem of unknown distributional properties of these variables. Further, the list of potential variables will usually include variables of interest that cannot be directly observed or measured. Alternatively, the researcher must find indicator or marker variables which are deemed to have some degree of association with the original variables identified to be of theoretical interest. As the characteristics of the research data presented in the previous section demonstrate, the assumption of normality cannot be sustained. For this reason, PLS was chosen as the most appropriate technique to use in the statistical analysis undertaken in this study.

Exhibit 5.2 outlines the path model in the style of Davis’s (1985) logic of causal order system, developed from the conceptual model outlined in Chapter 3. Path analysis allows the researcher to examine individual effects and associations between exogenous and endogenous variables crafted from the relationships developed in the formulation of the conceptual model. These effects and associations can be decomposed into total effects and total association, following the decomposition conventions described by Alwin and Hauser (1975), Stumpf and Hartman (1984) and Davis (1985).
Total association between two variables is measured by the zero order correlation \((-1 \leq r \leq 1)\) between them. The total effect of one variable on another is the extent of variation on a dependent variable which is caused either directly by a change in an antecedent variable (measured by the standardised regression coefficient \(\beta\)) or indirectly transmitted (or mediated) via intervening variables (Alwin and Hauser 1975). The difference between total association and total effect is due to common cause effects or spurious effects which is the variation between any two variables caused by other prior variables in the specified model (Stumpf and Hartman 1984). Davis (1985) likens common cause effects to forecasting error.

In summary, the total association between one variable and another is the zero order correlation between them. The total association can be broken down into two components, total effect (direct and indirect effect) and common cause effect.

In calculating the total association between two or more variables, PLS uses the algorithm of ordinary least squares (OLS). For the conceptual model, the structural equations are represented by the following three regression equations:

\[
X_1 = \beta_{1a}X_a + \beta_{1b}X_b + \epsilon_1 \tag{1}
\]

\[
X_2 = \beta_{2a}X_a + \beta_{2b}X_b + \beta_{21}X_1 + \epsilon_2 \tag{2}
\]

\[
X_3 = \beta_{3a}X_a + \beta_{3b}X_b + \beta_{31}X_1 + \beta_{32}X_2 + \epsilon_3 \tag{3}
\]

where \(X_i\) \((i = 1 \ldots 3)\) are endogenous variables and \(X_a\) and \(X_b\) represent exogenous variables and \(\beta\) the regression coefficients to be estimated.
This study uses the particular implementation of PLS based on Wold’s (1980) algorithm for solving the three structural equations of the path model (Sellin 1989a, 1989b). Other commonly adopted implementations of SEM techniques include LISREL (Joreskog 1973), AMOS (Arbuckle 1992) and EQS (Bentler 1992), which, according to Sellin (1986), should be seen as complementary rather than competitive estimation methods of the same type of path models. There are two fundamental groups of SEM techniques: those that rely on strict normality assumptions, this includes LISREL and AMOS, and those programs like PLS and EQS that do not. LISREL and AMOS use the method of maximum likelihood estimation while PLS and EQS utilise the OLS approach (Lohmoller 1988, 1989; Bentler 1992; Faulbaum 1993). EQS has the flexibility to handle both these methods. Joreskog and Wold (1982) provide a comparison of methods and report results from both groups in their discussion of the assumptions and limitations of using LISREL and PLS. Pedhazur and Schmelkin (1991) compare and discuss the merits of LISREL and EQS.

5.2.1 PLS AND STRUCTURAL EQUATION MODELLING

Within the context of multivariate statistics, Falk and Miller (1992:2) define the nature of PLS as

a least squares estimation procedure that makes few assumptions about the nature of data. It shares a common conceptual bond with principal component analyses, canonical analysis and alternating least squares. In PLS optimal linear relationships are computed between latent variables and are interpreted as the best set of predictions available for a given study considering all the limitations.

PLS is particularly useful in modelling situations which are multidisciplinary and where the problems under investigation may be complex and where theoretical knowledge between constructs is limited (Wold 1980). PLS falls into Wold’s category of soft modelling\(^3\), providing researchers with a means of expressing theoretical ideas about a sequence of events by relating the theoretical interests of the researcher to observations of the real world as they experience it.

In assessing the overall worth of the fitted model (LISREL uses the term *goodness of fit*), PLS provides three principal statistics to assist in the assessment. The traditional

---

\(^3\) Falk and Miller (1992) state that soft modelling involves the use of rigorous mathematical and statistical techniques, but is soft in the sense that it makes no measurement, distributional or sample size assumptions.
chi-square ($\chi^2$) statistic is commonly used by statistical techniques such as LISREL, EQS and AMOS. However, chi-square is very sensitive to departures from the multivariate assumption of normality and variations in sample size leading to misleading conclusions (Munck 1992). For these reasons alone, chi-square is inappropriate in assessing the goodness of fit of the current model. Three alternative statistics are discussed:

(a) The coefficient of determination or $R^2$, which expresses the amount of variance in the dependent variable ($Y$) accounted for by the regression on all explanatory (or independent) variables ($X$). $R^2$ is an indication of the predictive power of the regression model (Falk and Miller 1992). It may be expressed in a number of ways:

$$R^2 = 1 - \frac{\text{Residual Variance}}{\text{Total Variance}}$$

or

$$R^2 = 1 - \frac{\sum e_i^2}{\sum (y_i - \bar{y})^2}$$

The higher the value of $R^2$, the greater the explained variance in the model.

(b) The Stone-Geisser test of predictive relevance uses an adaptation of Ball’s $Q^2$ statistic as the test criterion (Sellin 1992). Essentially, the technique omits (or blindfolds) one case at a time, re-estimating the model parameters on the basis of the cases that remain. $Q^2$ is defined as follows:

$$Q^2 = 1 - \frac{\sum (Y_i - X_i b(o))^2}{\sum (Y_i - \bar{Y(o)})^2}$$

where $Y_i$ denotes the $i$th case value of the dependent variable and $X_i$ the row vector of the $i$th case values of the $k$ predictor variables. $\bar{Y}$ denotes the jackknife mean of $Y_i$ (i.e. the mean when the $i$th case is omitted) and $b_i$ is the coefficient vector obtained when the $i$th case is exempted from estimation (Sellin 1992). Another member of the resampling procedures family is the bootstrapping technique used in LISREL.

---

4 Jackknife procedures are one member of the family of resampling procedures used for the estimation of standard errors in circumstances where it is not possible to use direct formulae (as in the standard error of a mean for a simple random sample).
Sellin (1992) notes that $Q^2$ is an analogue of the coefficient of determination $R^2$, in that it is an $R^2$ evaluated without loss of degrees of freedom. The model has increased predictive relevance the higher the value of $Q^2$. In addition, $Q^2$ may be negative, indicating a misleading regression, while a value close to zero makes the decision uncertain (Falk and Miller 1992).

(c) Jackknife standard errors (JStd) for path and regression coefficients are produced in PLS as a by-product in the calculation of the Stone-Geisser test of predictive relevance, $Q^2$. The PLS algorithm produces jackknife standard errors for a given regression coefficient similar to standard errors produced in conventionally applied OLS used to calculate the $t$–statistic. Essentially, the jackknife standard error is a nonparametric test of significance defined in terms of the standard deviation of the corresponding jackknife estimates (see Tukey 1977), and is defined as:

$$JStd(b_k) = \left[ \frac{(n - 1)}{n} \sum_{i} (b_{ki} - b_{k(.)}) \right]^{1/2}$$

where $b(ki)$ denotes the estimate of $b_k$ with the $i$th case omitted, and $b_{k(.)}$ denotes the mean of all $b_{ki}$ obtained for a given data set.

The results of each of the models presented in the following section reports each of the statistics described in this section.

5.3 MODEL PROPOSITION RESULTS

This section presents the results for each of the two models (designated as model 92 and model 94). In each case, the total association between research variables is reported together with the decomposition of the total effect between the research variables. Section 5.4 discusses the results of the tests on each of the research propositions based on the path models presented in this section and the extent of support.

5.3.1 RESULTS FOR MODEL 92

Exhibit 5.3 presents the zero order correlations between each of the latent variables (research variables) of the path model outlined in Exhibit 5.2.

\footnote{Unlike $R^2$, $Q^2$ may increase when independent variables are removed.}
Exhibit 5.3  Latent Variable Zero Order Correlations ($r_{ij}$): Model 92

<table>
<thead>
<tr>
<th>LATENT VARIABLE</th>
<th>Company Size</th>
<th>Concentration of Trade</th>
<th>Level of Commitment</th>
<th>Extent of Integration</th>
<th>Net Benefits</th>
</tr>
</thead>
<tbody>
<tr>
<td>Company Size</td>
<td>1.00</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Concentration of Trade</td>
<td>0.17</td>
<td>1.00</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Level of Commitment</td>
<td>0.11</td>
<td>–0.18</td>
<td>1.00</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Extent of Integration</td>
<td>0.38</td>
<td>0.31</td>
<td>–0.20</td>
<td>1.00</td>
<td></td>
</tr>
<tr>
<td>Net Benefits</td>
<td>0.33</td>
<td>0.19</td>
<td>–0.17</td>
<td>0.51</td>
<td>1.00</td>
</tr>
</tbody>
</table>

The zero order correlations represent the total association between each of the latent variables of the PLS inner model. Exhibit 5.4 decomposes the total association into direct, indirect and common cause effects, together with the $R^2$, $Q^2$ and jackknife standard errors for each of the estimated regression coefficients ($b_{ij}$).

Exhibit 5.5 summarises the results of the direct effects estimated using PLS in the form of the estimated path model for 1992. The diagram includes both the inner model path coefficients (that is, the direct effects between each of the research variables) and the outer model results indicating the weights and loadings between the manifest and latent variables.

---

6 PLS defines an inner model, representing the relationships between each of the latent variables defined in the path model, and an outer model representing the relationship between the manifest variables and their latent variable constructs.

7 The population regression coefficient is designated as $\beta_i$, the estimated (sample) regression coefficient as $b_i$.

8 PLS calculates the weights with which a given exogenous latent variable is estimated (for example, the two variables $X_a$ and $X_b$) and the loadings which are the zero order correlations between a given manifest (or observed) variable and its associated latent variable (that is, for endogenous variables $X_1$, $X_2$ and $X_3$) (Sellin 1989b).
This model represents the final fitted model for Model 92. Unlike the conceptual model which was fully recursive (or saturated), the final fitted model was parsimonious as the path between concentration of trade ($X_b$) and level of EDI net benefits ($X_3$) was not significant based on the Falk and Miller (1992) criterion. In order to check whether there is any loss of predictive power between the fully saturated model and the parsimonious model reported in Exhibit 5.5, the jackknife estimates of redundancies were summed and compared following the convention employed by Igbaria and Greenhaus (1992).

The sum of the saturated model redundancies is 1.95, and the sum of the parsimonious model is 1.91, confirming little loss of predictive power by using the parsimonious model over the saturated model.

---

9 The Falk and Miller criterion specify that a direct path should be dropped if the regression coefficient is less than 0.07. The model is then re-run and tested for parsimony.

10 Redundancy indicates the amount of explained variance of a manifest variable accounted for by the latent variable with which the manifest variable is indirectly connected via inner model relationships. It is measured by the squared correlation between a manifest variable and the latent variable connected indirectly (Sellin 1989a).
5.3.2 RESULTS FOR MODEL 94

The results for the path model 94 are presented in Exhibits 5.6 (zero order correlations), Exhibit 5.7 (the decomposition effects of the path model 94) and Exhibit 5.8 (the final estimated path model for model 94).

Exhibit 5.6 Latent Variable Zero Order Correlations (r_{ij})

<table>
<thead>
<tr>
<th>LATENT VARIABLE</th>
<th>Company Size</th>
<th>Concentration of Trade</th>
<th>Level of Commitment</th>
<th>Extent of Integration</th>
<th>Net Benefits</th>
</tr>
</thead>
<tbody>
<tr>
<td>Company Size</td>
<td>1.00</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Concentration of Trade</td>
<td>-0.02</td>
<td>1.00</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Level of Commitment</td>
<td>-0.11</td>
<td>-0.08</td>
<td>1.00</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Extent of Integration</td>
<td>0.37</td>
<td>0.39</td>
<td>0.31</td>
<td>1.00</td>
<td></td>
</tr>
<tr>
<td>Net Benefits</td>
<td>0.43</td>
<td>0.21</td>
<td>0.06</td>
<td>0.54</td>
<td>1.00</td>
</tr>
</tbody>
</table>

Comparing the parsimonious model redundancies with those of the saturated model allowed the conclusion that there was negligible loss of predictive power in using the reduced form of the model. (Sum of redundancies: saturated model = 2.55 and parsimonious model = 2.61.)

5.4 DISCUSSION OF RESULTS

This section discusses the extent to which each of the research propositions outlined in Chapter 3 is supported by the results of the longitudinal model presented in section 4.3. Each proposition is discussed in the context of the three structural equation models used in estimating the two final path models. Exhibits 5.9, 5.11 and 5.13 summarise the key results for each component of the model. The section concludes with two exhibits summarising the level of support for each of the nine research propositions. Support for the model results is provided by the addition of evidence provided by a number of suppliers participating in case studies. Summaries of relevant parts of these interviews appear in Appendix D.
5.4.1 Model 1: Effects on Senior Management Commitment

The Effects of Company Size and Concentration of Trade on the Level of Senior Management Commitment (RP4 and RP7).

The results reported in Exhibit 5.9 for model 92 do not provide support for either the research proposition that company size has an inverse effect on senior management commitment ($b_{1a}=0.14$), or that the concentration of trade a component supplier undertakes with the automotive industry has a direct positive effect on management commitment ($b_{1b}=-0.20$). However, model 94 indicates support for both research propositions, although the support for concentration of trade on management commitment is only weakly supported ($b_{1b}=0.08$).

The results for model 92 are not surprising as during the period of the first survey (November 1991 – January 1992), only a few of the component supplier organisations had experienced EDI for more than two years, while the majority had experienced EDI for less than one year. An indication of this may be gained from the results presented in Exhibit 5.10 showing when component organisations made their first live EDI transmission.

Although not obvious from Exhibit 5.10, it was the larger and more crucial suppliers that came on line during 1990 and 1991. The smaller suppliers were encouraged but not expected until later, with most adopting EDI by the end of 1992. The industry EDI committee in fact set a drop-dead date of 1st April 1991, at which time all suppliers to the five locally based car companies were expected to be EDI capable. The date passed without any penalty to those suppliers failing to comply with the industry committee’s request, largely because two of the major customers (Toyota and Nissan) were not able to meet all the EDI capability requirements themselves.

Company Size—Management Commitment (RP4)

The model 94 results of the direct negative effect of company size on the level of management commitment is supported (though not for 1992). The 1994 effect confirms support for Macdonald’s (1992) research concerning firm size in the automobile industry and the benefits smaller firms may gain from electronic ordering. Because firms are small, there is a dual effect on commitment.
First, it is more likely the chief executive officer of a small firm will be directly involved in the day-to-day operational activities of the firm and be in a superior position to commit the necessary resources needed to ensure EDI success. In a larger firm, delegation to subordinates may result in insufficient follow-up being made by senior executives and either delay or total failure in allocating the necessary resources to guarantee a successful EDI project outcome and so ensure the achievement of net benefits from electronic ordering.

Evidence from the case studies supports the evidence from the model results. In the case of three of the four small suppliers, the EDI coordinator was the General Manager or CEO. For the four large and four medium companies, all EDI coordinators were from middle management (see Appendix C).

Second, the smaller firm size allows the organisation’s informal network interaction greater flexibility to adapt to changing circumstances in the sense suggested by Macdonald (1992). While this apparent duality impacting smaller organisations may exert positive externalities on the firm, they may of course be more than outweighed by other factors such as lower scale economies.

There are two manifest variables used in measuring company size, namely annual turnover and number of fulltime employees. The observed variable number of fulltime employees is the variable with the highest weight. That is, it contributes the most to the
estimation of company size (nearly three times that of annual turnover). The dominance of number of employees in the model appears to reflect the labour-intensity nature of the component sector, a reason sometimes given by firms as a spin-off effect of introducing EDI.

**Concentration of Trade—Management Commitment (RP7)**

The instability in model 92 is evident in lack of support for the proposition that management commitment is likely to be higher from organisations which are more dependent on their customers’ continued trade. The research proposition (RP7) proposed that increasing dependence (higher concentration of trade) will lead to greater senior management commitment to the EDI project, as EDI adoption is a requirement of their customers’ continued trade, lending support to Marceau’s (1992a) contention that tight control over the whole production process is necessary for the adoption of JIT inventory management systems. Successful JIT implementation can only be achieved if the supply chain is tightly controlled using control mechanisms like EDI. There is evidence from model 94 that the coercive nature of introducing EDI to component suppliers led to greater senior management commitment the more dependent suppliers were for their continued existence on remaining in the automotive industry.

Exhibit 5.11 lists the major reasons given by component suppliers for adopting EDI. Overwhelmingly, they did so because their much larger and dominant customers told them that to remain suppliers to the automotive assembly sector they had to become EDI enabled. This was particularly so with small suppliers as indicated in Appendix C—Case Study Component Manufacturers.
### Exhibit 5.11 Reasons for EDI Adoption

<table>
<thead>
<tr>
<th>Rank</th>
<th>Primary Reason for Adoption</th>
<th>First Ranking %</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Told to by Customers (i.e. by the car companies)</td>
<td>75.0</td>
</tr>
<tr>
<td>2.</td>
<td>Competitive Necessity</td>
<td>11.5</td>
</tr>
<tr>
<td>3.</td>
<td>Strategic Advantage</td>
<td>1.9</td>
</tr>
<tr>
<td>4.</td>
<td>Logical Business Decision</td>
<td>5.8</td>
</tr>
<tr>
<td>5.</td>
<td>To Reduce the Order/Delivery Cycle</td>
<td>0.0</td>
</tr>
<tr>
<td>6.</td>
<td>To Reduce Transaction Costs</td>
<td>1.9</td>
</tr>
<tr>
<td>7.</td>
<td>Supplier’s Suggestion</td>
<td>1.9</td>
</tr>
<tr>
<td>8.</td>
<td>To Ensure Common Standards</td>
<td>1.0</td>
</tr>
<tr>
<td>9.</td>
<td>JIT Program to Reduce Inventory</td>
<td>0.0</td>
</tr>
<tr>
<td>10.</td>
<td>To Reduce Staff</td>
<td>1.0</td>
</tr>
</tbody>
</table>

Three-quarters of suppliers adopting EDI did so, not primarily because of the perceived direct benefits of EDI to their business, but because they were instructed to by their major customers. This result would seem to indicate the dominance of strategic factors over short-term economic (benefit/cost) factors. The claimed economic benefits of EDI (reduction of inventory, transaction costs, staff levels, and so on) all rated in the lowest half of the suppliers’ rankings. This appears to indicate the coercive nature of EDI implementation in the automotive sector. This is not meant to imply that suppliers failed to gain those perceived benefits, only that they adopted EDI principally for strategic reasons.

The lack of support for research proposition seven evident in model 92 can best be explained in terms of the actual management commitment expended by component suppliers when asked to trade electronically using EDI. Initially, the smaller suppliers were extremely reluctant to adopt EDI. This attitude prevailed at the first EDI conference of the automotive industry held in Melbourne in 1990. Apart from the larger supplier organisations who were specifically targeted by their customers to adopt EDI, the smaller suppliers made it clear that they were either not going to adopt EDI immediately or, if they did, they were going to devote the bare minimum of resources to its introduction. In other words, the level of senior management commitment was absolutely minimal.

The FAPM’s project manager reported a number of occurrences of firms (generally small component companies) treating EDI like an expensive facsimile machine. The firms would read their electronic mailbox as required by their customers (Telecom’s system provided the sender with acknowledgment that a supplier had read the contents
of their mailbox), then either printed off the details on a locally attached PC printer, or waited a few days for the same electronic order to arrive by mail before entering details of the original electronic order into their own internal systems.\textsuperscript{11}

Case study evidence supports this contention, as all four small suppliers believed EDI was just an additional expense in doing business with the automotive industry. One, however, concluded that he could see EDI becoming a strategic resource once the company had integrated EDI into its internal application systems.

In summary, although the variance explained in sub-model $X_1$ is small ($R^2_{92} = 0.05$ and $R^2_{94} = 0.02$), and an element of instability is evident in the variable level of management commitment ($Q^2_{92} = -0.01$ and $Q^2_{94} = -0.03$), there is support for the two research propositions. As explained in the following section, the level of management commitment is an important intervening variable (indirect effect) in explaining the extent of system integration undertaken by component suppliers.

### 5.4.2 Model 2: Effects on Extent of System Integration

*The Effects of Level of Management Commitment, Company Size and Concentration of Trade on the Extent of System Integration (RP3, RP6 and RP9).*

Exhibit 5.12 reports the decomposition effects of the sub-model based on the predicted latent variable *system integration*. The strength and significance of the relationships between each of the exogenous variables (management commitment, company size, and concentration of trade) are consistent between both models 92 and 94, with one exception—the effect of management commitment on system integration (model 92).

\textsuperscript{11} When a supplier contracted with Telecom to adopt EDI, Ford agreed to run a parallel system with traditional paper-based orders being sent by mail for at least three months after the supplier’s first successful EDI transmission.
Management Commitment—Integration (RP3)

The proposition that the level of senior management commitment is a positive determining factor in the extent of system integration of component suppliers is not supported in the first model. In model 94, the proposition is supported and is both strong and significant \( (b_{21}=0.32, JStd=0.08) \). In fact, the strength of the association between the level of management commitment and system integration shown in Exhibit 5.12 for model 94 is virtually all a direct effect \( (r_{21}=0.31, b_{21}=0.32) \). There is a negligible common cause effect (that is, the effect of the two common antecedent variables company size and concentration of trade on both management commitment and system integration), adding marginally to the strength of association between the two variables.

An explanation for this apparent reversal can best be deduced from the reasons given by component suppliers for adopting EDI outlined in Exhibit 5.11. In the early days of EDI adoption (1988–91), only a few large component suppliers readily contemplated both adopting EDI and fully integrating EDI into their internal application systems. The results for survey 92 revealed that approximately 36 per cent of suppliers had integrated EDI by January 1992, while by January 1994 the number had risen to 48 per cent.

The negative coefficient for model 92 \( (b_{21}=-0.20) \) is indicative of the level of management support given to EDI during the time leading up to the first survey. Two years later, and following the continued dissemination of the potential benefits to be gained from integrating EDI into internal systems (particularly through the activities of the FAPM) by the automotive industry, results show that senior management had positively changed their attitude toward EDI and the potential benefits to be gained from integration. This empirical evidence supports the conclusions drawn by Swatman and Swatman (1992) and the experience at DEC (see Rochester 1989).

One of the medium-sized companies interviewed for the case study confirmed the importance of having senior management involvement in their EDI project. On one occasion, Ford suspended the Q1 status of the company because it could not trade electronically. The EDI coordinator reported that he had been unsuccessful in attracting the necessary internal resources to complete the task of integrating EDI with the firms order/entry system. When the system failed, causing the company to be unable to send or receive EDI messages, Ford reacted immediately by suspending its Q1 preferred status. Within one hour of the managing director being informed about Ford’s decision, adequate resources were provided for the full integration of the supplier’s EDI system.
**Company Size—Integration (RP6)**

Both model 92 and model 94 show strong support for the proposition that company size directly and positively effects the extent to which a supplier organisation integrates EDI. Like management commitment’s effect on integration, the total effect of company size on integration for both model 92 and model 94 is both strong and significant (b_{2a}=0.37 and b_{2a}=0.41). This should come as no surprise and supports the conclusion that the larger firms with inhouse computer professionals have both the necessary skills to perform the integration tasks and the incentive to undertake what many large suppliers concluded was a *relatively simple task*.

It was the smaller suppliers with no in-house computer professionals, and generally smaller volume of transactions to process, that had little incentive to integrate. Especially in the early days of EDI adoption, little manufacturing software was available with EDI capabilities. Smaller suppliers did not have the inclination to spend their scarce resources on employing outside consultants to perform the integration task. By the time of the second survey, EDI integrated software was becoming more readily available to smaller suppliers. However, the cost of integration was relatively higher for smaller suppliers than for their larger counterparts.

The small negative indirect effect of company size on integration (~0.03) is consistent with the negative direct effect of company size on management commitment. While a large company is more likely to integrate EDI, the direct effect is mediated by a small reduction in commitment by senior management in larger organisations.

The case studies reported in Appendix D show that all large component suppliers had integrated EDI, while the medium-sized suppliers had integrated some documents, but not all—generally only the ASN. In the case of small suppliers, only one of the four had attempted EDI integration at all.

**Concentration of Trade—System Integration (RP9)**

Both models support the proposition that the amount of trade actually undertaken by component suppliers directly and significantly effects the extent to which they are likely to integrate EDI into their internal application systems as a way of achieving net benefits (b_{2b}=0.21 and b_{2b}=0.38). Suppliers, wishing to remain in the automotive industry will continually need to assess their long-term future with their customer(s). In particular, the larger first-tier suppliers providing sub-assembly manufacturing for their
customers are more likely to integrate because of the mutual dependence existing between supplier and customer (Marceau 1992a; Marceau and Jureidini 1992).

The evidence provided from both models supports the proposition that increasing dependence on the industry leads dependent suppliers to examine ways of maximising their returns from trading. Suppliers whose level of business with the automotive industry (say 10 per cent) are less likely to integrate EDI into their internal application systems compared with suppliers whose trade is nearly 100 per cent with the car industry. A small supplier may comply with their customer’s request to use EDI in trading, but will simply rely on rekeying orders into their own application systems rather than undertake full integration. Simply, the evidence supports the proposition that dependent suppliers are more likely to integrate than less dependent suppliers.

A small amount of the total effect of concentration of trade on integration is mediated via senior management commitment (0.04 and 0.02). In other words, largely dependent organisations are more likely to integrate and seek the backing of senior management in achieving integration.

In summary, both the size of the company and the degree of dependence suppliers have on the automotive industry for their business, directly and indirectly, effect the extent to which suppliers are likely to integrate EDI with their internal application systems. The degree to which senior management is committed to the project is essential in achieving integration, although senior management in larger companies is generally less involved in the EDI project, leading to a small negative mediation effect on integration.

5.4.3 MODEL 3: EFFECTS ON LEVEL OF EDI NET BENEFITS

The Effects of Level of Management Commitment, Extent of System Integration, Company Size and Concentration of Trade on the Level of EDI Net Benefits (RP1, RP2, RP5 and RP8).

The results reported in Exhibit 5.13 for model 92 and model 94 confirm two direct causes of suppliers achieving net benefits from EDI. The two direct effects on net benefits are company size and the level of system integration of EDI. The variance in net benefits explained by the direct effects of company size and system integration is significant ($R^2=0.35$) for model 94. The size and closeness of $Q^2$ to $R^2$ confirms the jackknife significance of the variation in net benefits explained by the two variables. Each effect is discussed in turn, together with the probable reasons for lack of support
of concentration of trade and level of management commitment on achieving net benefits.

**Level of Management Commitment—Level of Net Benefits (RP1)**

The importance of senior management commitment in achieving net benefits from EDI adoption is clearly supported in model 94, but not in model 92. Once again, the level of management support for EDI adoption was not evident in the early part of the decade. Many component suppliers tended to comply reluctantly with their customers’ request to adopt EDI but had little commitment from senior management. In other words, achieving benefits from EDI adoption was not fundamental to the reasons for installing EDI within a firm during the period 1991–92 (see Exhibit 5.11).

Model 94 confirms that the most significant influence of senior management commitment on achieving net benefits is indirect. In fact, the total effect of commitment on net benefits is all indirectly achieved through management commitment’s effect on system integration (0.14).

This should not come as a total surprise, as the resources required to integrate EDI with internal application systems would necessitate senior management support, especially in larger firms integrating EDI with applications on mini or mainframe computers where scarce computer programming resources need to be allocated by senior management.\(^\text{12}\)

\(^{12}\) In 1994, the median establishment cost of EDI was approximately $11,000. A number of suppliers recorded total costs (including integration) in the range of $150,000-250,000.
The negative common cause effect of commitment on net benefits in model 94 is worthy of mention (–0.08). The effect is large and negative, reducing the total association ($r_{32}=0.06$), and suggests a degree of common influence of antecedent variables on net benefits that reduces the indirect effect of management commitment on net benefits.

In summary, the effect of management commitment on net benefits is not supported directly, but the importance of senior management commitment indirectly via system integration’s effect on achieving net benefits is important to the ultimate success of achieving net benefits from EDI adoption.

**System Integration—Level of Net Benefits (RP2)**

The results reported in Exhibit 5.13 for both models 92 and 94 confirm the critical role system integration plays in the achievement of net benefits from EDI adoption. The direct effect of integration on net benefits is strong and highly significant in both models ($b_{32}=0.42$; JStd=0.08 and $b_{32}=0.44$; JStd=0.08). The large coefficient on system integration in both models accounts for the majority of variance explained in the variation in EDI net benefits ($R^2_{92}=0.29$ and $R^2_{94}=0.35$).

Exhibit 5.14 reports the principal internal application systems that component suppliers have integrated with EDI by 1994.

<table>
<thead>
<tr>
<th>Application</th>
<th>MRS</th>
<th>ASN</th>
<th>JIT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sales/Order Entry</td>
<td>30</td>
<td>23</td>
<td>6</td>
</tr>
<tr>
<td>Finance</td>
<td>3.5</td>
<td>6</td>
<td>1</td>
</tr>
<tr>
<td>Distribution</td>
<td>11</td>
<td>22</td>
<td>5</td>
</tr>
<tr>
<td>Other (non-auto)</td>
<td>2</td>
<td>0</td>
<td>1</td>
</tr>
</tbody>
</table>

Other: principally for customs clearance

The higher percentage for MRS and sales/order entry integration is consistent with the order in which the industry implemented the release of EDI documents. It was expected that the release of the MRS would provide suppliers with the most benefit. Significant rekeying should be prevented with improved accuracy of data being amongst the expected major benefits to suppliers. The loadings illustrated in Exhibits 5.5 and 5.8
confirm the influence and dominance of the MRS document in both models for firms deciding to integrate EDI internally \( (r_{22}=0.90) \).

The majority of firms in both periods had not integrated EDI with their internal application systems. Despite the continued efforts of the automotive industry to convince suppliers of the advantages to be gained from EDI integration, many still believed that costs would exceed benefits. Among the difficulties suppliers reported having with integrating EDI into their internal application systems were: first, considerable variation in the way each of the car manufacturers used the various EDI documents, that is, the business rules varied from customer to customer, making integration far more complex and costly than need be for suppliers; second, the absence of off-the-shelf EDI packages integrated with suppliers’ existing application software, for example, MRP (materials requirements planning) software; third, the perceived lack of integrity of electronically transmitted data from their customers, for example, some suppliers felt that not all electronically transmitted order volumes could be accurately relied upon without subsequent confirmation by telephone or facsimile; and finally, the lack of a sufficiently high data processing priority within their organisations, possibly due to inadequate management commitment to EDI.

**Company Size—Level of Net Benefits (RP5)**

Research proposition five suggested that larger companies are more likely to gain net benefits from EDI adoption than smaller ones. The results of both models reported in Exhibit 5.13 support this proposition. The two influences worthy of particular mention in model 94 are the relative contributions of the direct effect of company size on achieving net benefits \( (b_{3a}=0.26; JStd=0.08) \) and the indirect effect company size has on net benefits via the mediating effects of management commitment and system integration. Sixty per cent of the total association \( (r_{3a}=0.43) \) between the two variables is directly the influence of company size on net benefits, while 40 per cent is indirect via the two intervening variables.

For smaller companies, the relative cost of implementing EDI is greater than for larger companies. For many large companies, the cost of implementing EDI (including integration) was seen as petty cash according to a number of firms interviewed. Once again, smaller companies, particularly in the earlier stages of their implementation, were only concerned with complying with their customers’ requests and were not expecting real benefits to flow from EDI adoption.
In addition, larger component organisations (typically first-tier suppliers) were keen to achieve backward integration, that is, to successfully establish electronic trading with their suppliers (second-tier). Maximum benefits could best be achieved if they themselves were fully integrated first.

**Concentration of Trade—Level of Net Benefits (RP8)**

Both model 92 and model 94 are consistent in showing little support for the proposition that concentration of trade has a direct and positive effect on achieving net benefits from EDI adoption. In other words, greater dependence on the industry did not have a direct effect on the achievement of net benefits.

However, the significant feature of the relationship is the indirect effect of concentration of trade on achieving net benefits. Eighty-six per cent of the total association between the two variables ($r_{3b}=0.21$) in model 94 is indirectly due to the combined influence on net benefits of the effect of the concentration of trade on the two intervening variables of management commitment and system integration.

In summary, both models 92 and 94 report that a significant proportion of the variation in EDI net benefits received by component suppliers can be explained in terms of both the direct effects of company size and system integration and the indirect effects on net benefits via the two intervening variables of management commitment and system integration. Two of the four research propositions are supported in both models, whereas the two not directly supported, exert indirect effects via other mediating variables.

One of the features of the two models presented in section 5.4 is the ability to analyse the nature of the particular net benefits which suppliers stated they received following EDI adoption. The following section reports the major net benefits suppliers gained from EDI from an examination of the outer model provided from the results of PLS.

**5.4.4 Nature of EDI Net Benefits**

By examining the zero order correlations (or loadings) between the manifest (or observed) variables and their latent construct EDI net benefits, evidence can be seen of the strength of association between the 15 individual components making up net benefits, providing evidence of the principal benefits component suppliers gained from
EDI adoption. The loadings for both model 92 and model 94 are reported in Exhibit 5.15.

Essentially, the claimed net benefits can be divided into three groups based on the model 94 total associations. First, reported benefits which make a notable contribution to net benefits (e.g. productivity improvements); second, those that make little or no contribution to net benefits (e.g. reduced inventory levels); and third, observed benefits that fall somewhere in between (e.g. document matching). The three groups are discussed below.

**Major Contributors to EDI Net Benefits**

For model 94, the zero order correlations demonstrating the greatest relationship with EDI net benefits are productivity \((r = 0.88)\), clerical staff savings \((r = 0.81)\), improved data accuracy \((r = 0.71)\), improved customer service \((r = 0.69)\) and reduction in administrative costs \((r = 0.66)\). All loadings showed a continued positive increase in benefit of between 5 per cent for improved data accuracy to 20 per cent for reduced administration costs.

The strength of these relationships is not unexpected, as firms using EDI seek to reduce the number of staff and administrative costs in particular, and consequently improve productivity. By using EDI, firms are directly contributing to an improvement in servicing their major customers. Once stability in data transmission and integration is achieved, without the necessity of rekeying customer information, improvements in data accuracy follow almost automatically. Additional support for the model results is reported in Exhibit 5.16.

The benefit ranked the highest was *Improved Relations with Trading Partners*. Sixty-four and a half per cent believed that their relations with the five car companies (or the ones they supply) had generated either marginal or significant net benefits. Only 2.5 per cent believed that they had actually brought about net costs.

The net benefit ranked second was improved *Customer Service*, that is, how well the supplier services the customer. Approximately 50 per cent believed that customer service had generated either marginal or significant net benefits through the use of EDI. The benefits ranked third and fourth respectively were *Data Accuracy* (36.3 per cent marginal or significant net benefits) and *Productivity* (33 per cent marginal or significant net benefits).
A further indicator of the productivity improvement suppliers experienced is provided from the survey question asking how much time was taken by suppliers to process the MRS documents both before and after adopting EDI. Suppliers were asked to state approximately how many hours of actual staff time were employed to process MRS documents from their customers both before and after adoption.

**Exhibit 5.15 Manifest Variable Loadings (rij)**

<table>
<thead>
<tr>
<th>$X_{3i}$</th>
<th>Manifest Variable</th>
<th>Net Benefit Loading ($r_{1992}$)</th>
<th>Net Benefit Loading ($r_{1994}$)</th>
</tr>
</thead>
<tbody>
<tr>
<td>3.4</td>
<td>Enhanced Productivity</td>
<td>0.78</td>
<td>0.88</td>
</tr>
<tr>
<td>3.5</td>
<td>Clerical Staff (savings)</td>
<td>0.72</td>
<td>0.81</td>
</tr>
<tr>
<td>3.3</td>
<td>Improved Data Accuracy</td>
<td>0.68</td>
<td>0.71</td>
</tr>
<tr>
<td>3.15</td>
<td>Customer Service</td>
<td>0.63</td>
<td>0.69</td>
</tr>
<tr>
<td>3.1</td>
<td>Administration Cost</td>
<td>0.55</td>
<td>0.66</td>
</tr>
<tr>
<td>3.11</td>
<td>Document Matching &amp; Transactions</td>
<td>0.43</td>
<td>0.61</td>
</tr>
<tr>
<td>3.13</td>
<td>Reduced Telephone Usage</td>
<td>0.34</td>
<td>0.55</td>
</tr>
<tr>
<td>3.12</td>
<td>Control Over Transport &amp; Distribution</td>
<td>0.23</td>
<td>0.51</td>
</tr>
<tr>
<td>3.7</td>
<td>Control of Purchasing &amp; Distribution</td>
<td>0.55</td>
<td>0.49</td>
</tr>
<tr>
<td>3.8</td>
<td>Relations with Trading Partners</td>
<td>0.59</td>
<td>0.49</td>
</tr>
<tr>
<td>3.14</td>
<td>Improved Product Quality</td>
<td>ns</td>
<td>0.45</td>
</tr>
<tr>
<td>3.9</td>
<td>Cash Management</td>
<td>ns</td>
<td>0.41</td>
</tr>
<tr>
<td>3.2</td>
<td>Reduced Postage</td>
<td>0.60</td>
<td>0.39</td>
</tr>
<tr>
<td>3.6</td>
<td>Reduced Inventory Levels</td>
<td>0.50</td>
<td>0.38</td>
</tr>
<tr>
<td>3.10</td>
<td>Flexible Buying Strategies</td>
<td>ns</td>
<td>ns</td>
</tr>
</tbody>
</table>

*ns = not significant*

**Exhibit 5.16 Principal Benefits From EDI Adoption**

<table>
<thead>
<tr>
<th>Ranking</th>
<th>Stated Improvement in:</th>
<th>Percentage Claiming Net Benefits (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Improved Relations with Trading Partners</td>
<td>64.5</td>
</tr>
<tr>
<td>2.</td>
<td>Customer Service</td>
<td>50.0</td>
</tr>
<tr>
<td>3.</td>
<td>Data Accuracy</td>
<td>36.3</td>
</tr>
<tr>
<td>4.</td>
<td>Productivity</td>
<td>33.0</td>
</tr>
</tbody>
</table>
before and after the introduction of EDI into their organisations. The responses are summarised in Exhibit 5.17.

**Exhibit 5.17 Average Processing Times for MRS Documents (1994)**

<table>
<thead>
<tr>
<th>Processing of MRS Documents</th>
<th>Average Hours (per month)</th>
<th>Max No. Hours (per month)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of hours before EDI:</td>
<td>41.9</td>
<td>459</td>
</tr>
<tr>
<td>Number of hours after EDI:</td>
<td>23.4</td>
<td>180</td>
</tr>
<tr>
<td><strong>Net Percentage Change:</strong></td>
<td><strong>– 44.2%</strong></td>
<td></td>
</tr>
</tbody>
</table>

Respondents indicated an average 44 per cent reduction in processing time of electronically generated MRS documents compared with their former paper-based manual systems. Given that 85 per cent of the participating suppliers began using EDI during 1990 and 1991, this is a significant result.

If suppliers with EDI integrated into applications systems are separated from those that are not, the results reported in Exhibit 5.18 are even more illuminating. Typically, it was the larger organisations with high volumes of monthly transactions that had undertaken integration. In the first survey, about one-third of component suppliers had integrated EDI with their internal systems. Two years later, this had risen to nearly half of the component sector.
Exhibit 5.18 Change in Processing Time for MRS Documents: Integrated Versus Non-integrated Suppliers (1994)

<table>
<thead>
<tr>
<th>Processing of MRS Documents</th>
<th>EDI Integrated (Average Hours per month)</th>
<th>EDI Not Integrated (Average Hours per month)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of hours before EDI:</td>
<td>55.9</td>
<td>31.8</td>
</tr>
<tr>
<td>Number of hours after EDI:</td>
<td>19.8</td>
<td>28.7</td>
</tr>
<tr>
<td>Net Percentage Change:</td>
<td>–64.5%</td>
<td>–9.8%</td>
</tr>
</tbody>
</table>

Virtually all of the suppliers who stated that EDI was of little use to them and only added to their costs, had not integrated EDI into their internal business systems. For those organisations taking the next step of integration, average savings of around 65 per cent of staff time were demonstrated, compared with about 10 per cent savings where EDI had been adopted but was not integrated with internal systems.

Small Contributors to Net Benefits

As reported in Exhibit 5.15, the time period between 1992 and 1994 saw increasing contributions to EDI net benefits resulting from a strengthening of association between three observed variables, namely document matching and transactions ($r=0.61$), reduced telephone usage ($r=0.55$) and improved control over transport and distribution ($r=0.51$). In 1992, these three reported variables contributed negligibly to net benefits. Clearly, the relative influence of these variables strengthened over the two-year period.

The observed variables *control of purchasing and distribution* ($r=0.49$) and *relations with trading partners* ($r=0.49$) both reduced their relative association with net benefits. In part, the reduced influence can be explained in terms of the initial impact EDI had with suppliers. It was to confer both an immediate improved control over purchasing and distribution of the products supplied to customers which predictably also enhanced trading relations with the car companies. Evidence of the change in trading-partner relationships between 1992 and 1994 is reported in Exhibits 5.19 and 5.20.

All suppliers were asked to evaluate the extent to which their relationship with their customers had been changed following the introduction of EDI into their organisations. While in the 1992 survey the great majority of respondents indicated that there had been *No Change* in their trading relationships with their customers, about a third of suppliers believed that EDI was bringing about some improvement.
The aggregate changes in relationships between trading partners shown in Exhibit 5.19 suggest that differences in relationships with particular customers, while only marginal, were at least showing some signs of improvement. Around 25–37 per cent indicated either marginal or significantly improved trading relationships with their customer(s). The results for the second survey are reported in Exhibit 5.19.

The most notable changes reported in 1994 have occurred amongst the suppliers formerly reporting *No Change* in their trading relationships with customers. In the 1992 survey, 78 per cent of Toyota suppliers reported no change in their trading relationships. Two years later, only 69 per cent reported no change. Further, the number of suppliers reporting both marginal or significant improvements in trading relationships had increased. Interestingly, Ford has gained the highest significant trading relationship with its suppliers, and is second only to GMH in having marginally improved trading relations. This may in part reflect the considerable effort exerted by Ford over the two-year period under consideration to develop stronger trading relations with its suppliers following EDI’s introduction to the industry.

*Non-Contributors to EDI Net Benefits*

This study found that five of the 15 listed benefits contributed the least to suppliers’ achievement of EDI net benefits. From the 1994 model they include improved product quality (*r*=0.45), better cash management (*r*=0.41), reduced postage (*r*=0.39) and reduced inventory (*r*=0.38). Flexible buying strategies was too low to be significant. Each of these observed variables accounts for less than 20 per cent of the variance in EDI net benefits.

Not surprisingly, the 1992 model showed reduced postage was a significant initial contributor to net benefits. This could be explained by the almost instant savings in postage within a few months of adopting EDI. The smaller contribution in 1994 could be explained in part by the fact that the industry has not completely rid itself of sending paper documents through the mail. When suppliers agree to establish EDI, their customers generally agree to continue sending the same (equivalent) paper documents for a number of months until the supplier is fully satisfied with the accuracy of the EDI transmissions. Once this occurs, paper transmissions by post are stopped. The savings reflected two years later have become insignificant compared with other variables listed in Exhibit 5.15.

**Exhibit 5.19 Combined Trading Relationships by Customer**
Research Results

1992

Perception of Change in Relationship

- Significantly WORSE
- Marginally WORSE
- NO Change
- Marginally IMPROVED
- Significantly IMPROVED

percent of total

- Ford
- GMH
- Mitsubishi
- Nissan
- Toyota

Data for specific years and companies is shown in the chart.
Suppliers were asked whether or not their level of inventory (finished goods) had been affected in any way because of the introduction of EDI into their organisations. The information supplied in the 1992 survey was limited, in that the majority indicated no change. However, one feature is worth reporting. For those with a change in inventory level attributed to EDI, the average reduction in inventory was close to 2 per cent. Such a reduction is not unexpected given the industry’s move towards just-in-time manufacturing. A more significant reduction is to be expected following a greater integration of EDI into all aspects of trading, together with the adoption of other techniques designed to improve overall industry efficiency. However, at this relatively early stage of adoption, the effects of EDI on inventory are really quite insignificant, and would instead be expected to increase as customers adopt JIT techniques, passing inventory costs onto their upstream suppliers. First-tier component suppliers would only expect a reduction in inventory with increased use of JIT techniques with their own suppliers further up the value chain.

Additional support for this contention is provided from respondents who were asked directly to what extent their inventory of finished goods had changed following the introduction of EDI. The results are presented in Exhibit 5.21.
While EDI has been used in the automotive industry since 1988, few suppliers were experiencing some reduction in inventories. Clearly, the majority of suppliers in the industry were not experiencing the expected inventory savings so often claimed achievable with EDI adoption. It may be that the time frame is too short in which expected reductions in inventory will be achieved. Certainly, Ford, one of the sector’s major customers, has achieved significant reductions in inventory. Ford reports reductions of 13 days requirement to 2.5 days, a stated saving of many millions of dollars in holding and storage costs (interview with Ford supply personnel).

Improved cash management through EDI use was not reported by suppliers as a significant net benefit. As very few suppliers reported integration of their internal finance application systems, and even fewer were using actual financial EDI, it is not surprising that expected net benefits from improved cash management was only a marginal contributor. The interesting result from the 1994 model is that it is a contributor, whereas in 1992 it was not.

Additional claims made for EDI include improved product quality. Because of the more timely flow of information, EDI contributes to improved quality of components through the facilitation of JIT inventory management systems. Timely information, for example, assists in the prevention of unwanted vehicles accumulating unnecessarily in exposed factory storage areas. In 1992, product quality was not a claim made by suppliers, as it may have been too early for organisations to have realised any improvement in product quality. By 1994, the emergence of a small contribution to EDI net benefits from improved product quality is evident.

(1994)

<table>
<thead>
<tr>
<th>Percentage of Change in Inventory (%)</th>
<th>Percentage of Suppliers (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>&gt; –30</td>
<td>2</td>
</tr>
<tr>
<td>–30</td>
<td>3</td>
</tr>
<tr>
<td>–20</td>
<td>2</td>
</tr>
<tr>
<td>No Change</td>
<td>89</td>
</tr>
<tr>
<td>+10</td>
<td>1</td>
</tr>
<tr>
<td>+30</td>
<td>1</td>
</tr>
<tr>
<td>&gt; +30</td>
<td>2</td>
</tr>
</tbody>
</table>
5.5 PURE LONGITUDINAL MODEL

The purpose in describing a pure longitudinal model of the type reported in this section and in Appendix I is slightly different from the main study. Its main purpose is to explore longitudinal transmission effects of the intervening and result component variables described in Chapter 4 of this thesis using data which derives directly from the two survey results reported in Chapter 5. Although anonymity was guaranteed to all respondents who completed the two questionnaires, the majority of respondents agreed to include their names, position and company details on the last page of both questionnaires for follow-up purposes. In all, 44 companies were uniquely identified, while the actual number is presumed to exceed 44.

The results which follow provide an insight into the degree to which the level of EDI net benefits in 1994 were consequent upon the level of EDI net benefits experienced two years earlier, the effects of changes in the level of management commitment between the two periods and the extent of system integration effects undertaken between the two survey periods.

5.5.1 PURE LONGITUDINAL PATH MODEL

The conceptual longitudinal model for this exploratory analysis is presented in Exhibit 5.22. The path analysis results for the model are presented in Exhibit 5.23. Exhibit 5.24 summarises the results for the inner model (the direct and indirect effects), while Exhibits 5.25 and 5.26 summarise the results for the outer model (the weights for the exogenous variables and the loadings for the endogenous and dependent variables). While no direct statistical comparison can be made between inner model results unless the weights are the same, direct comparisons may be made between outer model results (Sellin 1992), allowing general conclusions to be drawn regarding the relative predicability of the models.
**Inner Model Results**

The inner model, comprising the direct paths between latent variables measured by their respective beta coefficients, and the corresponding $R^2$ and $Q^2$, are in accord with the results for the repeated cross-sectional design presented in Exhibits 5.5 and 5.8 of this chapter. The main purpose for using the smaller number of firms is to gain some insight into the transmission effects between variables during the two survey periods, 1992 to 1994. The principal focus of the model was to discover the extent of changes which may be taking place between the two periods on the level of management commitment, the extent of system integration and the extent to which EDI net benefits in 1994 were influenced by the level of benefits received two years earlier. The results for each variable are discussed in turn.

*Level of EDI Net Benefits 1994*

Net benefits received in 1994 were influenced either directly or indirectly by a number of variables which are summarised in Exhibit 5.24. The direct influences on EDI net benefits 1994 are first, net benefits received two years earlier ($\beta=0.41$); second, the extent of system integration undertaken during the last two years ($\beta=0.26$); and third, the level of senior management commitment in 1994 ($\beta=-0.11$).

While no other direct effects between intervening variables and EDI net benefits in 1994 were significant, all remaining intervening variables accounted for some indirect effects on net benefits in 1994. These indirect effects are reported in column six of Exhibit 5.26. Two large indirect effects on EDI net benefits are worth noting. Company size and extent of system integration undertaken by 1992 influenced the level of net benefits in 1994 through their intervening effect on net benefits achieved in 1992, the level of management commitment in both 1992 and 1993, and the extent of system integration undertaken by 1992 and 1994. Both of these indirect effects are strong and positive (0.25 and 0.34).

*Extent of System Integration 1994*

The extent of system integration achieved by 1994 is affected directly by the level of benefits the firms received in 1992 ($\beta=0.17$) and by the extent to which the firm integrated in 1992 ($\beta=0.63$). Clearly the major influence for firms integrating was their experience with integration during the two years before 1994. Both of these effects are positive, and are enhanced by the
indirect effects of company size and concentration on three intervening variables, the level of management commitment in 1992, the extent of system integration by 1992, and EDI net benefits received by 1992.

**Level of Management Commitment**

The results of the path model for the level of senior management commitment in 1994 show that the direct effects on the level of commitment in 1994 are directly influenced by the extent to which firms received net benefits in 1992. Firms with high levels of senior management commitment in 1992 showed an inverse relationship with the level of senior management commitment in 1994. This result is consistent with the proposition that once senior management has committed itself to the EDI project, there is in fact a decrease in senior management commitment within a given period (two years in this study). In other words, the level of commitment falls once the EDI project has been implemented. However, management commitment in 1994 is positively influenced by the level of EDI net benefits achieved in 1992, suggesting that senior management will commit resources to the EDI project if they perceive the firm is receiving positive net benefits.

One significant difference between the results for the pure longitudinal model and the repeated cross-sectional model reported in Chapter 5, is the absence of a significant direct path between level of management commitment and extent of system integration. This result suggests that firms deciding to integrate after 1992 did so based on the level of net benefits they received by 1992, and their success with integration.

**Outer Model Results**

The outer model results of the pure longitudinal model are reported in Exhibits 5.25 and 5.26. The weights and loadings for the outer model exogenous and endogenous manifest variables are consistent with those reported for the repeated cross-sectional longitudinal model reported in Chapter 5 (Exhibit 5.8). A number of minor changes are evident in the rankings of the result variable, *EDI net benefits*, of firms in the pure longitudinal model.

Exhibit 5.26 lists the most significant and least significant contributors to EDI net benefits, and those benefits falling somewhere in between. The notable changes occur with (a) relations with trading partners ($r=0.67$), which moved up the scale of influence, and (b) document matching and transactions ($r=0.66$). Administrative cost ($r=0.63$) fell slightly, as did control over transport and distribution ($r=0.36$). Overall, apart from these
four minor differences, the results are in accord with the repeated cross-sectional model reported in Chapter 5.

**Exhibit 5.25 Weights and Loadings \((rij)\) for Exogenous and Endogenous Variables: 1992–94**

<table>
<thead>
<tr>
<th>(X_i)</th>
<th>Latent Variable</th>
<th>Manifest Variable</th>
<th>Weight ((rij))</th>
<th>Loading ((rij))</th>
</tr>
</thead>
<tbody>
<tr>
<td>(X_a)</td>
<td><em>Company Size</em></td>
<td>Annual Turnover</td>
<td>0.20</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>F/T Employees</td>
<td>0.85</td>
<td></td>
</tr>
<tr>
<td>(X_b)</td>
<td><em>Concentration of Trade</em></td>
<td>Percent of Trade</td>
<td>1.00</td>
<td></td>
</tr>
<tr>
<td>(X_1)</td>
<td><em>Management Commitment 92</em></td>
<td>Senior Management</td>
<td>0.86</td>
<td>0.88</td>
</tr>
<tr>
<td></td>
<td></td>
<td>EDI Coordinator</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(X_2)</td>
<td><em>System Integration 92</em></td>
<td>Integrated</td>
<td>0.82</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>MRS</td>
<td>0.94</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>ASN</td>
<td>0.74</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>JIT</td>
<td>0.91</td>
<td></td>
</tr>
<tr>
<td>(X_4)</td>
<td><em>Management Commitment 94</em></td>
<td>Senior Management</td>
<td>0.96</td>
<td>0.61</td>
</tr>
<tr>
<td></td>
<td></td>
<td>EDI Coordinator</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(X_5)</td>
<td><em>System Integration 94</em></td>
<td>Integrated</td>
<td>0.85</td>
<td>0.88</td>
</tr>
<tr>
<td></td>
<td></td>
<td>MRS</td>
<td>0.88</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>ASN</td>
<td>0.63</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>JIT</td>
<td>0.73</td>
<td></td>
</tr>
</tbody>
</table>

In conclusion, the variance explained by the pure longitudinal model \((R^2=0.32)\), with fewer degrees of freedom \((n=44)\), explains about the same variance as the original repeated cross-sectional model \((R^2=0.35)\) with more degrees of freedom \((n=120)\). Given the difficulties associated with tracking firms between study time periods (Menard 1991) and the additional complexity of the pure longitudinal model, the results provide a complementary explanation of the variance in EDI net benefits received by component manufacturers over the repeated cross-sectional longitudinal model.
### Exhibit 5.26 Manifest Variable Loadings ($r_{ij}$)


<table>
<thead>
<tr>
<th>$X_{3i}$</th>
<th>Manifest Variable</th>
<th>Net Benefit Loading ($r$) 1992</th>
<th>Net Benefit Loading ($r$) 1994</th>
</tr>
</thead>
<tbody>
<tr>
<td>3.4</td>
<td>Enhanced Productivity</td>
<td>0.80</td>
<td>0.93</td>
</tr>
<tr>
<td>3.3</td>
<td>Improved Data Accuracy</td>
<td>0.77</td>
<td>0.78</td>
</tr>
<tr>
<td>3.15</td>
<td>Customer Service</td>
<td>0.65</td>
<td>0.78</td>
</tr>
<tr>
<td>3.5</td>
<td>Clerical Staff (savings)</td>
<td>0.79</td>
<td>0.69</td>
</tr>
<tr>
<td>3.8</td>
<td>Relations with Trading Partners</td>
<td>0.70</td>
<td>0.67</td>
</tr>
<tr>
<td>3.11</td>
<td>Document Matching &amp; Transactions</td>
<td>0.48</td>
<td>0.66</td>
</tr>
<tr>
<td>3.1</td>
<td>Administration Cost</td>
<td>0.60</td>
<td>0.63</td>
</tr>
<tr>
<td>3.13</td>
<td>Reduced Telephone Usage</td>
<td>0.40</td>
<td>0.61</td>
</tr>
<tr>
<td>3.7</td>
<td>Control of Purchasing &amp; Distribution</td>
<td>0.61</td>
<td>0.60</td>
</tr>
<tr>
<td>3.12</td>
<td>Control Over Transport &amp; Distribution</td>
<td>0.17</td>
<td>0.36</td>
</tr>
<tr>
<td>3.2</td>
<td>Reduced Postage</td>
<td>0.60</td>
<td>0.29</td>
</tr>
<tr>
<td>3.6</td>
<td>Reduced Inventory Levels</td>
<td>0.49</td>
<td>0.29</td>
</tr>
<tr>
<td>3.9</td>
<td>Cash Management</td>
<td>ns</td>
<td>ns</td>
</tr>
<tr>
<td>3.10</td>
<td>Flexible Buying Strategies</td>
<td>ns</td>
<td>ns</td>
</tr>
<tr>
<td>3.14</td>
<td>Improved Product Quality</td>
<td>ns</td>
<td>ns</td>
</tr>
</tbody>
</table>

*ns = not significant*

### 5.6 CHAPTER SUMMARY

This chapter reported the statistical analysis of the repeated cross-sectional longitudinal model outlined in Chapter 4. Using path analysis, each of the nine research propositions detailed in Chapter 3 was tested for support based on the empirical evidence of data collected in 1991–92 and 1993–94. For model 92, only five of the nine propositions were supported, while for model 94, seven were supported. A summary of the extent of support for each of the nine propositions for both model 92 and model 94 are presented in Exhibits 5.27 and 5.28.
### Exhibit 5.27 Research Propositions and Extent of Support: Model 92

<table>
<thead>
<tr>
<th>Research Propositions</th>
<th>Model Relationships</th>
<th>Direction of Linkage</th>
<th>Extent of Support</th>
</tr>
</thead>
<tbody>
<tr>
<td>RP1</td>
<td>The level of senior management commitment has a direct effect on the achievement of net benefits from EDI.</td>
<td>Positive</td>
<td>Not Supported</td>
</tr>
<tr>
<td>RP2</td>
<td>The extent of system integration has a direct effect on the achievement of net benefits from EDI.</td>
<td>Positive</td>
<td>Supported</td>
</tr>
<tr>
<td>RP3</td>
<td>The level of senior management commitment has a direct effect on the extent of system integration achieved.</td>
<td>Positive</td>
<td>Not Supported</td>
</tr>
<tr>
<td>RP4</td>
<td>Company size directly affects the level of senior management commitment to EDI.</td>
<td>Inverse</td>
<td>Not Supported</td>
</tr>
<tr>
<td>RP5</td>
<td>Company size has a direct effect on the achievement of net benefits from EDI.</td>
<td>Positive</td>
<td>Supported</td>
</tr>
<tr>
<td>RP6</td>
<td>Company size directly affects the extent of system integration.</td>
<td>Positive</td>
<td>Supported</td>
</tr>
<tr>
<td>RP7</td>
<td>The concentration of trade an organisation achieves with the automotive sector has a direct effect on the level of senior management commitment to EDI.</td>
<td>Positive</td>
<td>Not Supported</td>
</tr>
<tr>
<td>RP8</td>
<td>The concentration of trade an organisation achieves with the automotive sector has a direct effect on the achievement of net benefits derived from EDI.</td>
<td>Positive</td>
<td>Not Supported</td>
</tr>
<tr>
<td>RP9</td>
<td>The concentration of trade an organisation achieves with the automotive sector has a direct effect on the extent of system integration.</td>
<td>Positive</td>
<td>Supported</td>
</tr>
</tbody>
</table>
Exhibit 5.28 Research Propositions and Extent of Support: Model 94

<table>
<thead>
<tr>
<th>Research Propositions</th>
<th>Model Relationships</th>
<th>Direction of Linkage</th>
<th>Extent of Support</th>
</tr>
</thead>
<tbody>
<tr>
<td>RP1</td>
<td>The level of senior management commitment has a direct effect on the achievement of net benefits from EDI.</td>
<td>Positive</td>
<td>Not Supported</td>
</tr>
<tr>
<td>RP2</td>
<td>The extent of system integration has a direct effect on the achievement of net benefits from EDI.</td>
<td>Positive</td>
<td>Supported</td>
</tr>
<tr>
<td>RP3</td>
<td>The level of senior management commitment has a direct effect on the extent of system integration achieved.</td>
<td>Positive</td>
<td>Supported</td>
</tr>
<tr>
<td>RP4</td>
<td>Company size directly affects the level of senior management commitment to EDI.</td>
<td>Inverse</td>
<td>Supported</td>
</tr>
<tr>
<td>RP5</td>
<td>Company size has a direct effect on the achievement of net benefits from EDI.</td>
<td>Positive</td>
<td>Supported</td>
</tr>
<tr>
<td>RP6</td>
<td>Company size directly affects the extent of system integration.</td>
<td>Positive</td>
<td>Supported</td>
</tr>
<tr>
<td>RP7</td>
<td>The concentration of trade an organisation achieves with the automotive sector has a direct effect on the level of senior management commitment to EDI.</td>
<td>Positive</td>
<td>Weakly Supported</td>
</tr>
<tr>
<td>RP8</td>
<td>The concentration of trade an organisation achieves with the automotive sector has a direct effect on the achievement of net benefits derived from EDI.</td>
<td>Positive</td>
<td>Not Supported</td>
</tr>
<tr>
<td>RP9</td>
<td>The concentration of trade an organisation achieves with the automotive sector has a direct effect on the extent of system integration.</td>
<td>Positive</td>
<td>Supported</td>
</tr>
</tbody>
</table>

Conclusions from the results presented in this chapter, perceived limitations of the study, and suggestions for future research activity are discussed in Chapter 6.
This final chapter is divided into five sections. Section one summarises the thesis, including the motivation for the thesis, its objectives, theoretical foundation, research method and the model developed in testing the research propositions. Section two summarises the conclusions from analysis of the results. Section three outlines the limitations of the study and considers potential threats to the research conclusions. Section four outlines the theoretical and practical implications of the research, suggesting the direction for future research activity. Section five summarises the chapter.

6.1 RESEARCH SUMMARY

This research study was motivated by a number of factors which relate directly to the re-engineering of organisational processes in manufacturing industries. These factors include international pressures experienced by national industries to become globally competitive, adopting technologies and management practices that will achieve, amongst other things, reduced unit costs of production, higher productivity, improved product quality and enhanced customer service.

The automotive industry was chosen for this investigation, because it is a manufacturing industry of major importance to most Western countries, including Australia, in terms of contribution to GDP and employment. The Australian automotive industry was one of the first manufacturing sectors in Australia to respond to the regulatory pressures imposed by the Australian Government following the policy initiatives outlined in the Button Car Plan of 1984. The principal thrust of the Button Car Plan was the continued reduction in the level of tariff protection from 1985 to the year 2000 on all motor vehicles assembled in Australia. This policy statement made all five Australian assemblers—Ford, GMH, Mitsubishi, Nissan and Toyota—reassess their Australian operations in the light of falling tariff barriers (of around 2.5 per cent per year). The implications for Australia, and indeed all North American vehicle manufacturers, was heightened by the pressures felt from Japanese vehicle producers, in particular Toyota, with their emphasis on lean-production/flexible-volume
manufacturing techniques—in stark contrast to the traditional Fordist methods of the North American manufacturers.

One of the responses of the Australian automotive industry to the Button Car Plan was the adoption of electronic commerce, in particular, EDI. EDI had been used by many of the automotive industry parent companies located in North America to improve the exchange of information between customers (the vehicle assemblers) and suppliers (the component manufacturers). A survey of literature produced mostly anecdotal evidence in support of the benefits which flowed from EDI adoption, claiming savings of, for example, $400 per car. Further, other industries adopting EDI were claiming similar benefits including improved productivity, reduced inventories and staff savings.

While the five vehicle assemblers were the prime initiators of EDI, it became obvious that the organisations which would be most affected by its adoption were the smaller locally-based component manufacturers. It was these manufactures that became the principal focus for this study.

This study developed a conceptual model incorporating the constructs of organisational size, concentration of trade, level of senior management commitment and extent of system integration in assessing the degree to which component manufacturers received net benefits from EDI adoption. The model proposed that the extent to which component manufacturers received net benefits from EDI were both directly and indirectly dependent upon the extent of system integration of EDI with internal application systems, the level of senior management commitment to the EDI project, the size of the firm, and the degree of dependence of the firm on the automotive industry (concentration of trade).

Nine propositions were derived from the research model to be tested empirically. Two longitudinal models were formulated—a repeated cross-sectional longitudinal model and a pure longitudinal model. Ford Australia and its 220 component suppliers were chosen to provide the industrial and organisational context for the study. Ford, the largest vehicle assembler in Australia, recently announced its intention to close its Australian manufacturing plant in Victoria if its Australian operation cannot become more world competitive (Gottliebsen 1995). Gottliebsen’s (1995:16) interview with Alexander Trotman, chairman, CEO and president of the Ford Motor Co., indicated that Ford Australia’s owners were serious about their intentions this time:

"Trotman announced that Ford would shut down motor manufacturing in Australia unless there was a substantial reduction in costs that would make..."
the operation world-competitive. He repeated the statement, so there was no room for ambiguity or misunderstanding.

In 1990–91 Ford Australia expressed similar sentiments to those expressed in February 1995, in which Ford management told the Australian and Victorian Governments that Ford will cease local manufacturing of vehicles if Ford’s efficiency could not be improved. Initially, one of the contributors to Ford’s efficiency was expected to be made through adoption of EDI, as well as by generally improving its relations with its core component suppliers.

Two surveys of Ford’s component suppliers were conducted between 1991 and 1994, providing the data for analysis. Scales of measure were developed and tested for validity and reliability. Each instrument was found to be both a valid and reliable measure of their constructs.

A structural equation model was used to test the hypothesised relationships between constructs of the model. Path analysis, using partial least squares, was used to analyse the data and estimate the model parameters.

6.2 SUMMARY OF CONCLUSIONS FROM THE RESEARCH

Until recently, the automotive sector’s use of EDI in Australia has been as a closed group of essentially five customers and about 280–300 component suppliers. Over half of the component sector relies almost exclusively on automotive industry trading for its continued existence. It is therefore not surprising that 75 per cent of suppliers claimed they adopted EDI because their major customers essentially specified this requirement for continued trading. Despite being required to adopt EDI, organisations that did so claimed to have received net benefits following its adoption.

The results from analysis of the model outlined in Chapter 5, demonstrates that the EDI benefits received depend on a number of influences. There appears little doubt of the noticeable impact that system integration of EDI with internal information systems has had on integrating organisations. This impact is one of the primary reasons why organisations have received significant EDI benefits, providing further empirical evidence in support of the research of Swatman (1993). The importance of system integration depends in part on the degree of senior management commitment to system integration, although this is a much smaller influence.
The size of company and concentration of trade an organisation has with the automotive industry was also seen to be significant in achieving net benefits—both directly and indirectly via the level of commitment and extent of integration. While there are a number of other influences which have both direct and indirect effects on the benefits organisations receive from innovations such as EDI, this model has demonstrated that the two exogenous variables—company size and concentration of automotive trade—and the two endogenous variables—level of commitment and extent of integration—explain around 35 per cent of the variation in EDI net benefits received. The pure longitudinal model showed no greater ability to predict this variation than did the repeated cross-sectional longitudinal model—the principal model used in this study.

Clearly there remain other variables which contributed to component manufacturers’ achievement of net benefits from EDI adoption. However, the four model variables confirm their effect on EDI net benefits. Further, the parsimonious model described in this study has approximately the same explanatory power as the fully saturated model. All but two of the nine research propositions were supported by the research model, although one—RP7—was only weakly supported. A summary of the research propositions, empirical measures, and degree of support is presented in Exhibit 6.1.

One of the objectives of the research was to discover which EDI net benefits were the most influential. The results of the second survey (1994) clearly demonstrated that the five most important net benefits received from EDI were: enhanced productivity, clerical staff savings, improved data accuracy, improvements in customer service, and reduced administration costs. The least contributors to company net benefits were reduced inventory levels,
Exhibit 6.1 Summary of Test Results
reduced postage and product quality—all claimed in the literature to be major benefits of EDI adoption.

At the individual company level of decision making, these results have significant implications, not only directly for EDI adoptees, but also as an indication of the diffusion of other forms of information technology that an organisation may be considering adopting. The next section briefly summarises the results of analysis of each proposition discussed in Chapter 5.

### 6.2.1 SUMMARY OF THE RESEARCH PROPOSITIONS

The first proposition stated that the level of senior management commitment had a direct and positive influence on the level of EDI net benefits received by the organisation. This proposition was not supported. However, there is an important indirect effect of senior management commitment on EDI net benefits, through system integration. In other words, organisations experiencing positive EDI net benefits were those organisations in which senior management were involved in facilitating system integration directly. The implication for non-integrating firms is that senior management did little more than agree to adopt EDI (largely because they were told to by their dominant customers), leaving its implementation up to the MIS department or someone else in the firm, with little or no other direct involvement.

The second proposition—that the extent of system integration has a direct positive effect on the achievement of net benefits from EDI—was supported. In fact, this proposition was the most significant of the seven supported propositions, supporting previous research (e.g. Swatman 1993; Bergeron and Raymond 1992; Pfeiffer 1990) on the impact of EDI integration with internal application systems. Despite the automotive industry’s best attempts at promoting the benefits of system integration, only 40 per cent or so of component manufacturers had integrated by the start of 1994.

The third proposition propounded that the level of senior management commitment has a direct and positive effect on the extent of system integration achieved. This proposition was strongly supported in the second model—1994—although the proposition was not supported in the first model—1992. A possible explanation for the change in support by senior managers is their realisation that significant EDI benefits will only accrue to the organisation if integration is undertaken, and successful integration requires top level management support and direct involvement.
The fourth proposition stated that company size has a direct but inverse effect on the level of senior management commitment to the EDI project. This proposition was supported by the research, confirming that larger companies tended to delegate EDI responsibilities to subordinates, but did not always provide the necessary follow-up activities to ensure the successful completion of the EDI project. Alternatively, EDI implementation in smaller companies was often the direct responsibility of the CEO, ensuring the required resources were allocated when necessary, without further reference to a more senior executive.

The fifth proposition—that company size has a direct positive effect on the achievement of EDI net benefits—was supported. Large firms were more likely to gain a higher level of net benefit from EDI than were smaller firms. Because smaller firms were generally the slowest to implement EDI, and only did so because of their customer demands, these firms expended the least resources in satisfying their customer’s minimum requirements—they therefore received the least in the way of net benefits.

Proposition six stated that company size directly and positively affects the extent of system integration. This proposition was strongly supported, and is one of the mediating effects of company size on the level of net benefits organisations receive from EDI. The main explanation for this contention is the support role played by MIS departments in larger organisations, which is generally absent in smaller firms. In other words, the larger the organisation, the more likely the firm is to integrate using inhouse information technology professionals. Smaller firms without direct access to these professionals were forced to rely on expensive outside consultants or the purchase of virtually non-existent EDI-integrated application software.

Proposition seven asserted that the concentration of trade an organisation achieves with the automotive sector has a direct positive effect on the level of senior management commitment to EDI. This proposition was only weakly supported, but provides some evidence for the conclusion that the more dependent suppliers were for their continued existence on remaining in the automotive industry, the more likely senior management was to be committed to the EDI project. Further, senior management commitment is an important intervening variable in explaining the level of net benefits received following system integration.

Proposition eight posits that the concentration of trade an organisation achieves with the automotive sector has a direct and positive effect on the achievement of net benefits the organisation derives from EDI adoption. This proposition was not supported. In other words, automotive industry-dependent firms did not directly receive greater net benefits
from EDI adoption. However, there were indirect effects of trade concentration on EDI net benefits via the two intervening variables—level of management commitment and extent of system integration.

The final proposition stated that the concentration of trade an organisation achieves with the automotive sector has a direct and positive effect on the extent of system integration. This proposition was strongly supported, suggesting that the more dependent organisations were on the automotive industry, the more likely they were to integrate in order to receive positive net benefits.

In summary, the achievement of net benefits from EDI adoption by automotive component manufacturers is affected by the level of senior management commitment to the project, and the extent of system integration undertaken with internal application systems.

6.3 LIMITATIONS OF THE RESEARCH

Cook and Campbell (1979) provide a taxonomy of potential threats to the validity of causal-based research propositions. This section discusses the potential threats to this study under five headings: statistical conclusion validity, internal validity, construct validity, external validity, and other limitations.
6.3.1 **Statistical Conclusion Validity**

Cook and Campbell (1979) describe threats to statistical conclusion validity in terms of invalid conclusions which may be drawn about the covariation of statistical evidence provided from the research results. Essentially such threats result in increases in two types of error—random error and extraneous error. Such errors may be due to the lack of control over participants in the organisation, and the *quickness* of completing the survey responses. A further threat is random heterogeneity of respondents.

In the context of this study, any threats to statistical conclusion validity were minimised by ensuring that company respondents were the EDI coordinators. Many surveys are conducted by sending the questionnaire to the CEO of the company, hoping that it will filter down to the *right* person to complete. In this study, Ford and Telecom provided a mailing list of all known EDI coordinators for each component manufacturer, so that each questionnaire was able to be sent directly to the EDI-responsible person (generally the EDI coordinator). As the two questionnaires were completed anonymously, it was not always possible to determine if the same person actually completed both questionnaires.

In completing the survey, respondents were asked to return their completed questionnaire as quickly as possible. While complete control over respondents in an organisational setting is seldom possible, the potential threat to statistical conclusion validity in this study is believed to be minimal.

6.3.2 **Internal Validity**

Cook and Campbell (1979:38) define internal validity as referring to ‘the validity with which statements can be made about whether there is a causal relationship from one variable to another in the form in which the variables were manipulated or measured’.

Three of Cook and Campbell’s risks to internal validity have been identified as potential threats to this study. They are, *instrumentation, ambiguity about the direction of causal influence, and diffusion or imitation of treatments.*
Instrumentation

The methodology outlined in Chapter 4 described the nature of the repeated cross-sectional longitudinal design used to collect the data for this study. Cook and Campbell (1979:52) suggest that a potential threat may exist due to a change in the measuring instrument between pretest and posttest—‘when human observers become more experienced between a pretest and posttest or when a test shifts in metric at different points’.

Because of the longitudinal nature of the questionnaire, a small number of component manufacturers were participants in the pilot test and in completing both questionnaires. Also, as outlined in Exhibit 4.2 of Chapter 4, a few minor changes were made to some of the questions. While these effects and changes may represent potential threats to internal validity, they are considered minimal. Indeed, the advantages of having the same EDI coordinator answer both questionnaires is potentially an advantage, as the coordinator would be the unique position of being able to observe the changes which took place within the organisation during the intervening period.

Ambiguity About the Direction of Causal Influence

This threat to internal validity proposes that there is a question as to the true causal direction between hypothesised relationships, exacerbated by the adoption of cross-sectional design methods for collecting data.

This study used a repeated cross-sectional longitudinal design which was designed to minimise potential threats to internal validity. In addition, reliance on theory in formulating the linkages between model constructs was clearly stated before testing the models. Further, a pure longitudinal model was developed to test transmission flows between the two periods, with supporting evidence provided from individual case studies.

Diffusion or Imitation of Treatments

When participants can communicate with each other, there is the potential for a further threat to internal validity. While the automotive industry is a relatively close-knit group—in the cooperative sense—competition is sufficiently prevalent to ensure little communication between participants in completing the questionnaires. While respondents may swap stories about their EDI experiences, the researcher has no evidence that collusion existed in completing the questionnaires.
6.3.3 **CONSTRUCT VALIDITY**

Cook and Campbell (1979:38) use the term *construct validity* of causes or effects ‘to refer to the approximate validity with which we can make generalizations about higher-order constructs from research operations’. In essence, construct validity is concerned with *confounding*. That is, the problem that arises when interpretations as to a causal relationship between two theoretical constructs might differ between investigators.

The study used triangulation methods to minimise the threat to construct validity. This method meant using case studies and other frequencies from the survey data to validate the results from the two models—1992 and 1994. While only 12 cases were used, it became apparent that a consistent *story* was being told in this small sample of cases, additional cases were unnecessary. Additional threats to construct validity are not identified in this research.

6.3.4 **EXTERNAL VALIDITY**

External validity ‘has to do with (1) generalizing to particular target persons, settings and times, and (2) generalizing across types of persons, settings and times’ (Cook and Campbell 1979:71). In the present research context, external validity refers to the extent that the results of this research can be extended to other settings—for example, other vehicle manufacturers and their component suppliers—and other industry customer-supplier relations—for example, the retail sector.

In so far as the Australian automotive industry consists of about 300 suppliers, many of whom supply more than one of the four locally-based vehicle manufacturers, its seems reasonable to conclude that the results of this study would be generalisable across not only Ford component suppliers but GMH, Mitsubishi and Toyota as well. Whether the results are generalisable to other international automotive industries remains within the bounds of potential threats to external validity described in this study.

In addition, it should be possible to consider the generalisability of the results to include related manufacturing industries represented by dominant customer-supplier relationships of the type found in retail industries, such as retail supermarkets (e.g. Coles-Myer). Tests for external validity could be undertaken before making such
generalisations (see Chow 1960). However, the researcher should be aware of Brousseau’s (1994:14) conclusion that:

> Although standardization may have beneficial effects by generating economies of scale and scope in coordination, as well as by inducing more competition, it can also cause inefficiencies by creating misfits between transaction requirements and coordination solutions, or inadequacies between coordination rule requirements and firms’ abilities, or even dynamic rigidity.

In addition, the inability of firms to anticipate or predict their future requirements—that is, to develop EDI messages that would adequately meet their future needs—limits the use of EDI in some industry sectors. In some industries, EDI can rigidify organisational responses because it removes human intervention (or mediation) in the coordination of inter-firm information flows. As Brousseau stresses, EDI needs to be bounded.

### 6.3.5 Other Limitations

A number of additional potential limitations to this study should be identified. They include the period of time between surveys and the time period during which the study was undertaken.

First, the time period between surveys was two years. The research was required to be undertaken in a timely manner. Allowing for identification of potential respondents and the completion of the preliminary research, two years was considered a minimum time in which worthwhile organisational changes could be readily observed. The results of this study support this contention. Ideally, a longer time period would have been preferred, and this is suggested as one of the activities for future research.

Second, the period during which the study was completed (1991–94) was a time when the Australian automotive industry was emerging from a downturn in economic activity. Most of the vehicle assemblers had experienced at least one or two years of low or negative profit following the recessionary effects of the late 1980s and early 1990s. Many component suppliers had also experienced similar effects due to the recession. It would be impossible to estimate the extent to which the recession had positive effects on, for example, productivity and staff savings otherwise attributable to EDI. It is sufficient to say that these effects may have influenced the final results to some degree.
6.4 IMPLICATIONS OF THE RESEARCH

As outlined in Chapter 1, little prior research had been attempted in assessing the net benefits from EDI in any industry. Organisations adopting this cooperative technology often did so because they believed that the benefits were so large compared with the establishment and associated costs that to attempt a benefit/cost analysis was deemed unnecessary. While this may have been a valid conclusion for the pioneers of EDI, such as Ford Australia, it was most certainly not valid for trading partners coerced into EDI adoption.

This section outlines the implications of this study for researchers, the automotive industry and individual component organisations. It concludes with suggested future research directions. The research results reported in this thesis have a number of theoretical and practical implications.

6.4.1 THEORETICAL IMPLICATIONS

The research reported in this thesis has made a theoretical contribution to knowledge in a number of ways.

First, the research extends the theory relating to interorganisational systems discussed in Chapter 3, through the construction of a theoretically-justified conceptual model that relates the level of senior management commitment and extent of system integration to the achievement of net benefits from EDI adoption. The model further proposes that the size of organisations and the extent to which they are dependent on the industry for continued business trade has a direct effect on the level of EDI net benefits, and an indirect effect on EDI net benefits through their effects on senior management commitment and system integration.

Second, the results provide confirmatory support for the conclusions drawn from the work of Swatman (1993), Bergeron and Raymond (1992) and Pfeiffer (1990).

Third, the study contributes to a better understanding of the productivity paradox in information systems through the information transmission mechanisms implied in the conceptual model (see especially Brynjolfsson 1993).
Finally, the research provided two methodological contributions in (a) the provision of a validated instrument for measuring economic net benefits from investment in information technology, and (b) development of two conceptual models, allowing a comparison between two methodologies—the repeated cross-sectional longitudinal model and the pure longitudinal model.

6.4.2 PRACTICAL IMPLICATIONS

First, the results provide evidence for the nature and extent of EDI net benefits in the Australian automotive industry. Until this study, all of the evidence available relating to the impact of EDI on the automotive industry appeared exclusively anecdotal. In so far as the component sector was concerned, no formal impact analysis had been attempted at all by the industry.

Second, the study provides component manufacturers with evidence of the types of net benefits possible from EDI adoption. Until this study, the majority of firms interviewed confessed that they had not critically reviewed the progress of EDI within their organisation. The smaller to medium-sized firms in particular admitted to establishing EDI with little or no thought to organisational consequences. Many believed it was merely an additional cost of production and so agreed to adopt EDI, because failing to do so would have meant, at best, the loss of Ford’s Q1 quality assurance status, or at worst, complete loss of contract to supply Ford and their other automotive customers.

The results reported from an analysis of the two surveys indicate that significant changes did take place both between vehicle assemblers and their component manufacturers, and within individual supplier organisations, during the two years following EDI adoption.

Third, the research provides the individual supplier with a model which may be used in assessing the principal contributing factors to successful EDI implementation, particularly the level of senior management commitment and extent of system integration undertaken. The 1994 survey indicated that approximately 48 per cent of suppliers had integrated EDI into their existing information systems. There is ample scope for the results of this study to assist the automotive industry in providing evidence to the remaining 52 per cent of suppliers of the potential net benefits of full system integration. Further, the model outlines the clear role for senior managers in the integration process if their firms wish to achieve maximum potential net benefits from EDI adoption.
Fourth, the study might demonstrate to the automotive industry—especially the four multinational car companies—and other industries contemplating EDI adoption, the consequences of coercively introducing a cooperative technology. Seventy-five per cent of suppliers stated that their number one reason for adopting EDI was because they were told to do so by their dominant customers. While net benefits to suppliers became apparent following EDI adoption, the process involved considerable and unnecessary anguish, particularly amongst small to medium suppliers. As Sokol (1989:72) explains: ‘if EDI is merely imposed upon the way you currently do business, it will not deliver the expected long-range potential benefits’. In continuing the trend toward globalisation of production resulting in heightened competition, global companies of the kind represented by automotive manufacturers could learn more from the lessons implied in this research.

While the automotive industry EDI committee representing the FCAI (i.e. the customers) and the FAPM (i.e. the suppliers) endeavoured to work cooperatively toward EDI implementation, they still acted independently. While the five assemblers were represented, only three suppliers (mostly medium to large corporations) were represented on the committee. Common dates were set for the introduction of each electronic document, but not all customers—let alone all the component suppliers—were in a position to abide by the date.

Telecom had some difficulties with the roll-out of their Tradelink software, and in setting an appropriate price for the product. Both these issues became hot topics at the monthly industry meetings. The lessons provided from the automotive industry’s implementation of EDI could assist other industries in their implementation.

Fifth, the results of the research should assist in dispelling the myth that simply adopting EDI will bring about almost immediate benefits without the need to re-engineer business processes. The research indicates that businesses adopting EDI (and potentially other forms of information technology) cannot simply impose the technology on their own business environment—or that of their trading partners—in a vacuum without ensuring the internal processes are redesigned. The changes to the flow of information between trading partners was to some organisations quite substantial. Larger organisations with internal information systems departments were generally in a superior position to cope with the re-engineering process. Smaller suppliers with often no information technology professionals were least able to contend with the required internal adjustments.
While Telecom provided the EDI application and translation software for all EDI users, the smaller firms generally relied upon pre-packaged application software that was not easily integrated with Tradelink. Smaller suppliers wishing to achieve the potential benefits from integration were often not in a position to do so, as EDI-integrated application software was generally not available. This, however, was not seen to be a responsibility or concern of the automotive industry EDI committee.

Despite the organisational difficulties reported here, this research, performed in the context of the Australian automotive industry, provides empirical evidence of the integrative potential of EDI (Reekers and Smithson 1994). The evidence provided in this study illustrates the beginnings of the formation of new cooperative arrangements which represent important cultural changes in the nature of customer–supplier relations in the Australian automotive industry. The changes move away from adversarial arrangements characteristic of Fordist production methods, to what Reekers and Smithson (1994:16) see as responsiveness, frequent interaction and a high level of integration of interorganisational processes. The continuous exchange of frequent information through EDI can be seen as ‘a gradual build up [of] a common production philosophy as well as a shared understanding of the business’.

Finally, there is an implication for policy-makers in promoting what Helper (1993) calls the development of the art of voice. Helper sees this in the encouragement by policy-makers in assisting the formation of regional networks of firms and in the reduction of switching costs from an exit system of behaviour. Reduced switching costs would be encouraged by providing infrastructure that encourages the adoption of techniques such as EDI, JIT and total quality management in the process of redesign of business practices. Such policy implications would extend to telecommunications policy (e.g. policy that encouraged greater network competition). As Helper (1993:154) concludes:

\[
\text{The networks of information and technological capability that exist between firms (and among different divisions of large firms) are an important type of infrastructure, one which is just as crucial to economic development (and which has been just as neglected) as roads, sewers, and bridges.}
\]

6.4.3 PROPOSALS FOR FUTURE RESEARCH ACTIVITY

This research could be extended in a variety of ways.

First, further research should include the impact of financial EDI on the automotive industry, or what the industry calls closing the business loop—the integration of
financial EDI into the electronic trading/payments cycle. In January 1994 Ford Australia commenced a form of financial EDI between themselves and their major suppliers. However, there has been some understandable reluctance on behalf of the major banks to allow other network providers, such as Telecom, to connect to their network. In essence, this means that financial EDI has been little more than a variation of electronic funds transfer and not pure EDI. However, expected future industry net benefits from an extension of EDI throughout the industry needs to be more extensively tested.

Second, the time period for measuring the diffusion process should be extended. Two years was considered by the researcher a minimum period in which to observe organisational changes. These changes were apparent, but should be incorporated into a longer period study, perhaps one that encapsulates financial EDI.

Third, this study listed a potential threat to external validity—the generalisability of the results across types of persons, settings and times (Cook and Campbell 1979). An extension of this research could include testing the results from the model in alternative environments. A suitable milieu might include the retail sector represented by organisations such as Coles-Myer and subsidiaries including K-Mart, Target, Myer, and Coles New World supermarkets.

Fourth, the automotive industry provides an opportunity to examine the consequences and potential for an open-EDI world. When the Australian automotive industry commenced electronic commerce in 1988, Telecom Plus (now Telstra Multimedia) provided a closed EDI network system. Network security barriers prevented both automotive customers and component manufacturers from trading outside their own industry environment. Non-automotive firms could not trade with automotive firms without becoming users of the Telecom network.

Schaber (1993) quite rightly observes that there is a growing need to provide an open-EDI environment in the face of an expanding but heterogeneous market of EDI adopters, made up of network and software providers and a plethora of trading partners. The automotive industry in Australia was the first industry to cooperatively adopt EDI. The industry learnt the lessons provided from North American experience of reliance on proprietary standards and internal networks. This research could be extended to provide an insight into the adoption of homogeneous communication service infrastructure,

1 According to Schaber (1993:57), open EDI ‘requires a unique and universal EDI message standard (EDIFACT), an open communication service, generally agreed security procedures and a common legal framework’.
especially for international EDI applications which are required for continued trading in the global automotive industry.

Finally, an issue which most researchers appear to be avoiding (including this researcher), is the role of restrictive trade practices which may be caused by adoption of EDI, an issue implied in the work of Webster (1994).

This study provides sufficient evidence to suggest that component manufacturers believed they were coerced into adopting EDI—75 per cent stated that the main reason for installing EDI was their customers’ demands. A number of automotive companies, including Ford Motor Co., have openly stated their intention to reduce the number of suppliers world-wide (Gottliebsen 1995) and have indicated that EDI is one of the vehicles by which this reduction could be brought about. The intent of this objective appears to be to lock EDI enabled suppliers into longer-term contracts, so restricting their competitive ability though an action of exerting greater control over suppliers.\(^2\)

Additional research activity should investigate the extent to which coercion to adopt a certain method of trading which locks in trading partners, falls under a breach of Part IV of the *Australian Trade Practices Act 1974—Misuse of Market Power and Vertical Restrictions on Competition* (Hurley and Wiffen 1994). Further, the requirement by some customers for suppliers to sign trading partner agreements might in fact be nothing more than information contracts (see EDI Council of Australia 1990b) and might attract attention from the Trade Practices Commission.

### 6.5 CHAPTER SUMMARY

This chapter summarised the research activities of this thesis. Conclusions drawn from the research results were summarised, including an outline of the potential limitations of the research. Implications of the results for both theory and practice and directions for future research endeavours concluded the chapter and this thesis.

\(^2\) Ford confirm that the introduction of EDI has facilitated longer-term contracts (generally 3–5 years which should potentially benefit most suppliers (previous contracts were often only 6–12 months). However, a breach of the *Trade Practices Act* may still occur even if a restriction in competition is simply implied.
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