How intimate are Australian e-business retail supply chains?

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Abstract

The adoption of electronic commerce strategies is becoming an important means of assisting industries, and indeed whole economies, to gain significant net benefits. The extent to which e-commerce-based strategies, such as quick response and efficient consumer response, might have an effect on local economies depends in part on how readily they are being adopted. The dominant form of adoption of these strategies is to be found in the business-to-business forms of e-commerce. To be successful, business partners must be in a position to develop customer intimacy through sharing of information, to improve their stock replenishment practices, and enhance their levels of online customer support. This paper presents the initial results of a national survey completed in the retail sector of the Australian economy, that assesses how well Australian industry is responding to these e-commerce challenges.

Introduction

Two independent reports prepared for the Australian Government (National Office for the Information Economy, 1999) and the European Commission (EC) (FAIR Project Consortium, 1998) outline many of the potential net benefits that the Australian economy and countries within the European Union (EU) could gain from the adoption of e-commerce strategies. These reports are significant, because they attempt to assess the impacts of the adoption of e-commerce on various sectors of each economy. In particular, they examine the likely macroeconomic effects from the continued rapid expansion of e-commerce by examining contributions to growth in output and consumption, in employment and productivity, to the economies of two quite different regions.

Both reports agree that there are generally potential positive multiplier effects and new job creation consequences. The EU predicts that, even taking into account direct substitution effects and traditional job reductions, the indirect multiplier effects on production, value added and employment growth are "three indirect jobs for each direct job created" (FAIR Project Consortium, 1998, p. 2). It further estimates that revenues of ECU 58 billion are possible by early in the twenty-first century. Much of the revenue will be generated from "introducing a new, richer dimension of interaction within supply chains and in seller-buyer relationships. New intermediation, rather than dis-intermediation, represents the largest source of new business opportunity" (FAIR Project Consortium, 1998, p. 2).

The Australian Government report, which focuses on the structural changes that e-commerce may bring, suggests that the widespread adoption of e-commerce predicts that the more efficient way of doing business (online) will result both directly and indirectly in net benefits. The simulation studies, conducted as part of the project, suggest that "the net impact could be a 2.7 per cent increase in the level of national output, and enhanced consumption (a better indicator of material wellbeing) by about $10 billion within the next decade" (National Office for the Information Economy, 1999, p. 2).

Both reports agree that the contributions to growth will initially be made in the business-to-business domain of e-commerce adoption.

Initially, this will be the domain that will gain the most from improved efficiencies through reduced costs and prices and improved business practices that will lead to greater international competitiveness.

This paper presents the results of a national survey conducted in Australia of organisations that have undertaken e-commerce activities primarily in the business-to-business domain of the Australian retail sector using QR and ECR strategies. The results presented in this paper provide additional insights into earlier work by Harris *et al.* (1999), Kotzab (1999) and McMichael *et al.* (1997, 2000) who concentrated on the effects of adoption of efficient consumer response (ECR) strategies in the Australian and European grocery industries and quick response (QR) in the Australian textile clothing and footwear industries.

This survey was completed during 1999, covering companies which are mostly suppliers to much larger retail customers. Where available, results are compared with those from an international report prepared by Kurt Salmon Associates (1998). This comparison allows the Australian retail sector to gauge how successful it is in comparison with the available US results.

E-commerce and the Australian retail sector

Quick response (QR) is a business strategy enabled by IT to improve communication and coordination between supply chain partners. By its strategic nature, QR creates a business opportunity that seeks to achieve an alteration to existing business practice (Hadjiconstantinou, 1998). QR has also been called the retail industry's version of just-in-time (JIT) manufacturing because it seeks to better manage and move inventory through the supply chain. A related strategy is efficient consumer response (ECR) which was originally based on QR, but specifically applies QR principles to the grocery industry (Harris *et al.*, 1999).

QR, ECR and JIT aim to keep inventories as low as possible, without goods running out, and to quickly resupply goods as they are needed to prevent stocking-out. QR and ECR extend beyond the paired relationships that are often found in JIT manufacturing by creating partnerships that extend to all levels of the supply chain. While existing views of QR have

been adequate for focusing on particular aspects of QR arrangements, they often overlook some of the essential elements required when QR is seen as a total business strategy.

One of the key drivers of this business strategy is the degree of competition being experienced by global firms. Strader *et al.* (1999) stress that it is this intense competition in most industries that is making organisations look toward better ways to improve product quality, customer service and operating efficiency, just to remain competitive. QR and ECR are two of the business outcomes firms have used to meet the competitive challenge.

Related prior research

There are many definitions of QR and ECR. The preferred definition for this study is:

> QR (and ECR) is a consumer-driven business strategy of cooperative planning by supply chain partners, to ensure the right goods are in the right place, at the right time, using IT and flexible manufacturing to eliminate inefficiencies from the entire supply chain.

This research focuses on the cooperative, computer-based communication aspects of QR and ECR, which, as Zwass (1998) describes, form part of a hierarchical structure of e-commerce levels, which includes partnerships (business relationships), IT and information sharing. In Zwass's terms, we reflect his meta-level of products and structures (Level 7) which relates directly to interorganisational supply-chain management.

A US study in 1986 examined the flow of products in the supply pipeline from raw materials into textiles, to apparel, to retail and finally to the consumer. The results of the study (see Blackburn, 1991) showed that it took on average 66 weeks to move from a raw material to a finished good distributed to the consumer, as outlined in Figure 1. A $25 billion efficiency loss was estimated to be occurring due mainly to forced markdowns, discounting, stock-outs and increased carrying costs for excess inventory. Forecasting problems affected the industry because the span of the forecasts in the product pipeline extended beyond a year. All parties could only estimate what goods the consumer would demand by the time the product reached the market.

Figure 1 The apparel pipeline
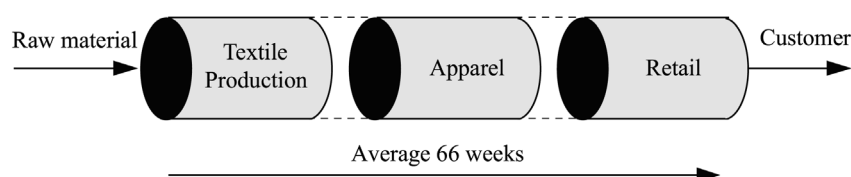
Source: Blackburn (1991)

Blackburn (1991) reports that the initial study suggested that forecasting could be improved in two ways. First, by increasing the accuracy of planning systems and, second, by reducing the time between making the forecast and the actual event occurring. It was thought that, while the accuracy of planning could be improved, the greatest gains could be attained from taking time out of the supply pipeline – to move the stock forecasting decisions closer to the customer in time. By eliminating the slack time, the length of the supply pipeline could be reduced, which would decrease the level of uncertainty in the decision-making process, because forecast error decreases in proportion to the time until the event. As a result pipeline acceleration was born.

The introduction of universal product codes (UPC) and point of sale (PoS) scanning in the mid-1980s made it possible for retailers to track product movements themselves at both the distribution centre (DC) from incoming and outgoing receipts and at the store level from PoS scanning. At the same time EDI networks were being established between retailers and their suppliers and some manufacturers were establishing EDI with their suppliers. Clemons and Row (1993) found that the adoption of EDI by retailers and their suppliers had led to short-term benefits, due mainly to administrative savings, where EDI was used to automate existing document exchanges. Clemons and Row concluded that the potential existed to achieve greater savings using EDI to restructure the logistics system to reduce costs.

The availability of detailed information collected at the PoS coupled with EDI made it possible to disseminate sales data throughout the supply chain as shown in Figure 2, where sales data flow back down the supply chain from the point of sale.

Using QR, the flow of products and the flow of information in the apparel pipeline are both increased in velocity. Goods are moved forward to the customer faster by reducing

manufacturing and shipment times, and by eliminating inefficiencies that are not beneficial to the supply chain as a whole. Allowing this faster flow of goods to occur is the increased responsiveness available through faster communication of consumer preferences back to all members of the supply chain using computer-based communication systems.

This research paper presents some initial results of a national survey of the extent of e-commerce (particularly the adoption of QR and ECR strategies) in supply firms within the Australian retail supply chain. The paper concentrates on the issue of process improvement (Beamon and Ware, 1998; Dale, 1994), and includes the issues of:

- consumer intimacy;
- collaborative planning and forecasting;
- stock replenishment;
- e-commerce support.

Australian retail survey

This national survey was conducted between March and June 1999. To make the survey internationally comparative, the Kurt Salmon Associates (1998) survey was used. The survey instrument itself was modified to reflect the Australian retail industry's use of local terms. Two separate questionnaires were sent to the quick response/e-commerce coordinator of each supply company (50 questions) and each retailing organisation (39 questions). This paper reports only on the supplier survey.

The targeted population was confined to suppliers to the Australian retail sector that were trading electronically with at least one customer. All suppliers included in the survey were trading electronically with their customer base that included the largest retailers in Australia (including Coles Myer group, Woolworths and Big W). Approximately 1,500 companies were identified from a list of suppliers provided with the assistance of the Australian Retailers Association. The effective

Figure 2 Two-way product and information flows in the supply chain
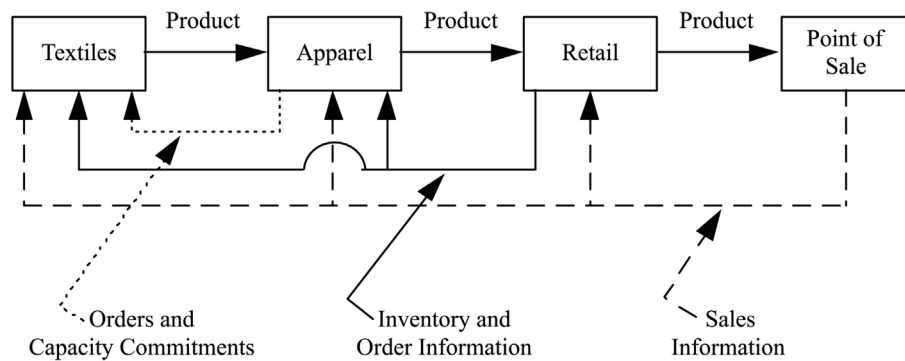
Source: Blackburn (1991)

response rate was 11 per cent. A profile of the type of companies and size of companies (measured by company sales volume) was presented to a senior representative of the Australian Retail Industry Association who confirmed that the sample profile of responses was a fair representation of the Australian retail industry.

A profile of these companies is illustrated in Table I and a profile of company turnover is illustrated in Table II.

Results

Customer intimacy

The term "customer intimacy" is now used to suggest that suppliers need to develop intimate partnerships with customers to differentiate themselves from competing suppliers. The aim is to turn a satisfied

Table I Profile of retail firms

Category	Frequency	Per cent
Clothing and footwear	3	1.8
Appliances/consumer electronics	9	5.6
Books/audio/video	9	5.5
Packaged/consumer goods	48	29.4
Hardware/home improvement	13	8.0
Sporting goods	8	4.9
Textiles and fabrics	10	6.2
Health and beauty aids	16	9.8
Furniture/home furnishings	9	5.5
Non-perishable food and beverages	15	9.2
Perishable food and beverages	10	6.2
Other	13	7.9
Total	163	100

Table II Turnover of retail firms

Turnover ($)	Frequency	Per cent
< 5 million	57	34.9
6-10 million	25	15.3
11-25 million	33	20.2
26-50 million	15	9.2
51-100 million	12	7.4
101-200 million	6	3.7
201-500 million	7	4.3
501 million-1 billion	3	1.8
Not reported	5	3.2
Total	163	100

customer into a loyal customer. Customer intimacy highlights the ability to understand and respond to highly specific and changing needs of very specific customers by continually tailoring products and services to precisely meet those needs.

Information systems give clues to customer preferences but Wiersema says that a human touch is required in learning what people really want (Wiersema quoted in Klinkerman, 1999). He points to three major customer priorities. The first is transparency where you must make customers feel that you are being accurate, reliable and responsive to their needs. The second is distinctiveness where you must give them a clear and compelling reason to choose you over other alternatives. And the third is leadership, where customers love to associate themselves with winners and companies that are going places. The degree of customer intimacy was measured by the extent of shared data between the customer and the supplier, in particular, the extent to which PoS data from customers are shared with suppliers.

A total of 52 per cent of suppliers who were trading electronically were given access to

PoS data from their major customers. This represented on average 32 per cent of their total sales. Kurt Salmon reported that in the USA in 1998 the comparable figure was 79 per cent with access to PoS data (Kurt Salmon and Associates, 1998). Interestingly, about one-third of suppliers were using a data warehouse to store the data received from customers. Table III illustrates the type of data maintained by suppliers with a data warehouse.

Collaborative planning and forecasting

Collaborative planning and forecasting is a set of business practices based on shared information and planning among partners. It consists of an established set of business practices that trading partners agree to follow. Its success depends on the partners sharing information and forecasts, usually via the Internet and electronic data interchange (EDI), to more accurately replenish shelves. Everyone involved in collaborative planning and forecasting agrees that its impact will be dramatic. Still, the concept will require not only trust in partners, but also an investment in the technology that will allow disparate systems to communicate fluently.

The ability to form new relationships between supply chain partners to eliminate inefficient practices and accelerate the flow of goods through the supply chain is the goal of QR and ECR efforts. Increasing the level of customer intimacy and joint planning are one of the keys to achieving that goal. Suppliers were asked the extent to which they developed seasonal forecasts with their key retail customers. Approximately 43.4 per cent indicated they do not participate in preparing seasonal forecasts at all. Of the remaining

57.6 per cent who are involved in seasonal forecasts, the modal class represents between 10-30 per cent of customers.

It is very significant to note that two out of five suppliers were not actively preparing seasonal forecasts with their customers. This further underlines the troubling finding of Harris et al. (1999) that, although there is quite a lot of interest in the QR and ECR supply chain initiatives, there is a general lack of interest from suppliers in implementing the complete strategy. Respondents were asked whether their larger customers provided forecasts. Only 14.5 per cent reported any forecasts, although a few stated that they had plans to receive data within three years. They were also asked if they set joint goals with formal metrics with their key retail customers. Table IV presents the results of the formal metrics used by suppliers.

Stock replenishment

Efficient retail replenishment is the single largest opportunity existing in the supply chain today (Williams, 1999). Many organisations are suffering from the dual problems of being out of stock at the shelf in some products and simultaneously having excessive inventories in retail stores in other products.

Consumers initiate the QR process of replenishment when they make purchases from the retail store – these purchases are expressions of their needs and wants. These needs and wants are recorded by the retailer as merchandise information usually by size, style, colour and brand from PoS scanning.

Table III Type of data stored in data warehouse

Data type	Australian Survey 1999[a] (%)	Kurt Salmon 1998[b] (%)
Own products	32.5	–
Category data	13.5	33
Promotion/in-store display history	11.0	14
Store demographics	6.1	14
Market basket data	4.3	8

Sources: [a]National Office for the Information Economy (1999); [b]Kurt Salmon Associates (1998)

Table IV Metrics used by suppliers

Formal metrics	Per cent using
Sales goals	71.8
In-stock goals	44.8
Goals related to mass customised product	3.7
Profitability goals	25.8
New product success goals	18.4
Goals related to electronic sales of merchandise	6.1
Inventory turns goals	20.9
Total lead time goals (from product concept to on the selling floor)	20.9
Consumer satisfaction goals (from product concept to on the selling floor)	20.2
Fulfillment objectives	18.4

There are three main ways in which a replenishment order can be generated from the PoS data. The retailer may give the supplier a blanket type authorisation to prepare and ship orders as per agreed methods, without any review of individual orders by buyers. This is the vendor-managed inventory (VMI) approach most commonly used by discount retailers and their suppliers. The extent to which this information is requested and used depends on the size of the supplier. Generally, large suppliers request this type of information and prefer to perform their own analysis in a VMI system, while smaller suppliers only want aggregated sales information.

The second approach involves the supplier preparing an order and then sending it to the retailer electronically as a reverse purchase order. Under this system the retail buyer reviews and approves the recommended quantities and makes any modifications if deemed necessary. While this approach takes more time than the VMI approach, it allows the retailer to make changes based on information to which the supplier may not be privy, such as rivals' products being on promotion.

The final approach involves the retailer preparing replenishment orders using in-house software and data analysis systems and then transmitting these orders, via EDI, to the suppliers. Some retailers that prepare their own orders still share their PoS data with their suppliers to give the suppliers a better basis for sales forecasting and production scheduling. Customers are keen to maintain the absolute minimum level of inventory possible, subject to being able to maintain sufficient product to meet the demands of consumers. Too large an inventory will result in excessive holding costs, while frequent out-of-stock occurrences will result in missed sales.

The main benefits of the VMI approach are that inventory levels (especially safety stocks) can be significantly reduced and the risk of stock-outs is consequently reduced. This benefits both the retailer (lower holding costs and elimination of purchase order transactions) and suppliers (advanced warning of stock demand makes production requirements far more predictable) (Christopher, 1998).

McMichael *et al.* (2000) found that improved planning had resulted from QR through increased information sharing from the elimination of "slack time" which had occurred due to retailers withholding information. However, this acceleration had only occurred in the first link of the supply chain between retailers and manufacturers and did not extend beyond this first tier. The demands by retailers to make smaller, more frequent deliveries, the increased distribution costs incurred and the infancy of automated replenishment programs were cited as reasons why the accelerated movement of goods had not flowed back through the supply chain.

Responding suppliers reported that 59.7 per cent were participating in automatic stock replenishment programs with their customers, while 27.2 per cent indicated they had no intention of participating in such a scheme. The remaining 13.1 per cent had plans to introduce automatic replenishment within three years.

The finding that just over one quarter of the suppliers surveyed had no intention of participating in automated stock replenishment was surprising, given that McMichael *et al.* (2000) had found that firms participating in QR had strengthened their competitive position compared with those firms which were not participating in QR. The small size of the respondent firms, 50 per cent with a turnover of less than $10 million, and the retailers' decision to concentrate on automated replenishment with large volume suppliers help to explain this finding. However, this finding clearly illustrates that e-commerce activities have not fully penetrated the retail supply chain and perhaps are unlikely to do so in the near future. This does call into question just how quickly some of the predicted benefits suggested in the EU and Australian Government reports will be realised and if these benefits will be partially offset by the incomplete adoption of e-commerce by smaller firms.

E-commerce support

The extent of electronic (online) support provided by organisations, particularly suppliers to their customers, often depends on the level of maturity that the organisation has with electronic commerce. Turban *et al.* (2000) suggest that the very lowest level of online support would be a basic Web site that provides current and potential customers with information about the nature of the products

they sell (manufacture, wholesale or distribution). This phase is the information-gathering phase, and often involves the setting-up of an electronic catalogue of the supplier's products. Links may be provided to other virtual sites associated with the company, which may include technical advice about the product. This level of service is similar to business-to-consumer type e-commerce where the individual shopper seeks basic information about a range of products they may wish to purchase. The difference between the two types of customers is that, in the business-to-business case, the customer is usually another business; in the case of business-to-consumer, the customer is usually an individual person. This stage is often termed electronic marketing.

At the other extreme, customers may be able to make their purchases online by filling out order templates which connect to back-end databases. More often than not, organisations are making use of EDI either formally using private value added networks or, increasingly, the Internet. Much larger organisations (both large suppliers and large customers) will offer access to their information systems via Extranets – a dedicated network between associated organisations via a private network arrangement or public Internet.

In between these extremes, e-commerce support implies the ability for business partners to check product delivery status, to act as electronic intermediaries, or to simply provide a mechanism for facilitating contact, e.g. using e-mail.

Apart from customers sharing information with suppliers using PoS and other data (e.g. direct forecasts from customers), suppliers are progressively using Web sites to provide customers with access to display catalogues, prices etc. The extent to which suppliers provide this facility is an indication of their support level for their customers.

Suppliers were asked if they had a Web site – 39.4 per cent indicated they did (the Kurt Salmon survey in the USA was 65 per cent). Of those companies that did not have a Web site, 39 per cent indicated their intention to have one within three years – 21 per cent had no plans at all. Of those with a Web site on the Internet, Table V indicates for what their Web site is used.

The finding that 60 per cent of respondent firms did not have a Web site and that 21 per

Table V Web site usage

Web site used for:	Australian Survey 1999[a]	Kurt Salmon 1998[b]
Providing general company information	27.0	
Displaying catalogues and product information	25.2	59.0
Taking orders from customers	6.1	18.0
Customer surveys	1.2	
Providing general information to other suppliers	31.3	
Providing specific information to individual suppliers	2.5	
Purchasing	0.6	
Other	6.1	23.0

Sources: [a]National Office for the Information Economy (1999); [b]Kurt Salmon Associates 1998)

cent of those firms had no intention of creating one clearly illustrates the difference in e-commerce technology use between the USA and Australia at present and probably in the longer term. This means that caution is needed when comparing the two markets because there are likely to be key technological as well as size and market differences between the two. In addition this reinforces the finding of Harris *et al.* (1999) that there is a lack of commitment to adopting the underlying technologies and essential business activities necessary for QR and ECR in Australia.

Conclusions

Today the massive investment in IT is leading organisations to make changes in the way they think about and run their businesses. Williams (1999) succinctly summarises the situation when he says we face "change in what we do, how we do it, with whom we do it, and the tools we use to get it done". There is no doubt that industry is facing new rules of business together with one of the toughest environments in which it has ever operated. When this environment is coupled with a consumer demand for more variety and immediate replenishment, supply chains have to cope with huge numbers of stock-keeping units.

With the early recognition of the importance of supply-chain management, industry leaders have used several different models to create uniform supply-chain management techniques. For instance, in the clothing, textile and footwear industry, QR has been used as a consumer-driven business

strategy of cooperative planning by supply chain partners (McMichael *et al.*, 1997). And, in the grocery industry, efficient consumer response (ECR) has been concerned with transforming the grocery supply chain from a "push system" to a "pull system" (Harris *et al.*, 1999).

The results presented in this paper suggest that there is clear evidence to indicate the growing need for Australian suppliers to become more intimate, with increased cooperation in planning and data sharing with their customers (the large retailers). Compared with their US counterparts, Australian suppliers are not receiving the quantity and type of data they require to assist with forecasting and planning, and so assisting them to become more internationally competitive. While formal metrics were being used, they principally concentrate on techniques to measure traditional sales goals. Very few organisations were actually using other techniques to measure performance, e.g. lead time goals, inventory turns, or goals related directly to electronic sales of merchandise. Greater intimacy should lead to additional shared benefits and in turn create a more efficient retail industry.

While the majority of supplier firms were involved in automatic stock replenishment schemes, it is of more concern that over a quarter of suppliers indicated that they had no intention of participating in such a scheme. This is not particularly good news for their large customers. The level of e-commerce support provided by suppliers is considerably less (less than half) than their US counterparts. This suggests that Australian suppliers have a long way to go in providing electronic support to their key business-to-business customers. This general reluctance to participate may in part be explained by the large retailers coercing their suppliers into adopting QR/ECR techniques with little explanation of the shared benefits that might flow.

In this new business environment driven by consumer demand, entire supply chains are under more pressure to be reliable, responsive and to fulfil orders even more quickly. For all organisations, the question today is how to build the business systems to deliver value tomorrow. If they are to deliver the sorts of economic benefits suggested by the FAIR Project Consortium and NOIE, then considerable efforts will be required by both partners on either side of the virtual fence.

References

Beamon, B.M. and Ware, T.M. (1998), "A process quality model for the analysis, improvement and control of supply chain systems", *Logistics Information Management*, Vol. 11 No. 2, pp. 105-11.

Blackburn, J.D. (1991), "The quick response movement in the apparel industry: a case study in time-compressing supply chains", *Time-Based Competition*, Irwin, Homewood, IL, pp. 246-69.

Christopher, M. (1998), *Logistics and Supply Chain Management*, Pearson Education Limited, London.

Clemons, E.K. and Row, M.C. (1993), "Limits to interfirm coordination through IT: results of a field survey in consumer-packaged goods distribution", *Journal of Management Information Systems*, Vol. 10 No. 1, pp. 79-95.

Dale, B.G. (1994), "A framework for the introduction of a process of quality improvement in retail organizations", *International Journal of Retail & Distribution Management*, Vol. 22 No. 8, pp. 25-32.

FAIR Project Consortium (1998), "Constructing the European information society", ACTS Unit, European Commission, Brussels, p. 32.

Hadjiconstantinou, E. (Ed.) (1998), *Quick Reponse in the Supply Chain*, Springer-Verlag, Heidelberg.

Harris, J.K., Swatman, P.M.C. and Kurnia, S. (1999), "Efficient consumer response (ECR): a survey of the Australian grocery industry", *Supply Chain Management*, Vol. 4 No. 1, pp. 35-42.

Klinkerman, S. (1999), "The ties that bind", *Banking Strategies*, Vol. 75 No. 1, pp. 32-7.

Kotzab, H. (1999), "Improving supply chain performance by efficient consumer response? A critical comparison of existing ECR approaches", *Journal of Business & Industrial Marketing*, Vol. 14 No. 5,6, pp. 364-77.

Kurt Salmon Associates (1998), *RIS News and Consumer Goods*, p. 34.

McMichael, H., Mackay, D.R. and Altmann, G.L. (1997), "Quick response in the Australian textile clothing and footwear industry", *European Conference on Information Systems*, University of Cork, Cork, pp. 295-312.

McMichael, H., Mackay, D.R. and Altmann, G.L. (2000), "Quick response in the Australian TCF industry: a case study of supplier response", *International Journal of Physical Distribution & Logistics Management*, Vol. 30 No. 7/8, pp. 611-26.

National Office for the Information Economy (1999) "E-commerce beyond 2000", Department of Communications, Information Technology and the Arts, Canberra, pp. 1-16.

Strader, T.J., Lin, F.R. and Shaw, M.J. (1999), "Business-to-business electronic commerce and convergent assembly supply chain management", *Journal of Information Technology*, Vol. 14, pp. 361-73.

Turban, E., Lee, J., King, D. and Chung, H.M. (2000), *Electronic Commerce: A Managerial Perspective*, Prentice-Hall, Upper Saddle River, NJ.

Williams, S.H. (1999), "Collaborative planning, forecasting and replenishment", *Hospital Material Management Quarterly*, Vol. 21 No. 2, pp. 44-51.

Zwass, V. (1998), "Structure and macro-level impact on electronic commerce: from technological infrastructure to electronic market places", in Kendall, K.E. (Ed.), *Emerging Information Technologies*, Sage Publications, Thousand Oaks, CA.