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Title: E-collaboration technologies in the supply chain and its impact on the performance

Cláudia Aparecida de Mattos

Production Engineering Department of Center University of FEI
Phone no.: 55 11 3207 68 00 e-mail: ccldmtts@terra.com.br

Fernando José Barbin Laurindo, Associate

Polytechnic School of the University of São Paulo
Production Engineering Department
Phone no.: 55 11 3091-5363 e-mail:fjblau@usp.br

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Abstract

The transparency provided by Information Technology (IT) allows companies to reposition themselves in the productive chain and dynamically collaborate with other companies with the purpose of optimizing their business. The global competition demands for transparent activities among suppliers with internal and external customers to facilitate inbound and outbound information flow and goods/services flow. The collaboration, more specifically e- collaboration has been considered as key enabler to supply chain integration and plays an important role, enabling organizations to establish relationships in order to foster, together, good results and performance. Thus, the aim of the research is to analyze through quantitative study in manufacturing firms (large and medium size) the application of collaborative tools in supply chain and to identify if for the group of companies that are applying these tools there is a perceived improvement in performance by managers. The cluster analyses were applied to study the objective of this study. The results of the cluster analysis reveal three major groups, differentiated by the level of e-collaboration where the group that presented the greatest e-collaboration level presented greatest level related to performance. A total of 95 companies answered the survey.

Key-words: E-collaboration, performance, internal integration, supplier integration and customer integration

1. INTRODUCTION

According to Azevedo (2000), the intensification of the use of information technologies (IT) in all economic activity sectors has allowed the transition from competitiveness centered on factors of a tangible nature to competitiveness in which the emphasis is placed on organizational questions, as well as on coordination and cooperation issues.

In this context, the emergence of new factors of external and internal scope, such as markets globalization, the launch of new products in shorter periods of time, and technological proliferation in very heterogeneous areas, have caused profound alterations to the organizations so that they can continue to be competitive. Gunasekaran & Ngai (2004) mentioned that supply chain management (SCM) is the 21st century global operations strategy for achieving organizational competitiveness. In that context, companies are attempting to find ways to improve their flexibility and responsiveness and thus their competitiveness by changing their operations strategy, methods and technologies.

The transparency provided by IT allows companies to reposition themselves in the productive chain and dynamically collaborate with other companies with the purpose of optimizing their business. The Internet and other integration tools, such as software for supply chain management (SCM), and electronic interactions between business players in the product value chain, have transformed the business world. This has allowed a deverticalization in the chain and new forms of companies' operation, implying a review of production architecture, of traditional relationships in the value chain, and of the role of logistics.(Shi ,2002; Shi e Gregory, 1997, 1998; Bitran et all,2006).

Fine (1998) mentions that in this new context competitive the process of the supply chain management should be faster and automatic. SCM seeks improved performance

through effective use of resources and capabilities via the development of internal and external integration (customers and suppliers) in order to create a seamlessly coordinated supply chain, thus elevating inter-firm competition to inter-supply chain competition. The main driver behind this transformation is the availability of technological platforms that modify the main attributes of information. Information-based linkages, if managed effectively, can give rise to visibility of customers' and suppliers' operational activities. Cassivi et al (2008) mentioned that in supply chain context, e-collaboration facilitates coordination of various decisions and activities beyond transactions among supply chain partners, both suppliers and customers over the Internet or other interorganizational information systems.

Based on this context, this paper seeks to explore the use of collaborative tools in manufacturing firms in Brazil and to analyze if for the group of companies that are applying collaboration tools there is a perceived improvement in performance by managers.

This paper seeks to answer research question as follows:

Does researched companies use collaboration tools in supply chain to improve operational performance?

This study has been developed based on the model that is presented in figure 1. This model is considering IT impact on the internal integration, supplier integration and customer integration. E-collaboration tools appear to be linked to tangible and intangible benefits and to operational performance.

The paper is divided into three sections. First, it is presented a review e-collaboration concepts, E-collaboration in the Supply Chain and e-collaboration and performance. Next, it is presented the methodology which comprises the use of quantitative study

with 95 companies from manufacturing sector. Finally, the results and findings are also presented.

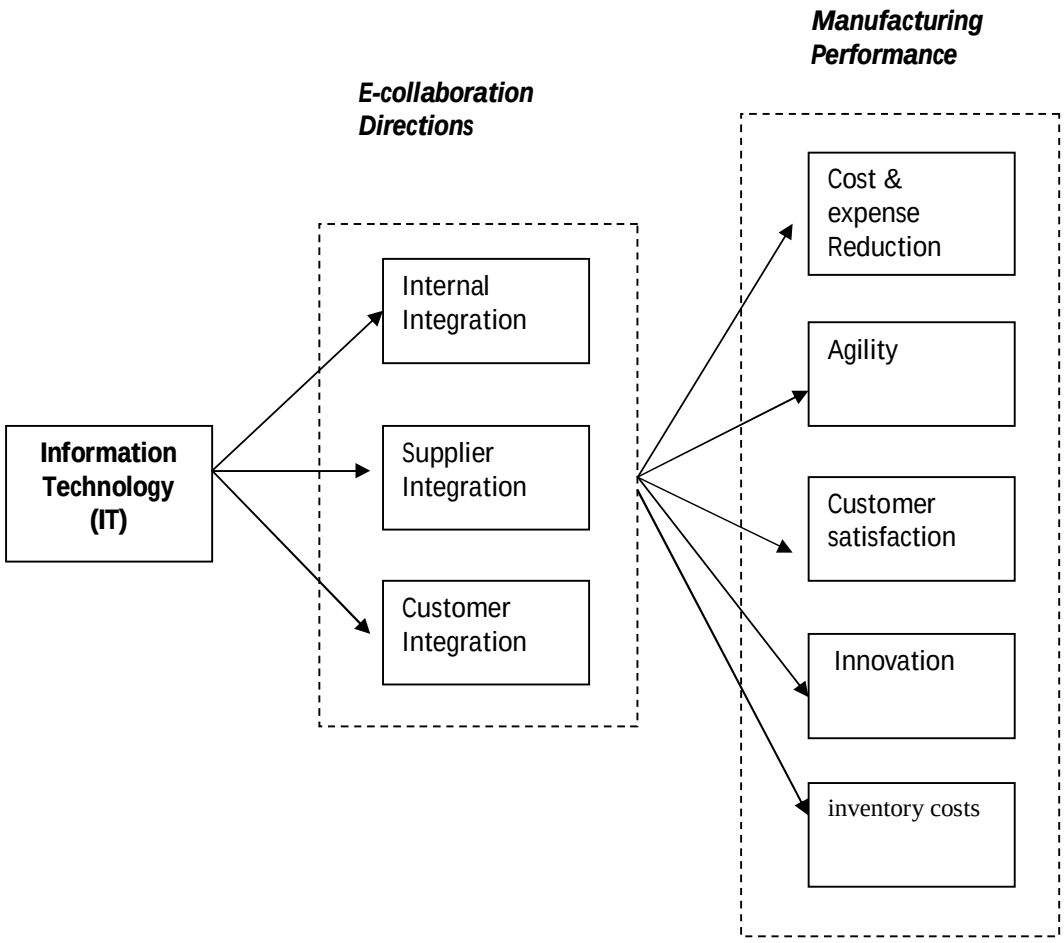

Figure 1 – Proposed Research Model (adapted from Teixeira, 2008)

2. LITERATURE REVIEW

2.1 E-collaboration concepts

Related e-collaboration can be observed many theories have been used to understand communication and e-collaboration behavior (Kick, 2004). McDonnell (2001) considers e-collaboration as internet-based collaboration that integrates people and processes giving flexibility to supply and service chains. According to Kock & Nosek (2005), e-

collaboration has been defined in many ways, and this situation has been intensified by the emergence of an e-collaboration tools industry. The definition of the e-collaboration is “collaboration among individuals engaged in a common task using electronic technologies”. This definition encompasses different types of systems, ranging from computer-mediated communication (CMC), through group decision support systems (GDSS), to Web-based collaboration tools (Kock & Nosek, 2005). Several definitions have been given to collaboration within the context of supply chain collaboration (Anthony, 2000; Akintoye et al., 2000; Simatupang and Sridharan, 2005; Manthou et al. 2004; McLaren et al. 2002) and electronic collaboration (Johnson and Whang, 2002). Johnson and Whang (2002) defines e-collaboration as “business-to-business interactions facilitated by the Internet. These interactions go beyond simple buy/sell transactions and may be better described as relationships. These include such activities as information sharing and integration, decision sharing, process sharing, and resource sharing” (figure 2).

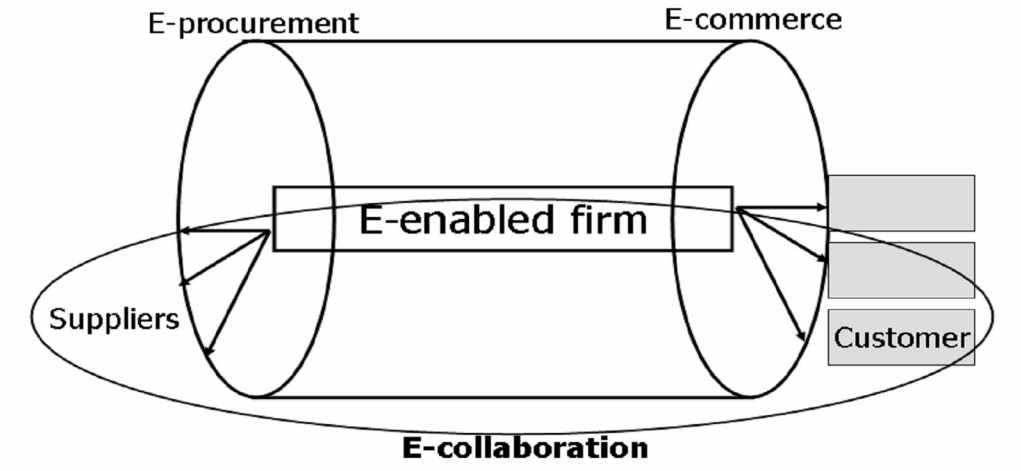

Figure 2 – E-business forms and their impact (Johnson and Whang , 2002)

According to Barratt “collaboration is a very broad and encompassing term and when it is put in the context of the supply chain it needs yet further investigation. It is an amorphous meta-concept that has been interpreted in many different ways” (Barratt, 2004).

Cassivi et al (2008) mentioned that e-collaboration is defined as collaboration among a group of allied parties through the use of information and communication technologies to initiate and facilitate the sharing of resources, especially across national boundaries in order to improve partners’ profitability. Cassivi (2006) stated that different roles may be attributed to collaboration tools, such as facilitating access to information, which affects knowledge creation capabilities, and assisting in the design of flexible supply chains.

2.2 E-collaboration in the Supply Chain

E-collaboration has been identified as a key enabler to supply chain integration (Crespo Marquez et al., 2004) and essential to facilitate the flow of information from any one source in the supply chain to all supply chain partners (Mentzer, 2001). In the Supply chain e-collaboration can help to integrated sales and supplier information and, as a result of this improved transparency.

The adoption and implementation of e-collaboration tools will strengthen the relationship between the partners involved (Cagliano Caniato, & Spina, 2005) and often necessitates the elaboration of new or revised interorganizational processes (Auramo, Aminoff, & Punakivi, 2002; Cagliano et al., 2005; Kock, 2002).

According to Lee et al (2008), global competition demands for transparent activities among suppliers with internal and external customers to facilitate inbound and outbound information flow and goods/services flow. Both end-user and buyer seller relationships are very complex and complicated. Accordingly, information sharing within business units (internal customers/partners) and with suppliers and other strategic partners

(external customers) is essential to assure the seamless execution of a supply chain plan and to enjoy the maximum benefits out of such an execution.

It should be mentioned that real integration comes with collaboration among separate organizations for both operational and strategic planning. GroupWare and simultaneous voice/visual communication and related technology facilitate enhanced coordination even when decision-makers are geographically dispersed. According to Vreed & Dickson (2000) there are Information Technology (IT) tools that have emerged offering new ways of coordinating and of collaboration business process.

Malone & Rockart (1991) observed that IT tools are shifting from supporting activities towards supporting coordination activities as well.

The capacity for electronically facilitated joint decision making in supply chains is limited only by organizational parameters of trust, compatibility and mutually recognized common goals (Chandrashekar and Schary, 1999). Chandrashekar and Schary (1999) mentioned that in a fully integrated network, production and delivery schedules, inventory, order tracking and drawing and design files become open to view and thus transparent to authorized supply chain members.

In nowadays business context, the competition is no longer between companies, but occurs between supply chains. Companies that succeed in strengthen the linkages between the participants and manage efficiently the assets, products, information and cash flows throughout the supply chain, presents better conditions to be competitive in the marketplace (Hassini, 2008).

According to Cassivi et al (2006) information visibility can be considered as a critical element in maintaining an efficient supply chain, but the companies should execute collaborative actions with both upstream and downstream partners.

Grey, Olavson, and Shi (2005) mention the importance of relationships for information sharing that has received considerable attention in the supply chain management (SCM) literature. Sharing sales information has been viewed as a major strategy to counter the bullwhip effect, in which the variability of orders is amplified as it moves upstream in the supply chain. This information distortion causes problems such as inaccurate forecasts, low capacity utilization, excessive inventory, and poor customer service.

Based on this context, this study was developed analyzing three directions and their integration as following:

[1] Suppliers integration

[2] Customers integration

[3] Internal Integration

[1] Suppliers integration

Supplier integration refers to the collaborative involvement of suppliers with an organization, providing operational as well as strategic information and supporting activities such as new product development processes. Electronic collaboration tools represent a multifaceted concept, which includes many types of information exchange tools, from simple e-mail systems to more complex interactive CAD systems, used to exchange product information and specifications. There are many collaboration tools that the companies are using with suppliers as the forecasting tool that allows to exchange the forecast information provided by both the buyer and supplier. The forecast, which is a prediction of sales and use of products in order to purchase the appropriate quantities in advance, is usually obtained from ERP software or from an advanced planning and scheduling (APS) tool. In addition, it can be cited replenishment tools, delivery and tracking tools, capacity planning tools and others.

[2] Customers integration

Teixeira (2008) mentioned that customer integration is defined as the collaborative involvement of customers within an organization, strategically sharing information and knowledge about their needs and organization's product performance such as quality, delivery time, and cost. In the same way, Lee et al (2008) mentioned that customer activity deals with the ability to communicate the delivery of products and services to end-user customers locally and globally. Customer activity is mainly sharing product information with customers, accepting customer orders, interacting with customers to manage demand, having an order placing in the system, sharing order status with customers during order scheduling, and informing the product delivery stage. The customer is in the center of all the transformations. His inclusion in the production process, the acknowledgment that the customer has changed from a passive role to an active role in the relationship with the enterprises probably constitutes the factor that is most demanding changes in the strategy formulation and in the organization architecture (Chandrashekar and Schary, 1999; Prahalad and Ramaswamy, 2000).

[3] Internal Integration

According to Teixeira et al (2008) internal integration refers to the cross-functional team orientation reflecting the linkages within organizational functions and teams, also known as horizontal linkages. This integration reflects on the degree of cross-functional integration resulting in a richer collaboration and communication among people and departments, increasing mutual feedback and the ability to solve problems. Others authors like Zhaoa et al (2011) mentioned that the internal integration refers primarily to data and information system integration through the use of enterprise resources planning (ERP), real-time searching of inventory and operating data, and integration of activities in different functional areas.

2.3 E-collaboration and Performance

Some impacts can be traced and evaluated. Reductions in transaction costs and gains on accuracy and agility are well documented according to Lefebvre, L and È, Lefebvre (2000) and Verhoest P. (1999). A number of researchers have suggested that such visibility can lead to improvements in operational performance (Mentzer et al., 2004; Barratt and Oke, 2007). As such, improvements in operational performance are considered in terms of increased sales; improvements in customer service; reduction in the levels of on-hand inventory; together with improvements in forecast accuracy and numbers of quality-related issues.

3. METODOLOGY

The conceptual definitions discussed before were used to develop the constructs of the research model and the questionnaire items which were used in quantitative study. The model considered to develop this study is based on four constructs: internal integration, customers, suppliers and operational performance (appendix 1).

3.1 Survey Study

Five hundred (500) questionnaires with an introductory letter were distributed by post and email. Two mailings and two follow-up emails resulted in 95 responses, representing 19% per cent response rate. Each responding firm completed each topic–related question which required the participation of multiple respondents in each company. The questionnaire presented to the firms was divided into four main topics (internal integration, customer, supplier and performance) and it had 29 statements that should be answered through a Likert scaling of 5 points being awarded a note on the degree of agreement of the statements in which 5 is "strongly agree" and a "strongly

disagree". After the questionnaire is completed, each item may be analyzed separately or item responses may be summed to create a score for a group of items.

1. Strongly disagree
2. Disagree
3. Neither agree nor disagree
4. Agree
5. Strongly agree

The profile of the companies that participated in the survey are listed below:

SECTORS	**N= 95 COMPANIES (%)**
MANUFACTURE OF FOOD PRODUCTS	6%
MANUFACTURE OF TEXTILES	1%
MANUFACTURE OF PAPER AND PAPER PRODUCTS	4%
MANUFACTURE OF CHEMICALS	13%
MANUFACTURE OF PHARMACEUTICALS	9%
METALLURGY	4%
MANUFACTURE OF METAL PRODUCTS, EXCEPT MACHINERY AND EQUIPMENT	1%
MANUFACTURE OF COMPUTER EQUIPMENT, OPTICAL AND ELECTRONIC PRODUCTS	13%
MANUFACTURE OF MACHINERY AND EQUIPMENT	11%
MANUFACTURE OF AUTOMOTIVE VEHICLES, TRAILERS AND CARTS	13%
PRODUCTION OF BUSINESS	19%
MAINTENANCE, REPAIR AND INSTALLATION OF MACHINERY AND EQUIPMENT	6%

Table 1 – Responding Companies Profile

3.2 Statistical Analysis

The aim research consist to analyze virtuality as a measurable construct along dimensions (internal integration, customer , suppliers) enable by IT tools and to identify if for the group of companies that are applying these tools there is a perceived improvement in performance by managers. The cluster analysis was applied to analyze the objective of this study. According to Hair et al (1998), the primary objective of cluster analysis is to organize a set of objects into two or more groups based on their similarity with respect to the statistical variable that consists of a set of specified characteristics. Cluster analysis seeks therefore to group data elements based on the similarity between them. Thus, groups are determined in order to obtain homogeneity

within groups and heterogeneity between them. This analysis is also characterized by being a technical type of interdependence, it is not possible to determine in advance the dependent and independent variables. Rather, it examines relationships of interdependence between the whole set of variables (Hair et al., 1998).

4. RESULTS AND DISCUSSION

The results of the cluster analysis reveal three major groups, differentiated by the level of e-collaboration (Table 1). The table 1 shows the three groups of firms where cluster 1 (one) has significant differences of e-collaboration level ($p<0.003$). Further validation of these configurations can be obtained from discriminant analysis (the classification efficiency of the model was 95.8% of all companies surveyed). Cluster 1 presents the greatest virtuality level (internal integration = 4,31; customer = 3,82 and supplies = 4.04) and greatest level related to performance (mean = 4,38). Cluster 2 and Cluster 3 do not show difference in terms of operational performance with virtuality level different for customer and supplier directions.

Table 1- Cluster Analysis (Manufacturing Firms)

Construct	Cluster 1 Mean[a]	Cluster 2 Mean[a]	Cluster 3 Mean[a]
Internal Integration	4,31	3,39	3,08
Customer Integration	3,82	2,29	1,99
Suppliers Integration	4,04	2,95	1,94
Operational Performance	4,38	3,13	3,38
Enterprises (%)	33%	23%	44%

Note: [a] Based mean Likert scale (1 a 5) ;

Table 1 – Cluster Analysis (K-means) (outcome SPSS)

In addition to the cluster analysis, a correspondence analysis was also applied in order to identify the profile of each cluster (table 2). According to the correspondence analysis, it is possible to observe that the cluster # 1 is formed by companies that implemented IT systems in order to easily transmit, integrate and process data

originating from suppliers and customers through Internet, providing the setting and change orders online for customers. Sharing inventory and demand information is a characteristic of companies that make part of this cluster. Another feature is related to the quality of the information that is exchanged in real time. Clusters # 2 and # 3 present as a predominant characteristic, the data sharing between internal systems and access by employees, but does not feature the transmission of data captured externally. This finding may indicate that this is an essential variable to be worked by the organizations in order to obtain a different level in the direction of internal integration, which combined with variables related to the sharing of electronic information storage and demand can impact positively on corporate performance. Cluster # 2 presents the online transmission of invoices and payments directed for vendors, suggesting an integration focused on the functional aspect. Regarding to the clients, there are features that enable them to make online payments.

In summary, each cluster can be described as follow below:

• Cluster 1: Collaborative

Execution of trades carried out through established relationships among supply chain partners and customers are worked in this cluster in collaborative aspects (information sharing, collaborative product development with suppliers and use of communities to capture ideas from customers for new product development)

• Cluster 2: Transactional

Implementation of business-related electronic transactions (orders, electronic payments, transfer of invoice);

• Cluster 3: Traditional

Companies that are predominantly promoting organizational integration, but only implement the functional modules that seek integration in the internal administrative and financial aspects.

The results obtained are in line with the aspects discussed in the theory by Brown; Dennis; Venkatesh (2010). These authors mentioned that collaboration technology characteristics, individual and group characteristics, task characteristics, and situational characteristics are predictors of performance expectancy.

Table – 2 Cluster Summary

Cluster	Profile	Main features
Cluster 1	"Collaborative " (Virtual Relationship) Performance = 4,38	firms share information related to demand and inventory and collaborate with partners to support supply chain activities; internal integration (operational and functional)
Cluster 2	"Transactional" (Virtual Transaction) Performance = 3,13	business-to-business or business-to-customer transactions such as ordering, invoicing and payment; internal integration (only functional)
Cluster 3	"Traditional" Performance = 3,38	Internal integration (only functional)

Table 2 – Cluster Summary

The results could reveal the extent of synchronicity in virtualization across these three directions. An organization can then examine whether differences, if any exist, are on account of a planned prioritization in the virtualization strategy or whether they could actually be flagging the need for some remedial action.

Research indicates that organizations may provide virtual connectivity with its customers, but not necessarily translated into improvements in performance (increase in

customer base, for example), by virtue of not being able to perform the complete cycle of online applications line, due to the lower levels of internal integration and integration with suppliers. Thus, there must be synchronization of the directions (internal integration, suppliers and customers). Returning to the theoretical framework, the authors Henderson and Venkatraman (1998) addressed this issue by stressing the importance of working interdependently virtuality and synchronized to improve performance.

CONCLUSION

The results confirm the arguments that firms can obtain benefits by internal integration, which in turn improves the flow of information through suppliers and customers, and eventually impact the company's performance. In this study, using cluster analysis, we attempted to create e-collaboration level. Thus, three separate groups with different levels of use collaboration tools has been identified. The group with collaborative profile has presented the greatest perceived performance by managers.

It is very important to emphasize is that value-added activity generated from internal integration can be easily passed on to customers and suppliers. Companies that evolved to encompass new forms of interaction and collaboration show better performance result. Success in synchronize value chains can achieve faster time-to-market, higher margins, greater capital productivity and significantly lower costs.. The results indicated that when a company has a high level of internal integration, can be more capable to achieve a high level of external integration.(cluster 1). Another important point that study indicated is that collaborative relationships change the way of doing business in a supply chain and to improve performance.

In general, collaboration tools are essential in helping businesses to stay connected with employees, partners and clients but these tools have to work integrated and synchronize. Further studies should be developed in order to deepen the points highlighted in this paper.

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Appendix 1 – Constructs and variables research

Constructs	Items	Sources
Customer Integration	• Capture data via WEB (CRM) for incorporation into the market study • Placing orders online • Change orders online • Product Configuration • Payments Online • Social networks and communities to interact with customers to develop products • Automatic notification of the status of requests • Delivery and monitoring of electronic application	Shaw (1997), Venkatraman e Henderson (1998); Venkatraman (2000); Ordannisi e Pol (2001); Travica (2005); Basu e Muylle (2007)
Internal Integration	-Sharing data between internal systems -Access to the database by employees -Integration, transmission and processing of external data (functional and operational)	Barua et al. (2001) ;Davenport (2004) ; Barki e Pinsonneault (2005) Bitran et al. (2006);
Suppliers Integration	• Sharing of information updated inventory • Sharing of information on demand • Sharing of Production Planning • Share real-time information on process quality • Payment Processing • Transmission and automatic processing of invoices • Collaborative development of products • Portals and-procurement (electronic procurement)	Chandrashekar e Schary (1999), Hagel e Singer (1999), Bititci et al. (2005); Hagel III et al. (2002) ; Kock (2005); Cassivi et al. (2008) , Bitran et al. (2006); Travica (2005); Kaplan e Sawhney (2000);