Logist. Res. (2012) 4:19–38
DOI 10.1007/s12159-012-0067-z

REVIEW ARTICLE

E-markets and supply chain collaboration: a literature-based review of contributions with specific reference to the semiconductor industries

Bikram K. Bahinipati · S. G. Deshmukh

Received: 10 November 2010 / Accepted: 12 January 2012 / Published online: 15 February 2012

Abstract While exploring buyer–supplier collaborative relationships and new procurement opportunities through optimized use of the available resources, the present work proposes a framework depicting an appropriate policy. The proposed framework captures the technological and business basis for the integration of various elements for e-market characterization with expected outcomes. E-markets as coordination structures interact between various enterprises of the semiconductor industry supply chain (SSC) through the process of bidding and pricing system. In this regard, the factors affecting e-market adoption by the participants and the impact of e-market on customer service in the SSC are explored with the objective to develop strategies for collaborative relationships between buyer(s) and supplier(s) in e-market.

Keywords Characterizing e-markets · Classification of e-markets · Semiconductor industry supply chain · Supply chain coordination · Collaboration · E-market models

1 The promise of E-market transactions for semiconductor industries

This paper is concerned with the analysis of supply chains of industries dealing with high-tech products, semiconductors, electronic products, personal computers and short life-cycle products. The semiconductor manufacturing environment is primarily driven by time-based competition to provide responsive and flexible supply to a customer [42, 46, 101, 108]. Shortened product life cycles and the emergence of contract manufacturing reflect trends towards rapid product innovation cycles, an exceptionally volatile nature of product demands and increasingly complex manufacturing and supply chain (SC) partnerships [20, 99, 124]. In order to retain their customer base and to gain new revenue opportunities, manufacturers in the semiconductor industry must structure their procurement process to respond to upstream-side demand and to absorb downstream-side risks without creating excessive inventory or capacity [119]. As a consequence, decision-making is done primarily at tactical and operational levels while negotiating with the suppliers during procurement planning. Collaborative efforts related to investment, knowledge and information sharing, resource sharing and R&D for technology development are project specific [12, 31] and hence short term. The members in the supply network are assumed to possess operational competencies to sustain the relationships [44].

But the management of capacity in the semiconductor industry requires long lead-time for expansion, because of its capital intensity. Buyers need to maintain vertical collaborative relationships with the contract manufacturers and component suppliers to increase the responsiveness of the SC [5]. In order to tackle the demand uncertainties and time compression, competing suppliers and/or contract manufacturers need to build horizontal collaborative relationships for effective capacity utilization [25]. This necessitates the use of compatible information systems and technology and of market intermediaries for the procurement process [111].

B. K. Bahinipati (✉)
Quantitative Methods and Operations Management Group, Indian Institute of Management Kozhikode, Kozhikode, India
e-mail: bikrambahinipati@yahoo.co.in

S. G. Deshmukh
Department of Mechanical Engineering, Indian Institute of Technology Delhi, New Delhi 110 016, India

Under these contradictory conditions, the use of e-markets opens up new opportunities for buyers and suppliers to optimize their resources [48, 91]. As transaction costs decline through the use of e-markets, reverse auctions are becoming feasible to facilitate trading tasks between buyers and suppliers [1, 138]. Decisions are evaluated through the market mechanism between potential business partners in the market. With the wide spread use of Internet in the market place, SCs can be dynamically set up in response to changing market requirements [36, 140]. The schematic representation of such a dynamic Internet-enabled SC has been depicted in Fig. 1.

2 Motivation and purpose of this research

Existing coordination theories may suggest optimal solutions to a specific coordination problem but have limited real-time applicability [68, 73]. However, many industries, such as semiconductor industries, realize that they must have complete information in time, adequate rationality, low uncertainty or idealistic behaviour [2, 117]. Improved sharing of information can lead to improved coordination for faster response, increased flexibility, and lowered inventory, transportation and manufacturing costs [69, 83]. This is why there is a need to generate novel schemes to leverage firms' knowledge for rich decision support followed by assessing productivity [3]. These approaches will provide the basis to enable e-business and supply chain management (SCM) paradigms based on rich and rapid sharing of information [57, 134, 129]. Furthermore, in the context of supplier competition, simple and robust capacity or resource allocation mechanisms may be developed to analyse multilateral interaction between the members of an SC [15, 49].

In view of the above aspects in SSC, e-procurement could be a viable option [52, 100], where the market intermediary would be the solution provider. Due to this relationship among the SC members, it is imperative to explore the operational and tactical decision policies to determine the effectiveness of the SC. The key features of such electronic systems to support procurement activities would be the decision-making support and collaboration support for the short life-cycle products/components under single-period uncertain demand scenario [88].

In this paper, an attempt is made to review the literature on SC collaboration, supplier–buyer interactions and coordination in e-market mode of operation. The focus of this systematic review is on several levels and aspects of SC management from the perspective of semiconductor, electronic goods, personal computer, high-tech goods and short life-cycle products manufacturing industries with the objectives to:

- Assess the sustainability of change in the management of procurement activities and ICT infrastructure supporting the e-market service mode and build a control framework that could provide insight to the managers of the semiconductor manufacturing industries.
- Characterize the e-markets for (SSC) and identify the most appropriate e-markets.
- Develop a framework for SSC coordination.

3 E-market design considerations

Positive changes of business processes in the semiconductor industries may become possible through the introduction of e-marketplaces [82]:

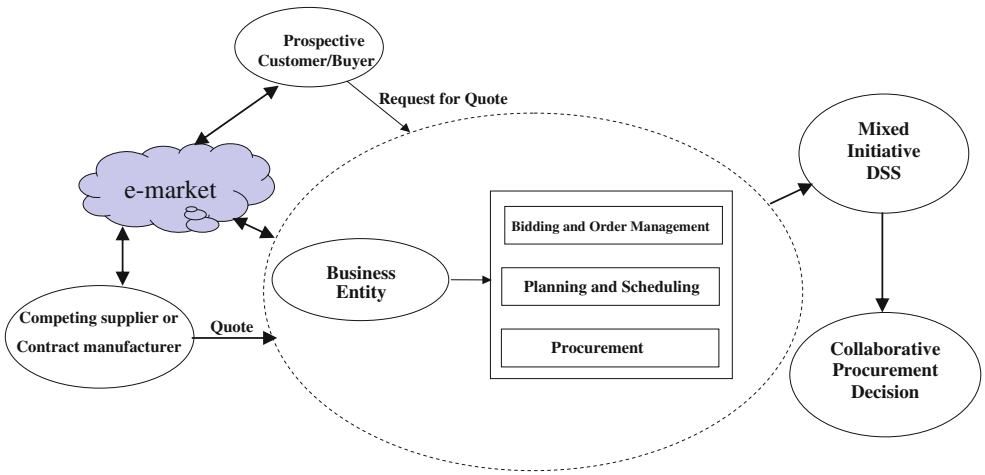

Fig. 1 Dynamic Internet-enabled supply chain

- Services for the participants (buyers/suppliers) are becoming more customer-oriented and demand-driven [24].
- Common organizational infrastructure is strengthened, regarding policies, standards, performance objectives, regulatory compliance, to support operations of individual members of the SSC [104].
- The 'e-market' mode of operation transforms the nature of the business and services, requiring integration across processes. This reinforces the need for governance networks to oversee the design, implementation and operations of holistic business of semiconductor industry [100].
- However, the 'e-market' mode of operation is feasible only with extensive deployment of robust ICT infrastructure to support SC member-specific procurement operations [131].

E-market design in the SSC is concerned with developing structures and rules for marketplaces to promote business opportunities for buyers and suppliers [36]. The rapid development of information and communication technology (ICT) and the extensive use of Internet have enabled the buyers to locate and interact with a large number of suppliers in the market [118, 133]. This forms an important basis for classifying market structures and determines the extent of competition in the industry [28]. The conditions necessary for perfectly competitive market structure are as follows: (1) homogeneity of the product sold in the semiconductor industry, that is, the item delivered by one supplier in the market is identical to the product delivered by another supplier, (2) existence of many buyers and suppliers in the marketplace, that is, they do not have any power to influence the price of the product or component under consideration and (3) perfect mobility of resources or factors of production, that is, all resources used in the manufacturing process can be switched from one use to another.

Kaplan and Sawhney [62] classified e-markets based on product types and procurement practice into four categories: exchanges, catalogue hubs, yield managers and MRO hubs, as shown in Fig. 2. Most of the semiconductor manufacturing industries have two types of procurement activities (manufacturing inputs/direct materials and operating inputs/indirect materials) and two types of transactions (procedural buying and spot buying). MRO hubs are horizontal markets, which facilitate procedural buying of indirect materials. Yield managers use an auction framework to facilitate buying of operating inputs, such as capital goods. Exchanges are typically used for spot buying of manufacturing inputs in an industry standard format. Catalogue hubs are vertical markets, which enable the

	Operating Inputs	Manufacturing Inputs
Procedural Buying	**MRO Hubs** Wide variety of low value products Large number of transactions Large number of suppliers	**Catalog Hubs** Procurement of manufacturing inputs Similar to procurement through traditional SCM
Spot Buying	**Yield Managers** Auctioning excess capacity Buying to meet temporary demand fluctuations	**Exchanges** Meeting daily requirements Smoothen sudden supply and demand fluctuations

Fig. 2 E-marketplace for semiconductor industry/B2B matrix [62]

suppliers/manufacturers in the industry to market their products/components in a single marketplace. The exchange-catalogue model for the buying groups to support B2B collaboration through e-market is proposed by Wang and Archer [139].

The purest manifestation of the market mechanism is found with auctions, where the supplier wishes to generate maximum revenue and a buyer wishes to pay minimum. The procurement auction (reverse auction) is a market mechanism that offers the buyer a number of competing suppliers at a low search cost and determines the market-based prices [1]. This approach offers a transparent mode of competition for the suppliers that focuses on quantitatively defined terms (price and delivery time), takes place at a pre-specified time period and treats the members equal under the rule. The main negotiation technique for procurement auction in the e-market is determined by the characteristics and the number of negotiating members [47, 72]. A multi-lateral negotiation protocol, known as an auction protocol, is well suited for business activities due to the tough competition among suppliers in the market place [67]. Other types of market mechanism applications typically found in the semiconductor industry include e-market applications and business services, such as electronic shops, electronic procurement, creation and maintenance of online catalogues, online auctioning, order tracking, Internet banking and market intermediaries.

The variety of available e-market design options requires to (1) define and characterize online marketplaces [6], (2) demonstrate smooth and efficient operations between the firms by visualizing the problem from the perspective of business and business processes, to understand the issues of participating in an online marketplace and generate maximum return [48] and (3) make the businesses interoperable to a minimum acceptable and predefined standard with minimum investment [10, 19, 140].

3.1 E-market models for semiconductor industry supply chains

The semiconductor industries have recognized that the costs to most business transactions for buyers [91], content-management costs to suppliers [133] and integration costs for all the SC members are higher than the expected due to investments in process and IT [131]. So, the benefits to the participants of the e-market are more elusive than anticipated [91, 112]. Liquidity rather than build-out capabilities is the priority for many e-markets. Still, the semiconductor industries believe that B2B e-markets are the only solutions on their business landscape [109]. Three robust models have emerged for semiconductor industries:

- Public-independent trading exchange.
- Semiconductor industry-sponsored marketplace.
- Private exchanges.

These industries will adopt a portfolio approach to e-market participation, using different models for different business requirements during procurement of materials and components [7].

Each e-market model has certain advantages; however, the adaptive and collaborative capabilities of the private exchange explain its important role in the next-generation SSC. Although many models can support a variety of business functions, not a single model is able to support all functions equally well. That is why, it is essential to create a portfolio of e-markets to optimize all the procurement activities from community content to SC collaboration for the semiconductor industries for best results [13, 77].

Private virtual marketplaces are e-markets controlled by individual buyers or suppliers, which set the communication standards for all other participants. In buyer-owned markets, the buyers develop an e-market on their own servers and invite potential suppliers or contract manufacturers to bid on the request for quote. The buyers compensate the cost for maintaining the data by a reduction in the purchasing costs due to improved control and simplicity and by a reduction in the direct material cost through increased purchasing power, allowing better price negotiation [17, 51, 114]. Such markets are typically owned by large semiconductor manufacturers or buying member of the SC (PC manufacturers). Buyer-owned markets may support other coordination mechanisms, such as contract negotiation, catalogue-based price and auctions [1, 23]. Various types of e-markets for semiconductor manufacturing industries and electronic component manufacturing industries are depicted in the "Appendix".

3.1.1 Public-independent trading exchanges (PITE)

Independent trading exchanges are established to serve a particular industry or product group. The value proposition includes the exploring of business partners globally, single venue for conducting business, virtual management of business relationships and visibility to prices around the globe [6, 83]. High value of venture capital is invested for such e-markets [29, 142]. Hence, a rapid consolidation of such exchanges is essential. Basic economics worked against these exchanges [140]. As barriers to entry are low, many participants will enter. This results in extreme competition and low margins. For long-term survival, independent trading exchanges develop more differentiated and hard to replicate capabilities for SC relationships. It is more easily accomplished in highly fragmented industries.

Some independent trading exchanges find that their most favourable roles focus on low-risk business activities, such as purchasing materials for MRO, or on functional niches, such as disposing of surplus materials. Other independent exchanges partner with the major industry-sponsored marketplaces to provide focused and specific services to the semiconductor industry. As a consequence, strategically well-positioned independent trading exchanges will influence the companies' portfolio of e-markets, but they would not be the dominant model. However, this model can complement and extend traditional ERP capabilities through collaborative information sharing [69].

3.1.2 Industry-sponsored marketplaces (ISM)

Industry-sponsored marketplaces are mechanisms for traditional companies with their own e-market strategies [75]. These marketplaces offer major industry players the opportunity to capture directly the online benefits and control of B2B services provided to the participants [112, 133]. These marketplaces represent a substantial portion of industry's business volume, and hence marginalizing the potential competitors. However, establishing a sponsored marketplace that can serve the procurement requirements of specific industry and its SC partners is inherently very challenging. This is due to the fact that the e-marketplace for collaborative procurement demands visibility, speed, flexibility and agility [6, 8]. However, a large number of powerful owners can make the decision-making process slow and tedious [64].

Industry-sponsored marketplaces are facing governance issues, due to very slow build-out capabilities [142]. Furthermore, it is difficult to find industry participants with strong SCM capabilities, who are willing to share sensitive and proprietary business information [36]. As a consequence, many industry-sponsored marketplaces require more time in developing their supplier base than expected. Industry-sponsored marketplaces emphasize standard setting, indirect procurement and must create robust capabilities for direct material procurements over time [7]. They gain advantage in providing community content and

specialized services for their industry. In select markets that require the coordination of engineering efforts across many industries, these marketplaces will facilitate improved design collaboration among members. Then, the participants will be able to engage in real-time SC coordination while ensuring that proprietary and sensitive information is kept private from other members for business applications [36, 130]. Also, this model complements and extends traditional ERP capabilities through joint ventures, networks and purchasing partnerships [69].

3.1.3 Private exchanges (PE)

Private exchanges enable perfect integration between a company and its business partners. These e-markets leverage existing enterprise systems to enable SC collaboration and visibility and extend the competitive advantage of their members [71, 106]. Private exchanges are software platforms developed for single enterprise to create a competitive environment for their suppliers. As the buyers and suppliers are known to each other, the knowledge of the partner and of the product allow for a less complex description. The private exchanges are able to support an enterprise's unique strategy and requirements. Dell, CISCO and Motorola use private exchanges to provide a level of intimacy with their business partners that is not achievable in a public marketplace [27, 71].

Taiwan Semiconductor Manufacturing Corporation (TSMC) use private exchange technology to enable the geographically dispersed engineers to collaborate on-chip design projects. Engineers with access along TSMC's SC view part or all of a given design simultaneously, isolate and mark individual circuits or lines, trace circuits and provide comments for all to see (http://www.tsmc.com). CISCO's private exchange allows customers to configure, place and check the status of orders independently and online (http://www.cisco.com). Most of the CISCO's orders come in through the private exchange [27].

The semiconductor industries are shifting focus to connect the buyers online as well as optimizing inter-enterprise information flow [16, 27, 145], which can be termed as 'semiconductor network exchanges (SNE)'. This scheme assumes a closed network with EDI [85], based on a public communication protocol (TCP/IP). This supports business relationships which are negotiated outside the network and works as a connecting system for information exchange between enterprises [104]. The relationships are long term when the enterprises collaborate among themselves and exchange products that are designed together. The PC manufacturing industries access to business partners in the semiconductor manufacturing industries and other component manufacturers. The SNE facilitate the reengineering of the SCs by connecting business partners and electronically allow them to collaborate on product design and development, processing orders and facilitating just-in-time manufacturing and transportation schedules [92, 113]. The enterprises connect to the suppliers with the help of SNE. These transactions are made between the members with whom specific business agreements are in place with compatible Internet development standards [111]. This is advantageous due to the flexibility and low cost associated with online linkage [6]. The number of suppliers/buyers is predetermined, and connections to these firms are easier to manage due to open infrastructure of the semiconductor network exchange.

3.2 Portfolio management of E-markets

The online B2B e-market models make one or more of the following functions more efficiently: (1) supplier selection and search, (2) price visibility, (3) product tracking, (4) logistics, (5) product innovation and development, (6) procurement, (7) SC planning and collaboration and (8) services management. No e-market model can deliver all these benefits [122]. That is why, the e-markets for semiconductor industry build a strategically and dynamically managed portfolio approach that aligns e-market types and capabilities with business needs [102]. The industry involves a number of e-marketplaces to best meet its diverse needs.

The analysis of various e-market models for semiconductor industries suggests that these industries participate in purchasing consortia and customize the basic activities to fit their strategic needs [52, 93]. So, a hybrid e-market model [94] is developed for each SSC by considering the capabilities of e-markets for procurement and business processes as well as the size of the enterprises (Table 1). The analysis of the semiconductor industry procurement processes favours the private exchanges for e-procurement based on supplier relationships [105]. However, the hybrid e-market model incorporates the best-in-class features of independent trading exchanges and industry-sponsored marketplaces to customize the private exchanges for most responsive and efficient e-procurement.

The private exchanges for the semiconductor industries are characterized as buyer orientation or supplier orientation and transaction orientation or collaboration orientation.

- Buyer-oriented private exchanges are designed to make SCM functions more efficient and effective, as they operate on the premise of make-to-order SC [121]. At the elementary level, these e-markets allow online ordering, confirmation and invoicing. Sophisticated exchanges are designed to provide for collaboration with suppliers on forecasts, supply planning, product

Table 1 Capabilities of various e-markets for semiconductor industries

Business activities	E-markets for semiconductor industries		
	Independent trading exchanges	Industry-sponsored marketplaces	Private exchanges
Community content	1	3	1
Procurement (indirect materials)	3	3	1
Procurement (direct materials)	2	2	3
Settlement and payment	3	2	1
Fulfilment and logistics	2	2	3
Product development	1	1	3
SC planning and collaboration	1	2	3
Customer service and support	2	2	3

Source Accenture Analysis (2005)

1 = Least Capability 2 = Moderate Capability 3 = Strong Capability

innovation and design, exception management and other functions [92, 113]. The implication for the semiconductor industries is to make customer data available to suppliers through private exchanges. This enables the suppliers to analyse sales-trend data and make recommendations about store assortments, market segmentation and inventory management.

- Supplier-oriented private exchanges are designed to add value for key customers to make SCM procurement and business functions more responsive and efficient [53, 139, 141]. Also, these exchanges remind buyers to order certain regularly purchased items or even allow the supplier to examine the customer's future inventory and replenish it automatically. As a consequence, the buyers are empowered to collaborate on product design, track orders and otherwise collaborate with the suppliers.
- Transaction-oriented e-marketplaces are characterized by catalogues, auctions or exchanges and support for negotiated pricing [51]. Transaction cost theory provides the theoretical framework for such an e-market.
- Collaboration-oriented e-marketplaces are characterized by planning capabilities, such as continuous planning, forecasting and replenishment or product life-cycle management [95, 135]. The motivation ability, EDI/Internet adoption and SC relationship concepts provide the theoretical framework for such an e-market [85].

It is obvious from the above discussion that e-markets led by private exchanges should enable next generation SCM synchronization and collaboration gains. The semiconductor industries that fail to recognize that e-markets entail more than buying and selling goods risk will lose the competition in future. This implies that the e-markets provide the most ideal coordination structure for procurement business applications [22, 130].

3.2.1 *Managerial implications*

The analysis of various e-market models for SSC and the capabilities of various e-markets (depicted in Table 1) bring forward some insights for the managers of these industries, which are as follows:

- In semiconductor industries where SC is simple and straightforward, and SC efficiency is minimum, the managers may select industry-sponsored marketplace or independent trading exchanges [83].
- When the SC is complex, small members will have to trade-off between the start-up costs and the benefits. One approach may be that the big and powerful members of the SC build the private exchange infrastructure and allow the participating members to leverage its capabilities. As a consequence, the smaller business members receive advanced capabilities for minimal cost and the big members receive significant improvements in SC efficiency. Over time, additional low cost options become available for firms as technology standards develop, start-up costs reduce and private exchange hosting services would evolve [27, 145].
- Large semiconductor industries with complex, unpredictable SCs examine a priori investing in a private exchange infrastructure [http://www.tsmc.com, and http://www.cisco.com]. When the product life cycle is long, the number of suppliers or customers is small, outsourcing is infrequent and engineering is rather simple. So, it is not reasonable to build a low-cost private exchange to deliver good results [71, 27].
- More customized private exchange capabilities is a necessity for the semiconductor industries with high engineering-intensive unique design and manufacturing requirements, high degrees of SC collaboration, rapid cycles, and volatile supply and demand [104, 145].
- The semiconductor industries with a dominant position and world-class SCM capabilities will choose to build their own private exchanges, as the capabilities available in an industry-sponsored marketplace fall below their specific business requirements and SCM processes [36, 64].

4 Characterizing E-market options

Market characterization study examines the structure and dynamics of e-market prior to the development of SC

coordination mechanisms. It includes a description of a market's size, its key participants and the process by which products/components are manufactured and sold. A good understanding of the e-markets provide insights about their activities and help in the process of designing business-oriented metrics to establish resource management policies for the buyers and the suppliers. This market characterization is critical during the development of realistic benchmarks for the viability of collaborative SC business practices in information sharing, decision synchronization and incentive alignment [35, 125, 126].

The market characterization for an SSC include detailed analysis of real data from market places, to uncover the patterns related to the major activities in the e-market to enable the procurement process responsive and effective [20]. These metrics are used to devise dynamic pricing and SC coordination models in the e-market [51]. The key attributes for market characterization in a semiconductor SC may be: (1) market-bids, (2) information and financial transaction rights, (3) site design, (4) multilateral transactions, (5) tightly integrated versus loosely coordinated interactions, (6) single versus multiple control operators/intermediaries, (7) types of products/components with specifications and (8) resource commitment decisions. Furthermore, market characterization is used to design innovative algorithms for improving the quality of service provided to the buyers and suppliers through optimized resource allocation and for improving the revenue throughput [87].

4.1 Framework for market characterization

The Internet-based markets are developed based on the concepts of marketing mix [21]. The elements of traditional marketing mix, such as price, place, product and promotion serve as a starting point for market characterization. A detailed analysis of semiconductor industry web sites demonstrates that modifications of this framework are needed to reflect the activities of the e-market. The contemporary literature on market proposes that customer service and community are essential for market characterization. Furthermore, the concepts of personalization, security and privacy of the industry web sites will provide the policy and technological basis for integration of aforesaid elements. Personalization allows the participants to create accounts and log into their personal accounts. Once the user creates an account and a profile, this information can be used to personalize the aspect of participants' interaction with the site. Privacy policy addresses what information is being collected and how it will be used, and whether the information will be shared with the third parties and if so, in what context. The issues concerning the security of the web sites include whether a participant/intermediary can intercept the transaction and information and how easy it would be for the hacker to enter the web site. The e-market characterization process is incomplete without the most appropriate site design based on relational database. The site design must provide a compelling customer experience for search, display, purchasing and order tracking. The proposed framework for e-market characterization is depicted in Fig. 3.

The proposed framework will evolve an appropriate policy and technological and business basis for integration of various elements for e-market characterization in the semiconductor SC. This will provide a strategy development tool and a structure to characterize the strategies for e-market, such as how different elements are being mixed. These initiatives will lead to an analysis of comparative strategies of competitors in the same market. Since the marketing mix specifies the scope of marketing activities, it will serve as a reference point for budget allocation in e-market. The offer the e-market provides to the customers (buyers and suppliers) during the sale/purchase of products/components in a semiconductor manufacturing industry can be altered by varying the mix elements.

In the context of the SSC, the market is characterized by the following: (1) perfectly flexible prices for products and components, (2) perfect information about market prices of products/components, (3) reduced barriers to entry of new competitors [103], (4) competitive bidding among suppliers, that is, dynamic bidding [142], (5) charging of transaction fees to the participants by the e-market owners, (6) market dominance by bigger players (buyer/supplier orientation), (7) optimal increase in supplier base due to reduced transaction costs and coordination costs [85, 91], (8) designing innovative procurement transactions, such as the purchase of utilities and transportation between buyer and suppliers [105], (9) incentives to participants through optimal design of supply contracts [23], (10) decision to participate in the e-marketplace based on cost savings, information sharing and expected relationship between the members [120, 140], (11) insignificant switching over cost [29], (12) fragmented market with many suppliers and (13) transaction facilitation by electronic market intermediaries [64]. Furthermore, transaction complexity and frequency, decision-making powers among the members, existing market structure and incomplete contracts play important roles in the formation and sustainability of e-markets.

Market characterization for the SSC is expected to have the following outcomes: (1) understands buyer/customer needs, (2) identifies appropriate target market niches, (3) proposes market estimates from multiple external sources, (4) develops an interface between the suppliers and buyers/end customers, (5) proposes complete component/product performance requirements (both technical specifications and cost), (6) presents competitive positions in the market

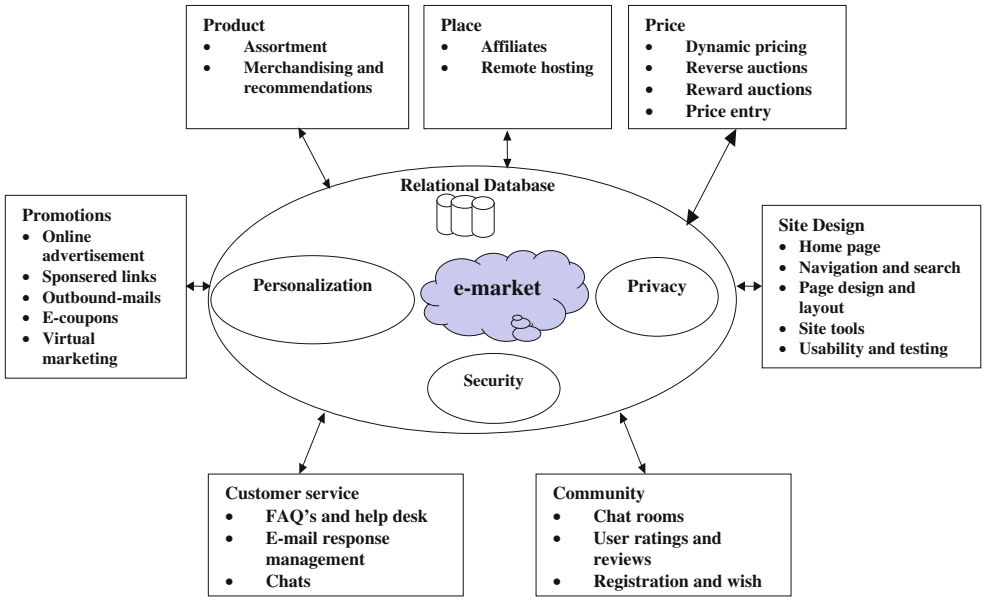

Fig. 3 Framework for e-market characterization

place, (7) develops compelling value propositions (guided by the commodity matrix) presented by Handfield and Straight [45], (8) presents the details on the source and nature of the cost share between buyers and suppliers, (9) provides auditable facts and figures (information), (10) establishes coordinated relationships among the participants of the SC that add significant value, (11) ensures that the information reflect the actual scenario, which are reasonable from both a financial and business perspective and (12) demonstrates that the market has the appropriate expertise to understand the unique circumstances, requirements and resources needed to produce the desired outcomes. The market characterization helps the business decision-making processes credible when the participants financially invest in decision-making and make the decision to invest in SCM technology for processing, purchasing and selling. Ultimately, this provides competitive advantages to both buyers and suppliers [10, 131].

5 Semiconductor supply chain coordination in e-market

The market-driven SSC is attributed to reach the customer anytime and anywhere through various strategies, such as mass customization, supplier-owned inventory, quick response, postponement and cross-company coordination. Contemporary literature suggests that hierarchical coordination is based on long-term relationships between organizations with clearly defined rules and procedures, which uses authority and other procedural coordination approaches. In contrast, e-market as a coordination structure coordinates between various organizations (buyers and suppliers) through the process of bidding and pricing systems. In a real market, organizations build a relationship for every customer demand [40]. All organizations are fully autonomous and make decisions of their own. Market coordination relies mainly on price mechanisms. The advent of information technology in the market witnessed a paradigm shift from hierarchical coordination to market coordination and subsequently to SC collaboration [32, 139]. It is expected for the future semiconductor industries to select an optimal mix of coordination mechanisms, which can be characterized as 'hybrid coordination mechanisms' [98].

5.1 Framework for supply chain coordination

The SC coordination is the starting point in developing a collaborative relationship in an SC. The SC coordination must consider various inter-related perspectives to be successful in the e-marketplace. In order to demonstrate the impact of inter-organizational coordination for the SSC in e-market, the proposed framework focuses on eight different inter-related perspectives: (1) information accuracy to buyers and suppliers for reduced inventory in the SC [59], (2) supply of products/components to buyer/manufacturer for customer satisfaction [24], (3) e-market support, which has a potential to change the coordination mechanisms as there is a substantial reduction in the coordination costs [144], (4) renewed planning methodologies for e-market participants in procurement, manufacturing, distribution, and demand management [110], (5) buyers' decision to adopt e-procurement instead of

traditional extranets, based on operational performance, pricing strategies, coordinated demand forecasting strategies, supplier competition, and strategic partnerships and trust [41], (6) focus on coordination mechanisms/structures and supply contracts [113], (7) strategies to resolve the SC conflicts in e-market when both supplier and buyer try to resolve such conflicts (in decentralized SC) using supply contracts [88] and (8) incentive alignment (revenue/profit sharing) in decentralized SC to develop long-term relationship [23]. This framework (Fig. 4) demonstrates that the perspectives of SC coordination in electronic market place are inter-related and have an impact on each other.

Supply chain coordination in e-market is aimed at improving the total expected system profits in a decentralized structure and to bring them closer to those of a centralized structure [136]. It is generally believed that the use of ICT enables organizations to shape coordination, which may lead to an overall shift towards smaller firms and proportionally extra use of markets. If the coordination costs are low, the buyers compare all offers and select the one best serving their needs. The prices of products/components are low because of increased competition among suppliers in the market place. Furthermore, the coordination between the members in the decentralized structure results in a mutually agreeable way of sharing the resulting profits. The sharing is done by means of fixed payments between the members of the SC, quantity discounts, rebates, return policies or a combination of all these. It is negotiable between the members of the SC, or forced by one member to influence the behaviour of the other member. All these ways for achieving profits in a

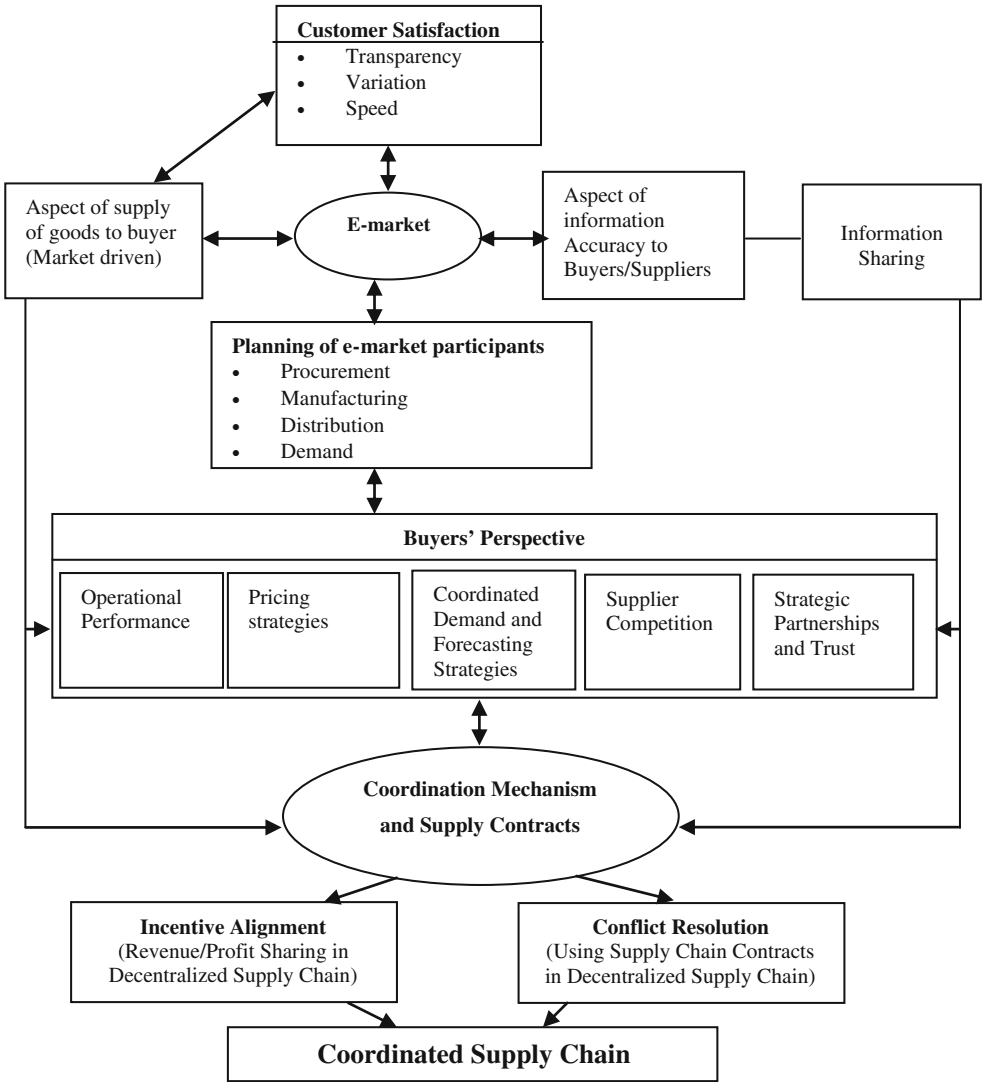

Fig. 4 The inter-related perspective of SC coordination through e-market

decentralized SC structure in e-marketplaces are called "coordination mechanisms".

In the following sections, some observations are presented about how the uses of e-market impact on the customer service in the SSC. Based on the literature review, a number of broad observations are developed as to how the use of e-market might affect buyer–supplier relationships, and in particular the communication related aspects of the relationships.

6 Impact of E-market on customer service: some observations

The development and use of information and communication technologies (ICT), such as electronic data interchange (EDI), Internet or the intranet networks have enabled enterprises in the (SSC) to perform operations, such as new product development, collaborative inventory control and order assignment decisions in an integrated way [39, 85].

For the development of SSC management, member organizations coordinate their inter-organization activities. The ICT helps in the electronic transmission of information or documents, such as invoices or purchase orders between computer systems in member organizations based on a standard, structure, and machine retrievable format [57]. ICT benefits are usually classified in two groups: operational and strategic [70, 112]. Operational benefits refer to improvements made to the internal functioning of the member organizations in routine activities, such as reducing clerical errors or inventory costs. Strategic benefits relate to the development of corporate strategies through the building of external relationships with buyers and competitors, such as improving customer services or information sharing along the SC. The use of ICT automate inter-organizational activities [90], whereas SC management would integrate these activities [112]. So, it would be interesting to analyse whether ICT users offer better customer service in the SSC than non-users of ICT. This analysis is even more important given that the semiconductor manufacturing industries incorporate the dimension of customer service in their total quality management (TQM) programmes with component manufacturers and suppliers [37, 56]. The above discussion leads to the following observation:

Observation 1 ICT is one technology that facilitates the SSC coordination in e-market.

ICT is a technology that facilitates its inter-organizational use for the SC in e-market. E-market builds the potential to influence different perspectives of customer service, by decreasing the clerical errors in processing orders or reducing the order cycle time, which impact positively on customer service [90, 141, 145]. As customer service is defined in different ways, it is necessary to analyse this impact through several dimensions of customer service. The e-market also impacts on other variables of the buyer–supplier relationship, such as mutual trust, conflict and frequency of delivery, which directly affects the customer service [137]. In view of the above, it is necessary to study the relationship between the semiconductor industries' e-market adoption and use and its level of customer service. Furthermore, it is imperative to consider the drivers of customer service related to the buyer–supplier relationship, which is influenced by the participation in e-market [64].

Customer service is considered as a process for providing value-added benefits to the SSC [6]. An effective way to evaluate customer service is through the performance and outputs of the various logistics process in the company [112, 115]. The major indicators of customer service are as follows [80, 123]: product availability, order cycle time, distribution system flexibility, distribution system information, distribution system malfunction and post-sale support.

Product availability concerns the semiconductor industries' inventory capability to deliver the product/component when the buyer requires it. This is enhanced by the participation in e-market, because the technology improves the accuracy and timeliness of information needed to maintain proper levels of inventory [78]. An improvement in the coordination of the SC is due to the reduction in inventory levels by the control of shipments and purchasing orders [50, 117].

Order cycle time is the time from when a buyer places an order to when it is received. Time flexibility, and fast and accurate service are competitive advantages that impact positively on customer service in semiconductor manufacturing industries [6, 48, 90]. The use of e-market reduces the time required for the ordering process [141]. The reduction of order processing time is one of the main reasons for adopting ICT in the semiconductor industry [54].

System flexibility is needed to avoid disruptions in the product/component flow due to unexpected situations, such as interruptions or uneven demand situations [113]. The e-market can help in the decision-making processes to implement the actions quickly, because ICT makes it easy to access information, such as requests to expedite shipment or specific carrier selection instructions [38, 68].

Quality of information in the SSC is another perspective of customer service, which is improved by the participation in e-market [8, 59]. Information accuracy is required for the efficiency of the SSC, such as shipping delays or price changes. The lack of accuracy or the delays in delivering

this information influence negatively upon other dimensions of customer service, such as order cycle time or inventory capability [24].

The information overload is also considered as a dimension of customer service. The participation in e-market results in the fact that there is no need to repeat the transmission of information. The users pool out only the required information for the semiconductor industries, thereby reducing the processing volume, time and cost.

Post-purchase support, such as product warranty or parts and repair services, are also supportive of the product in order to build customer confidence. The ability of e-market to provide fast and error-free information contributes to post-purchase support, like other information systems that allow the integration of information across various systems, databases, and organizations [89]. The optimal use of ICT reduces the reaction time to a maintenance or technical assistance request, if these activities are integrated with EDI in the SSC [97, 112].

The above discussion leads to the following observation:

Observation 2 Participation of members of the SSC in e-market impacts directly on the customer service.

The flow of information between buyer and supplier is an important input to an efficient buyer–supplier relationship and improved customer service [113]. An important driver to participate in e-market is to improve the communication process [86, 131]. Intensity and quality of information are two main indicators of the communication process in a buyer–supplier relationship in the semiconductor industry. Intensity of information is concerned with the degree of willingness to share any information that is needed in the SSC during the business relationship [128]. Quality of information considers the factors, such as relevance and timeliness of the information flow between member organizations [8, 59]. Furthermore, the participation in e-market changes the way to transmit information and also increases the scope of that information. The enterprises are more open to communicate any volume and type of information [96]. The semiconductor industries that interchange more and better information among the chain members (two-way information sharing) perceive a better customer service, as they are able to react better and more quickly to the needs of the customer. As the use of e-market improves the information flow in the SSC, the following observation is made:

Observation 3 The level of quality and intensity of information in the e-market is positively related to customer service in the semiconductor industries.

The key role for ICT employed in e-market is to increase information-processing capabilities in a relationship, which supports greater inter-firm cooperation. In particular, the use of e-market applications across multiple functions, such as design, purchasing, production control, delivery or payment provides greater information-processing capabilities that support a more comprehensive and cooperative buyer–supplier relationship in an SSC [61, 105]. Trust and commitment foster the long-term relationship between buyers and suppliers [58, 104], which may improve customer service.

Task uncertainty is driven by predictability and reliability of the activities in the SSC. It results in increased complexity related to higher lead-time and throughput time, which directly affects delivery performance and hence poor customer service [66]. Furthermore, SC coordination is the process of managing dependencies among activities of the members to analyse and redesign firms [113]. This is based on the procurement activities that directly contribute to the output of the process or task, and the coordination mechanism designed to manage various interdependencies among activities and resources [13]. The concepts of task interdependence and resource exchange between the members of the SSC are considered as determinants for the choice of most appropriate coordination mechanisms in e-market. The above discussion leads to the following observation:

Observation 4 The e-market as a coordination mechanism is used to increase inter-organizational information-processing capabilities and reduce task uncertainty.

Frequent and timely exchange of information fosters confidence in long-term buyer–supplier relationship and reduces dysfunctional conflict [116]. The use of ICT through the participation in e-market contributes to an increase in the frequency and timing of information [54]. As a consequence, lower conflict in the buyer–supplier relationships contribute to improved customer service. The high quality of information exchange between the SC members occurs in a context with low conflict [83]. This suggests that e-market act as a coordination mechanism for semiconductor manufacturing industries that establish closer relationships with the customers. The conflict is resolved through collaborative processes based upon problem-solving and negotiation by use of appropriate information rather than confrontation [4].

The frequency of supply is another driver of customer service in semiconductor manufacturing industries. The more the number of deliveries to the buyer, the more frequent are the buyer–supplier interactions. This frequency of transactions in a relationship helps to reduce conflict in the supply system and increases the semiconductor manufacturing industries' perception of customer service [141]. This discussion leads to the following observation:

Observation 5 The level of conflict in the buyer–supplier relationship in e-market is negatively related to the frequency, timely exchange of information and supply and the satisfaction in the relationship.

The adoption and integration of ICT in the SSC due to the participation of its members in e-market positively impacts on customer service [64]. Management information systems based on the use of ICT differentiate products or services through customer service, and strengthen customer relationships in the logistic process [79]. Managers of these industries should not assume automatic benefits in all areas of customer service, but they may have to take appropriate steps in order to achieve the desired performance improvement [8]. The results are applicable to several functional areas, such as purchasing or logistics. So, the participation of members of the SSC in e-market may be facilitated through the implications of strategic benefits to different functional areas, such as receipt of more invoice notices, better product/component availability, shorter order cycle time or fewer malfunctions in the transmission of information among these members [90, 141]. This discussion leads to the following observation:

Observation 6 The diffusion of ICT among different tiers of suppliers in the SSC would improve the performance of suppliers, semiconductor manufacturers and all the stakeholders.

7 Factors affecting e-market adoption by participants of supply Chain

Multilateral inter-organizational information is used to improve SC efficiency, coordination and control in international procurement [16, 43, 112, 145]. The e-market improves coordination by ensuring effective communication and negotiation with global suppliers [74, 85, 97, 107, 147]. EDI and extranet applications help to reduce lead-times, improving order release, coordinating parts delivery schedules and tracking order status [18, 76]. Access to multilateral systems based on Internet is facilitating the manufacturers/buyers to broaden their search for global suppliers, which reduces the search and material cost [29, 63, 140]. The above discussion leads to the following observation:

Observation 7 The proportion of global supply is expected to influence positively on e-market adoption in semiconductor manufacturing.

The primary benefit of adopting e-market in SC management is the reduction in the procurement cost; the semiconductor industries with higher material costs may obtain greater financial return from these strategies. This is true in case of dedicated systems, such as EDI and extranets, which involve large investments in hardware, long-term costs for maintenance, support, system upgradation and system integration [29, 81]. Furthermore, Internet technology is inexpensive and widely accessible [146]. This justifies the adoption of e-market by semiconductor industries for high or low direct material cost. The above discussion leads to the following observation:

Observation 8 The relative share of direct material costs on manufacturing cost structure is an incentive for participating in e-market for the semiconductor manufacturing industries.

Improvements in supplier performance in e-market depend largely on the frequency and timeliness of information sharing between buyers and suppliers in e-market [109]. Continuous communication between the SC members is needed to foster trust and commitment, which is a precondition for sustainability of collaborative business practices in e-market [60]. Multilateral interactions for Internet auctions require the involvement of small number of suppliers to ensure that the participants will be able to fulfil the contracts effectively. There is a negative relationship between the buyers' satisfaction with Internet auctions and the number of suppliers negotiated during auction [1, 55]. Furthermore, the asset-specific investments in e-markets rely on small supplier base to generate financial returns for all participants [10]. The buyers develop capacity to manage information transfer with the entire supplier base [8, 9]. The above discussion leads to the following observation:

Observation 9 A smaller supplier base expects to provide a positive incentive for e-market adoption by the semiconductor industries.

Collaboration among the SC members in the semiconductor industry is an approach based on relationships, which focuses on cooperative rather than competitive behaviour [4, 11, 127]. It necessitates improved coordination, joint decision-making and creation of common working standards among the SC members. This initiative increases resource utilization and adds value to products and services [132]. Collaboration-oriented buyers focus on supplier capabilities, such as innovation ability, contract flexibility, continuous improvements and willingness to share the information [65]. Industries are using EDI and Internet to develop collaborative transportation facilities [34, 85]. Extranet applications enable the implementation of just-in-time deliveries by raw material suppliers [74]. However, Internet auctions are more suited to members having close relationships requiring limited coordination [1, 26, 112]. The industries are incorporating problem-solving features to support information sharing, product

co-design and joint marketing activities on the procurement platform [33, 115]. The above discussion leads to the following observation:

Observation 10 Collaboration among the SC *members to reduce the cost and improve the reliability of information sharing has a positive relationship on e-market adoption in the semiconductor manufacturing industries.*

In view of the above discussions, it is imperative to identify the operational variables for improved customer service and financial performance in the SSC [137]. This is done by a review of literature in the in the high-tech industries, such as semiconductor industries and other similar industries. The theoretical explanations of factors that impact the change due to e-procurement implementation are explored. The primary factors are as follows: (1) SC member-network theory, (2) Organizational theory and (3) Virtual enterprise concepts, as these are relevant in the context of e-procurement. SC member-network theory focuses on relationships that shape among stakeholders (buyers, suppliers and e-marketplaces) in a changing environment [117, 123]. The organizational theory provides a basis for viewing e-market as an organization where the participants (SC members) comply with governing values and principles, using common regulations, information and processes [122, 128]. The virtual enterprise concept addresses organizational and operational aspects of e-market structure to support coordinated procurement [84, 88, 99]. These theoretical foundations can be linked together for addressing issues related to the change management and building an e-procurement framework for SSC [119, 143]. Basing on the above observations, the present work proposes a schematic base of the number of operational variables for members in the SSC operating in e-market for improved customer service [8, 14, 30, 36, 66, 117, 120, 121], which is depicted in the Table 2.

Table 2 Operational variables for SC members in e-market for improved customer service

Operational variables	Description
Product availability	Average order fill rate of line items
	Meeting of promised delivery date
Order cycle time	Average order cycle time
	Final delivery time on orders beyond due date
Supply chain system flexibility	Ability to expedite shipments
	Ability to handle special shipping instructions
Supply chain system information	Notice of price change
	Notice of new product information
	Notice of shipping delays
	Availability of order status information
Supply chain system function	Accuracy of billing
	Accuracy of delivering the right product/component
Post-delivery product support	Time taken corrective action on complaints
	Average response time to a request for technical advice or maintenance information
Information quality	The information shared among SC members is complete
	The information shared among chain members is timeless
Information overload and intensity	The chain members share any information among themselves that may be useful
Trust and commitment	The chain members keep the promises made to any member
	The chain members offer the whole knowledge when advise any other member about anything
Frequency of delivery	Several times per year
	Several times per month
	Once in a week
	Several times per week
	Several times per day
Experience in business	Number of years of business relationships
Conflict	The members have conflict with any other member about quality, payments and profit sharing. (these conflicts are to be minimized to improve customer service)

8 General observations from the literature

The literature classification in the area of collaborative procurement in the SSC under 'e-market' mode of operation reveals that the perspectives of SC collaboration, either in the same echelon or in different echelons, is an important aspect, which needs to be emphasized in greater detail. The collaborative procurement problems can be solved by developing and implementing certain schemes or mechanisms to support SC decisions. The importance of these schemes will help in determining the scope and value of collaboration in SCs.

The present work also considers the various perspectives of the SSC and e-market in the domain of collaborative procurement. A number of frameworks and observations are presented. The contributions of these literature review-based frameworks and observations to collaborative relationships are summarized in Table 3.

Table 3 Contribution of literature survey-based frameworks and observations to collaborative relationships

Frameworks/ observations	Description	Perspectives and implications
Framework 1 (Fig. 1)	E-market characterization framework	Aids in analysing the comparative strategies of competitors in the e-marketplace
		Predominantly supports vertical collaborative relationships in the supply chain
Framework 2 (Fig. 2)	Inter-related perspectives of supply chain collaboration in e-market	Demonstrates the impact of various inter-related perspectives on inter-organizational coordination in e-market
		Establishes the starting point of the collaborative relationships
		Supports incentive alignment and conflict resolution
Observation 1	ICT facilitates SC coordination in e-market	Electronic transmission of information and documents for coordination of inter-organizational activities
		Supports horizontal, vertical and lateral collaborative relationships among supply chain members
Observation 2	E-market participation impacts directly on customer service	E-market participation impacts directly on the variables of customer service and buyer–supplier relationships, such as product availability, order cycle time, distribution system flexibility, distribution system information and post-sale support
		Predominantly supports vertical collaborative relationships among supply chain members
Observation 3	Level of quality and intensity of information positively impacts the customer service	Two-way information sharing is critical for improved customer service
		Intensity and quality of information are critical indicators of the communication process in the buyer–supplier relationship
		Supports vertical, horizontal and lateral collaborative relationships among supply chain members
Observation 4	E-market, as an enabler of supply chain coordination, enhances information-processing capabilities and reduces task uncertainties	ICT increases inter-organizational information-processing capability
		ICT facilitates predictability and reliability of procurement activities and reduces task uncertainty for customer satisfaction
		Predominantly supports vertical, horizontal and lateral collaborative relationships among supply chain members
Observation 5	Level of conflict in buyer–supplier relationships negatively impacts the frequency, timely exchange of information and supply, and the customer satisfaction	Frequency of information exchange, timely exchange of information and supply in e-market fosters confidence and reduces conflict, resulting in improved customer satisfaction
		Supports vertical collaborative relationships among supply chain members

Table 3 continued

Frameworks/ observations	Description	Perspectives and implications
Observation 6	Diffusion of ICT among different tiers of suppliers in e-market improve the performance of all stakeholders	Adoption and integration of ICT differentiates products or services for customer service
		Supports horizontal and lateral collaborative relationships among supply chain members
Observation 7	Proportion of global supply in the supply chain influence positively on e-market adoption	E-market improves coordination through effective communication and negotiation with global suppliers
		Multilateral inter-organizational information systems supported by EDI, Internet and extranet reduces lead-time, material costs and search costs
		Predominantly supports vertical, horizontal and lateral collaborative relationships among supply chain members
Observation 8	Relative share of direct material cost on manufacturing cost structure is an incentive for e-market adoption	E-market adoption results in improved supplier performance through reduction of procurement costs
		Supports vertical collaborative relationships among supply chain members
Observation 9	Smaller supplier base provides incentive for e-market adoption	Continuous and multilateral interaction in e-market requires the involvement of smaller number of suppliers
		Asset-specific investments in the supply chain generate financial returns to all participants
		Supports vertical and lateral collaborative relationships among supply chain members
Observation 10	Collaboration among supply chain members has a positive relationship on e-market adoption	Collaboration in e-market among competing supply chain members reduces cost and improves the reliability of information sharing

9 Concluding remarks

Planning, designing and implementing the collaborative initiatives in the SC present the most difficult aspects of SC management. The specific mention in the literature review about the magnitude and complexity of SCM in the semiconductor industry is explored and presented. Many enterprises in the SC network of the semiconductor industry are unaware of the fundamental dynamics inter-enterprise collaborative procurement approaches. With the emergence of e-market and due to supplier competition for components of short life-cycle products, developing the supplier is not the issue for the buyer. Instead, the priority is to sustain time-based competition and volatile product demand for responsive and flexible SC. So, the semiconductor industries are focusing more on tactical and operational issues instead of strategic issues.

The present work explores various aspects of e-market design for collaborative procurement practices in the SSC and suggested the most appropriate e-marketplace. The frameworks for e-market characterization and inter-related perspectives of SC collaboration will form the basis for collaborative procurement in the semiconductor industry. However, the present work has not considered the aspects of supplier competition in the marketplace. So, future scope lies in developing most appropriate auction processes and mechanisms in the presence of competing suppliers in the e-market for the SSC.

Acknowledgments The authors are grateful to the reviewers and the editor-in-chief for their valuable comments and suggestions, which led to significant improvement in the manuscript.

Appendix

See Table 4.

Table 4 E-marketplaces for semiconductor and electronics industry supply chain

E-marketplaces	Products and services traded	Geographic focus
ACE Suppliers	IT, communication, electronics/electrical, security and safety products as well as electronic components and productive equipments	Asian manufactures looking for International buyers
Adibank-Ptl.com	Electrical and electronic components and items such as electronic voltage controllers, isolation transformers, insulators and metal conduits	Spain
BidVantage	Computers and electronics components	Global with focus on the USA
Bizipoint	Power Transformer, integrated circuits, mobile phones, LCD panels, electronic switches	Global with focus on China
Click2procure	Procurement of strategic material and equipment	Global
Converge	Semiconductors, logic chips, memory devices, microprocessors, computer peripherals, software, finished goods, electronic components, other computer products and networking equipment	Global
Data Collection Online	Equipment, technology and tools used for data collection, e.g. hand-held computers, line printers, Radio Frequency Identification (RFID) printers	North America
DCI Web TradeCenter	IT and telecommunications products, digital cameras, MP3 players	Europe with a focus on Germany
DRAMeXchange	DRAM (Dynamic Random Access Memory), random access memory (RAM) for personal computers and workstations	Global
EEchain	Computers, OEM stock, related equipment and other IT products and services	Asia
eeParts.com	Electronic components and semiconductors	Global
ElectrExnet	Several products as far as Bar coding, HVAC, Electronic Appliances, Lighting, Security, Printed Circuits and Photography are concerned	Global
ElectrnicsWeb	Electronics and electrical products including: computers, memory, embedded systems, integrated circuits, microprocessors, modems, multiplex systems and others	Global, main focus on North America
ElectroSupport Online	Electronic parts including include ICs, semi conductors, diodes, relays, capacitors, connectors, transistors, resistors, passives, actives	Canada and USA
eXcessportal.com	Electronic components, including chips, smartcards et.	Global
eXcessTrade.com	Excess and obsolete electronic components such as semiconductors, capacitors, diodes, and transistors. (OEM/CEM stock only)	Global
First index	Industrial custom-manufactured parts and assemblies within different categories such as: machining, casting, forging, sheet metal, medium and heavy fabrication, plastic moulding, electronics, etc.	Global
Global Sources	A board range of products and services such as computer products, electronic components, electronics, fashion accessories and supplies timepieces, gifts and home products, hardware, security products, and telecom products	Focus on China and Asia
IT Reseller Online	IT accessories and machines designed to be integrated in a larger system, e.g. portable data terminal, printing products, scanners, and others	North America
Materialboerse.de	New and surplus electronic, optoelectronic and mechanical components	Global
Mectronic	Electronics and mechanical components and services	Global with focus on USA
NetCOMPONENTS	Active, passive and electromechanical component line items including integrated circuits (ICs), semiconductors, diodes, transistors, memories, microprocessors, capacitors, resistors and much more	Global
PartMiner freetradezone	Electronic components	Global
PCB-Broker	PCB-broker is a trading platform for unfinished PCBs—printed circuit boards	Global
Photonics Online	Laser, optics, optoelectronics, fiberoptics, and imaging products	Global, with a focus on North America
Powersource Online Inc	New and used computer parts, systems, peripherals, printers, and networking equipment	USA and Canada
Premises networks.com	Cables, optic fibres, routers, switches, hubs, media access control devices, etc.	Global, with a focus on North America
RFID SolutionsOnline	Radio, Frequency Identification (RFID) products such as antennas, printers, readers, servers, and software	North America
Semiconductor Online	Supplies and equipments for semiconductor manufacturing, i.e. silicon wafers, chemicals gases, test and measurement equipment, etc.	Global, with focus on North America

Table 4 continued

E-marketplaces	Products and services traded	Geographic focus
Test and Measurement.com	Resource for professionals in the test and measurement industry. Information on instrumentation equipment, automated test equipment, oscilloscopes, ATE, data analysis and more	Global with focus on USA
The Broker Forum	Electronic components	Global
Tooling Online	All manner of industrial and high technology tools	Global, with focus on North America
USBid.com	Electronic components (diodes, passives, memories etc.)	Global
Vendorbase	Aftermarket, excess and re-marketed technology products including networking devices, memory, computer systems, accessories, storage, cameras and others	Global with focus on USA
Virtual Chip Exchange	Active and passive electronic components and all kinds of semiconductors	Global
Wireless Workforce Online	Mobile and wireless technology, e.g. notebooks, portable printers, hand-held computers	North America
Adibank-Ptl.com	Electrical and electronic components and items such as electronic voltage controllers, isolation transformers, insulators and metal conduits	Spain

Source http://www.emarketservices.com (eMarket service Directory, October 2005)

References

1. Amelinckx I, Muylee S, Lievens A (2008) Extending electronic sourcing theory: an exploratory study of electronic reverse auction outcomes. Electron Commer Res Appl 7(1):119–133
2. Arshinder K, Kanda A, Deshmukh SG (2008) Supply chain coordination: perspectives, empirical studies, and research directions. Int J Prod Econ 115(2):316–335
3. Attaran M (2007) Collaborative computing: a new management strategy for increasing productivity and building a better business. Bus Strategy Ser 8(6):387–393
4. Attaran M, Attaran S (2007) Collaborative supply chain management: the most promising practice for building efficient and sustainable supply chains. Bus Process Manag J 13(3):390–404
5. Bagchi PK, Ha BC, Skjoett-Larsen T, Soerensen LB (2005) Supply chain integration: a European survey. Int J Logist Manag 16(2):275–294
6. Barlow A, Li F (2005) Online value network linkages: integration, information sharing and flexibility. Electron Commer Res Appl 4(2):100–112
7. Bartezzaghi E, Ronchi S (2004) A portfolio approach in the e-purchasing of materials. J Purch Supply Manag 10(3):117–126
8. Bartlet PA, Julien DM, Baines TS (2007) Improving supply chain performance through improved visibility. Int J Logist Manag 18(2):294–313
9. Bichler M (2001) The future of e-markets: multi-dimensional market mechanisms. University Press, Cambridge
10. Blankley A (2008) A conceptual model for evaluating the financial impact of supply chain management technology investments. Int J Logist Manag 19(2):155–182
11. Boddy D, Macbeth D, Wagner B (2000) Implementing collaboration between organizations: an empirical study of supply chain partnering. J Manag Stud 37(7):1003–1017
12. Byrne PJ, Heavey C (2006) The impact of information sharing and forecasting in capacitated industrial supply chains. Int J Prod Econ 103(1):420–437
13. Caniels MCJ, Gelderman CJ (2005) Purchasing strategies in the Kraljic matrix—a power and dependence perspective. J Purch Supply Manag 11(2–3):141–155
14. Cassivi L, Lefebvre E, Lefebvre LA, Leger P-M (2004) The impact of e-collaboration tools on firms' performance. Int J Logist Manag 15(1):91–110
15. Cetindamar D, Catay B, Basmaci OS (2005) Competition through collaboration: insights from an initiative in the Turkish textile supply chain. Supply Chain Manag Int J 10(4):238–240
16. Chae B, Yen HR, Sheu C (2005) Information technology and supply chain collaboration: moderating effects of existing relationships between partners. IEEE Trans Eng Manag 52(4): 440–448
17. Chaffey D (2002) E-business and E-commerce management. Prentice Hall, Harlow
18. Chau PYK (2001) Inhibitors to EDI adoption in small businesses: an empirical investigation. J Electron Commer Res 2(2):78–88
19. Chen M, Zhang D, Zhou L (2007) Empowering collaborative commerce with web services enabled business process management systems. Decis Support Syst 43(2):530–546
20. Christopher M, Peck H, Towill D (2006) A taxonomy for selecting global supply chain strategies. Int J Logist Manag 17(2):277–287
21. Constantinides E (2002) The 4S web-marketing mix model. Electron Commer Res Appl 1(1):57–76
22. Copacino WC, Dik RW (2001) Why B2B e-markets are here to stay. Outlook 2: 22–29. http://www.accenture.com
23. Corbett CJ, DeCroix GA, Ha AY (2005) Optimal shared-savings contracts in supply chains: linear contracts and double moral hazards. Eur J Oper Res 163(3):653–667
24. Croom SR (2005) The impact of e-business on supply chain management—an empirical study of key developments. Int J Oper Prod Manag 25(1):55–73
25. Cruijssen F, Cools M, Dullaert W (2007) Horizontal cooperation in logistics: opportunities and impediments. Transp Res 43(2):129–142
26. Dai Q, Kauffman RJ (2002) B2B e-commerce revisited: leading perspectives on the key issues and research directions. Electron Mark 12(2):71–82
27. Daniel EM, Hoxmeier J, White A, Smart A (2004) A framework for the sustainability of e-marketplaces. Bus Process Manag J 10(3):277–290

28. Debenham J, Wilkinson I (2006) Exploitation and exploration in market competition. Ind Innov 13(3):263–289
29. Determirhan D, Jacob VS, Raghunathan S (2007) Strategic IT investments: the impact of switching cost and declining IT cost. Manag Sci 53(2):208–226
30. Devaraj S, Kohli R (2003) Performance impacts of information technology: is actual usage the missing link? Manag Sci 49(3):273–289
31. Dulluri S, Raghavan NRS (2008) Collaboration in tool development and capacity investments in high technology manufacturing networks. Eur J Oper Res 187(3):962–977
32. Emberson C, Storey J (2006) Buyer-supplier collaborative relationships: beyond the normative accounts. J Purch Supply Manag 12(5):236–245
33. Ertek G, Griffin PM (2002) Supplier and buyer-driven channels in a two-stage supply chain. IIE Trans 34(8):691–700
34. Esper TL, Williams LR (2003) The value of collaborative transportation management (CTM): its relationship to CPFR and information technology. Transp J 42(4):55–65
35. Fawcett SE, Allred C, Magnan GM, Ogden J (2009) Benchmarking the viability of SCM for entrepreneurial business model design. Benchmarking Int J 16(1):5–29
36. Giménez C, Lourenco HR (2008) e-SCM: internet's impact on supply chain processes. Int J Logist Manag 19(3):309–343
37. Gonzalez J, Dale B (2001) Supplier quality and reliability assurance practices in Spanish auto components industry: a study of implementation issues. Eur J Purch Supply Manag 7(3):187–196
38. Grewal R, Comer JM, Mehta R (2001) An investigation into the antecedents of organizational participation in business-to-business electronic markets. J Mark 65(3):17–33
39. Grey W, Olavson T, Shi D (2005) The role of e-marketplaces in relationship-based supply chains. IBM Syst J 44(1):109–123
40. Grieger M (2003) Electronic marketplaces: a literature and a call for supply chain management research. Eur J Oper Res 144(2): 280–291
41. Gunasekaran A, Nagi EWT (2008) Adoption of e-procurement in Hong Kong: an empirical research. Int J Prod Econ 113(1):159–175
42. Gunasekaran A, Lai K-H, Cheng TCE (2008) Responsive supply chain: a competitive strategy in a networked economy. Omega 36(4):549–564
43. Hadaya P, Cassivi L (2007) The role of joint collaboration planning actions in demand-driven supply chain. Ind Manag Data Syst 107(7):954–978
44. Halley A, Beaulieu M (2009) Mastery of operational competencies in the context of supply chain management. Supply Chain Manag Int J 14(1):49–63
45. Handfield R, Straight S (2003) What sourcing channel is right for you? Supply Chain Manag Rev 7(4):62–67
46. Harker PT (2004) Coordinating supply chain with competition: capacity allocation in semiconductor manufacturing. Eur J Oper Res 159(2):330–347
47. Hartley JL, Lane MD, Hong Y (2004) An exploration of the adoption of e-auctions in supply management. IEEE Trans Eng Manag 51(2):153–161
48. Hausen T, Fritz M, Schiefer G (2006) Potential of electronic trading in complex supply chains: an experimental study. Int J Prod Econ 104(2):580–597
49. Hazra J, Mahadevan B, Seshadri S (2004) Capacity allocation among multiple suppliers in an electronic market. Prod Oper Manag 13(2):161–170
50. Hill C, Scudder G (2002) The use of electronic data interchange for supply chain coordination in the food industry. J Oper Manag 20(4):375–387
51. Hines P, Francis M, Bailey K (2006) Quality-based pricing: a catalyst for collaboration and sustainable change in the agrifood industry. Int J Logist Manag 17(2):240–259
52. Huber B, Sweeney E, Smyth A (2004) Purchasing consortia and electronic markets: a procurement direction in integrated supply chain management. Electron Mark 14(4):284–294
53. Hwang B-N, Chang S-C, Yu H-C, Chang C-W (2008) Pioneering e-supply chain integration in semiconductor industry: a case study. Int J Adv Manuf Technol 36(7–8):825–832
54. Iskandar B, Kurokawa S, LeBlanc L (2001) Adoption of electronic data interchange: the role of buyer-supplier relationships. IEEE Trans Eng Manag 48(4):505–517
55. Jap SD (2002) Online reverse auctions: issues, themes, and prospects for the future. Acad Mark Sci 30(4):506–525
56. Johnson D (2002) Empirical study of second-tier automotive suppliers achieving QS-9000. Int J Oper Prod Manag 22(8): 902–928
57. Johnson PF, Klassen RD, Leenders MR, Awaysheh A (2007) Utilizing e-business technologies in supply chains: the impact of firm characteristics and teams. J Oper Manag 25(6): 1255–1274
58. Johnston DA, McCutcheon DM, Stuart FI, Kerwood H (2004) Effects of supplier trust on performance of cooperative supplier relationships. J Oper Manag 22(1):23–38
59. Kaipia R, Hartiala H (2006) Information-sharing in supply chains: five proposals on how to proceed. Int J Logist Manag 17(3):377–393
60. Kampstra RP, Ashayeri J, Gattorna JL (2006) Realities of supply chain collaboration. Int J Logist Manag 17(3):312–330
61. Kannan G, Haq AN (2007) Analysis of interactions of criteria and sub-criteria for the selection of supplier in the built-in-order supply chain environment. Int J Prod Res 45(17):3831–3852
62. Kaplan S, Sawhney M (2000) E-hubs: the new B2B marketplaces. Harv Bus Rev 78(3):97–103
63. Kaufmann L, Carter CR (2002) International supply management systems: the impact of price vs. non-price driven motives in the United States and Germany. J Supply Chain Manag 38(3):4–17
64. Ke W, Liu H, Wei KK, Chen H (2009) How do mediated and non-mediated power affect electronic supply chain management system adoption? The mediating effects of trust and institutional pressures. Decis Support Syst 46(4):839–851
65. Kerrin M (2002) Continuous improvement along the supply chain: the impact of customer-supplier relations. Integr Manuf Syst 13(3):141–149
66. Ketokivi MA, Schroeder RG (2004) Perceptual measures of performance: fact or fiction? J Oper Manag 22(3):247–264
67. Kim K, Paulson BC, Petrie CJ, Lesser VR (2000) Compensatory negotiation for agent based project schedule coordination. In: Proceedings of the fourth international conference on multiagent systems. IEEE Computer Society Press, California
68. Klein R (2007) Customization and real time information access in integrated eBusiness supply chain relationships. J Oper Manag 25(6):1366–1381
69. Koh SCL, Gunasekaran A, Rajkumar D (2008) ERP II: the involvement benefits and impediments of collaborative information sharing. Int J Prod Econ 113(1):245–268
70. Kuan K, Chau P (2001) A perception-based model for EDI adoption in small businesses using a technology-organization-environment framework. Inf Manag 38(8):507–521
71. Kumaran S, Huang Y, Chang J-Y (2002) A framework based approach to building private trading exchanges. IBM Syst J 41(2):253–271
72. Kwak M (2002) Potential pitfalls of e-auctions. Sloan Manag Rev 43(2):18

73. Lai K-H, Wong CWY, Cheng TCE (2008) A coordination-theoretic investigation of the impact of electronic integration on logistics performance. Inf Manag 45(1):10–20
74. Laukkanen S, Sarpola S, Kemppainen S (2007) Dual role of extranet portals in buyer-supplier information exchange. Bus Process Manag J 13(4):503–521
75. Le TT, Rao SS, Troung D (2004) Industry-sponsored marketplaces: a platform for supply chain integration or a vehicle for market aggregation. Electron Market 14(4):295–307
76. Lee S, Lim GG (2005) The impact of partnership attributes on EDI implementation success. Inf Manag 42(5):503–516
77. Li X, Wang Q (2007) Coordination mechanisms of supply chain systems. Eur J Oper Res 179(1):1–16
78. Li M, Wang J, Wong YS, Lee KS (2005) A collaborative application portal for the mould industry. Int J Prod Econ 96(2):233–247
79. Liker J, Choi T (2004) Building deep supplier relationships. Harv Bus Rev 82(12):104–113
80. Lim D, Palvia P (2001) EDI in strategic supply chain: impact on customer service. Int J Inf Manag 21(3):193–211
81. Ling RR, Yen DC (2001) Extranet: a new wave of internet. SAM Adv Manag J 66(2):39–44
82. Lu D, Antony F (2003) Implications of B2B marketplace to supply chain development. TQM Mag 15(3):173–179
83. Lumsden K, Mirzabeiki V (2008) Determining the value of information for different partners in the supply chain. Int J Phys Distrib Logist Manag 38(9):659–673
84. Manthou V, Vlachopoulou M, Folinas D (2004) Virtual e-chain (VeC) model for supply chain collaboration. Int J Prod Econ 87(3):241–250
85. McLaren T, Head M, Yuan Y (2002) Supply chain collaboration alternatives: understanding the expected costs and benefits. Internet Res Electron Network Appl Policy 12(4):348–364
86. Melville N, Kraemer K, Gurbaxani V (2004) Information technology and organizational performance: an integrative model of IT business value. MIS Q 28(2):283–322
87. Menasce DA, Almeida VA (2000) Scaling for E-business. Prentice Hall, New Jersey
88. Moses A, Ahlstrom P (2008) Problems in cross-functional sourcing decision processes. J Purch Supply Manag 14(2):87–99
89. Muffatto M, Payaro A (2004) Implementation of e-procurement and e-fulfillment processes: a comparison of cases in the motor cycle industry. Int J Prod Econ 89(3):339–351
90. Mukhopadhyay T, Kekre S (2002) Strategic and operational benefits of electronic integration in B2B procurement processes. Manag Sci 48(10):1301–1313
91. Muller M, Seuring S (2007) Reducing information technology-based transaction costs in supply chains. Ind Manag Data Syst 107(4):484–500
92. Myhr N, Spekman RE (2005) Collaborative supply-chain partnerships built upon trust and electronically mediated exchange. J Bus Ind Mark 20(4–5):179–186
93. Naesens K, Gelders L, Printelon L (2007) A swift response tool for measuring strategic fit for resource pooling: a case study. Manag Dec 45(3):434–449
94. Nair A (2005) Emerging internet-enabled auction mechanisms in supply chain. Supply Chain Manag Int J 10(3):162–168
95. Nakano M (2009) Collaborative forecasting and planning in supply chains: the impact on performance in Japanese manufacturers. Int J Phys Distrib Logist Manag 39(2):84–105
96. Narasimhan R, Nair A (2005) The antecedent role of quality, information sharing and supply chain proximity on strategic alliance formation and performance. Int J Prod Econ 96(3):301–313
97. Nurmilaakso J-M (2008) Adoption of e-business functions and migration from EDI-based to XML-based e-business frameworks in supply chain integration. Int J Prod Econ 113(2):721–733
98. Omicini A (2000) Hybrid coordination models for handling information exchange among internet agents. working paper, University of Bologna, Italy. web site: http://www-lia.deis.unibo.it/~ao/pubs/pdf/2000/aiia.pdf
99. Parker H (2000) Inter-firm collaboration and the new product development process. Ind Manag Data Syst 100(6):255–260
100. Pearcy DH, Guinipero LC (2008) Using e-procurement applications to acieve integration: what role does firm size play? Supply Chain Manag Int J 13(1):26–34
101. Peng Y-C, Trappey CV, Liu N-Y (2005) Internet and e-commerce adoption by the Taiwan semiconductor industry. Ind Manag Data Syst 105(4):476–490
102. Petersen KJ, Ogden JA, Carter PL (2006) B2B e-marketplaces: a typology by functionality. Int J Phys Distrib Logist Manag 37(1):4–18
103. Porter ME (2001) Strategy and the Internet. Harv Bus Rev 79(3):63–78
104. Power D, Singh P (2007) The e-integration dilemma: the linkages between internet technology application, trading partner relationships, and structural change. J Oper Manag 25(6):1292–1310
105. Pyke D, Johnson M (2003) Sourcing strategy and supplier relationships: alliances vs. e-procurement. In: Billington C, Lee H, Neale J, Harrison T (eds) The practice of supply chain management. Kluwer Publishers, Dordrecht, pp 77–89
106. Raisch W (2001) The e-marketplace: strategies for success in B2B e-commerce. McGraw Hill, New York
107. Rash M, Kragh H (2004) Motives for e-marketplace participation. Electron Market 14(4):270–283
108. Reichhart A, Holweg M (2007) Creating the customer-responsive supply chain: a reconciliation of concepts. Int J Oper Prod Manag 27(11):1144–1172
109. Rosenzweig ED, Roth AV (2007) B2B seller competence: construct development and measurement using a supply chain strategy lens. J Oper Manag 25(6):1311–1331
110. Rudberg M, Klingenberg N, Kronhamn K (2002) Collaborative supply chain planning using electronic marketplaces. Integr Manuf Syst 13(8):596–610
111. Ruppel C (2004) An information systems perspective of supply chain tool compatibility: the roles of technology fit and relationships. Bus Process Manag J 10(3):311–324
112. Saeed KA, Malhotra MK, Gover V (2005) Examining the impact of interorganizational systems on process efficiency and sourcing leverage in buyer-supplier dyads. Decis Sci 36(3):365–396
113. Sahin F, Robinson EP Jr (2005) Information sharing and coordination in make-to-order supply chains. J Oper Manag 23(6):579–598
114. Sairamesh J, Mohan R, Kumar M, Hasson L, Bender C (2002) A platform for business-to-business sell-side, private exchanges and marketplace. IBM Syst J 41(2):242–252
115. Sandberg E (2007) Logistics collaboration in supply chains: practice vs. theory. Int J Logist Manag 18(2):274–293
116. Sanders N (2005) IT alignment in supply chain relationships: a study of supplier benefits. J Supply Chain Manag 42(2):4–13
117. Sanders NR (2008) Pattern of information technology use: the impact of buyer-supplier coordination and performance. J Oper Manag 26(3):349–367
118. Sanders NR, Premus R (2005) Modeling the relationship between firm IT capability, collaboration, and performance. J Bus Logist 26(1):1–23
119. Sardinha A, Benisch M, Sadeh N, Ravichandran R, Pedobnik V, Stan M (2009) The 2007 procurement challenge: a competition to evaluate mixed procurement strategies. Electron Commer Res Appl 8(2):106–114

120. Sezen B (2008) Relative effects of design, integration and information sharing on supply chain performance. Supply Chain Manag Int J 13(3):233–240
121. Sharif AM, Irani Z, Lloyd D (2007) Information technology and performance management for build-to-order supply chains. Int J Oper Prod Manag 27(11):1235–1253
122. Sharifi H, Kehoe DF, Hopkins J (2006) A classification and selection model of e-marketplaces for better alignment of supply chains. J Enterp Inf Manag 19(5):483–503
123. Sheu C, Yen HR, Chae B (2006) Determinants of supplier-retailer collaboration: evidence from an international study. Int J Oper Prod Manag 26(1):24–49
124. Simatupang TM, Sridharan R (2002) The collaborative supply chain. Int J Logist Manag 13(1):15–30
125. Simatupang TM, Sridharan R (2004a) A benchmarking scheme for supply chain collaboration. Benchmark Int J 11(1):9–30
126. Simatupang TM, Sridharan R (2004b) Benchmarking supply chain collaboration: an empirical study. Benchmark Int J 11(5): 484–503
127. Simatupang TM, Sridharan R (2008) Design for supply chain collaboration. Bus Process Manag J 14(3):401–418
128. Skjoett-Larsen T, Kotzab H, Grieger M (2003) Electronic marketplaces and supply chain relationships. Ind Mark Manag 32(3):199–210
129. Smart A (2008) eBusiness and supply chain integration. J Enterp Inf Manag 21(3):227–246
130. Soroor J, Tarokh MJ, Shemshadi A (2009) Initiating a state of the art system for real-time supply chain coordination. Eur J Oper Res 196(2):635–650
131. Sriram V, Stump R (2004) Information technology investment in purchasing: an empirical investigation of communications, relationships and performance outcomes. Omega 32(1):41–55
132. Stank TP, Keller SB, Daugherty PJ (2001) Supply chain collaboration and logistical service performances. J Bus Logist 22(1):29–48
133. Subramani M (2004) How do suppliers benefit from information technology use in supply chain relationships? MIS Q 28(1): 45–73
134. Swaminathan JM, Tayur SR (2003) Models for supply chains in e-business. Manag Sci 49(10):1387–1406
135. Thron T, Nagy G, Wassan N (2006) The impacts of various levels of collaborative engagement on global and individual supply chain performance. Int J Phys Distrib Logist Manag 36(8):596–620
136. Tsay A, Nahmias S, Agrawal N (2000) Modeling supply chain contracts: a review. In: Tayur S, Ganeshan R, Magazine M (eds) Quantitative models for supply chain management. Kluwer Academic Publishers, Norwell, pp 299–330
137. Vickery SK, Jayaram J, Droge C, Calantone R (2003) The effects of an integrative supply chain strategy on customer service and financial performance: an analysis of direct versus indirect relationships. J Oper Manag 21(5):523–539
138. Wang S, Archer N (2007) Business-to-business collaboration through electronic marketplaces: an exploratory study. J Purch Supply Manag 13(2):113–126
139. Wang CX, Benaroch M (2004) Supply chain coordination in buyer centric B2B electronic markets. Int J Prod Econ 92(2):113–124
140. Wang T-W, Tadisina SK (2007) Simulating internet-based collaboration: a cost-benefit case study using a multi-agent model. Decis Support Syst 43(2):645–662
141. Welker GA, van der Vaart T, van Donk DP (2008) The influence of business conditions on supply chain information-sharing mechanisms: a study of supply chain links of SMEs. Int J Prod Econ 113(2):706–720
142. Wise R, Morrison D (2000) Beyond the exchange: the future of B2B. Harv Bus Rev 78(6):86–96
143. Wu YN, Cheng TCE (2008) The impact of information sharing in a multiple-echelon supply chain. Int J Prod Econ 115(1):1–11
144. Wu F, Zsidisin A, Ross AD (2007) Antecedents and outcomes of e-procurement adoption: an integrative model. IEEE Trans Eng Manag 54(3):576–587
145. Yao Y, Palmer J, Dresner M (2007) An interorganizational perspective on the use of electronically-enabled supply chains. Decis Support Syst 43(3):884–896
146. Yu CS (2006) Exploring influences on Taiwanese SMEs e-marketplace adoption decision. J Global Inf Technol Manag 9(2):5–21
147. Zsidisin A, Ragatz GL, Melnyk SA (2005) An institutional theory perspective of business continuity planning for purchasing and supply management. Int J Prod Res 43(16):3401–3420