A Benchmarking Scheme for Supply Chain Collaboration[*]

Togar M. Simatupang[**]
Institute of Information Sciences & Technology,
Massey University
Palmerston North
New Zealand
E-mail: t.m.simatupang@massey.ac.nz

Ramaswami Sridharan
Institute of Information Sciences & Technology,
Massey University
Palmerston North
New Zealand
E-mail: r.sridharan@massey.ac.nz

[*] To appear in *Benchmarking: An International Journal*, Vol. 9 No. 6, 2003.
[**] Corresponding author.

A Benchmarking Scheme for Supply Chain Collaboration

Togar M. Simatupang and Ramaswami Sridharan
Institute of Information Sciences & Technology,
Massey University, Palmerston North, New Zealand

Abstract

Intense competition forces companies to become involved in supply chain collaboration with their upstream and downstream partners. The key to ensuring that the participating members are progressing on the right track of creating the best-in-class practice is to conduct benchmarking. Benchmarking stimulates collective learning for performance improvement that brings benefits to all participating members. However, previous research has focused mainly on supply chain benchmarking at the intra-company- rather than the inter-company-level. Inter-company benchmarking requires a new perspective for understanding collaborative learning amongst the participating members that encourages them to improve supply chain performance as a whole. This research aims to develop a benchmarking scheme for supply chain collaboration that links collaborative performance metrics and collaborative enablers. The proposed benchmarking scheme can be used to examine the current status of supply chain collaboration amongst the participating members, identify performance gaps, and systematize improvement initiatives.

Keywords: Benchmarking, Supply chain management, Supply chain collaboration, Performance measurement

Introduction

Intense competition compels companies to create close relationships with their upstream and downstream partners. The traditional arm's length relationship is no longer effective in the dynamic environment of global competition (Bowersox *et al.*, 2000). As a company may belong to many supply chains, few areas of logistics decision and market access are under their direct control. The revolution of supply chain management in the

last decade has testified that an increasing number of companies seek to enhance performance beyond their own four walls (Boyson *et al.*, 1999; Poirier, 1999). It is not surprising that the emerging trend of supply chain collaboration has been quickly adopted in many companies. For example, the pilot project of the collaborative planning, forecasting, and replenishment (CPFR) scheme helps Wal-Mart and its suppliers to improve in-stock levels, reduce lead-times, slash on-hand inventory, create more consistent orders, and smooth production cycles (Parks, 2001). For its substantial benefits, the trend of adopting collaborative schemes such as CPFR will continue to increase in the coming decade. The rapid advancement of information technology makes it easier for companies to adopt certain types of collaborative schemes.

The motivation for supply chain collaboration is to improve overall supply chain performance (Horvath, 2001; Simatupang and Sridharan, 2002a). Internal and external metrics are monitored to enable the chain members to assess the progress of performance improvements (Stewart, 1997). An integrated performance system is thus required by all members to facilitate their monitoring of, and response to, actual performance status along the supply chain (Lapide, 2000). This includes a clear linkage between individual and collaborative metrics at different managerial levels because the participating members become committed only if their individual performance is clearly linked to collaborative performance (Lambert and Pohlen, 2001). To ensure that they move on the right track of the best-in-class practice, they need also a collaborative benchmarking that provides ideas of improvement based on comparisons between their collaborative performance against customer and competition requirements (Boyson *et al.*, 1999; Cox *et al.*, 1997; Watson, 1993).

However, previous research on benchmarking often emphasizes on internal performance metrics and has paid little attention to the importance of collaborative metrics that span inter-companies. The focus of the previous research is limited to an individual company as a part of the supply chain. A new relationship amongst independent but related members in the supply chain requires a novel type of benchmarking (Cox *et al.*, 1997; Gunasekaran, 2002). This would make it relevant to study benchmarking that involves

more than one company. In addition, the traditional benchmarking study often provides ideas on what to improve rather than how and why improvements should be made (Bogan and Callahan, 2001). Since the responding ability of performance improvement depends on how rather than on what metrics to improve, a novel scheme is required to help companies to identify clearly what areas need improvements and use benchmarking to provide direction of improvement.

This research aims to conceptualize a benchmarking scheme that assists the chain members to understand the linkage between supply chain performance metrics and possible enablers of performance improvement. The proposed scheme can be used to compare performance not only with the best-in-class practice but also with customer expectations in order to reinvent key levers used to enhance performance. Compared to previous research in benchmarking, this research moves away from the intra-company level to the inter-company level and thereby provides a novel approach to the study of benchmarking in the supply chain.

The remaining paper is organized as follows. The next section reviews prior literature on supply chain benchmarking. The succeeding section presents the revisited view of collaborative performance metrics that incorporate three different levels of performance learning cycles. Collaborative enablers as a means for leveraging supply chain performance are introduced in the next section. A benchmarking scheme is then proposed which includes collaborative performance metrics and collaborative enablers. The concluding section highlights the contributions of this study and its limitations, and provides some directions for future research.

Literature review

This section reviews previous benchmarking studies including definition, benchmarking in supply chain management, and benchmarking supply chain collaboration. The following paragraphs discuss these issues.

Benchmarking defined

The concept of benchmarking has received much attention in the management literature (e.g., Bogan and Callahan, 2001; McNair and Leibfried, 1992; Spendolini, 1992). Many definitions have been proposed for benchmarking. Bogan and Callahan (2001) argue that benchmarking is a universal management tool that can be defined as the systematic process of searching for best practices, innovative ideas, and effective operating procedures that lead to superior performance. According to McNair and Leibfried (1992), benchmarking is simply an external focus on internal activities, functions, or operations in order to achieve continuous improvement. Spendolini (1992) defines benchmarking as a continuous and systematic process for evaluating the products, services, and work processes of organizations that are recognized as representing best practices for the purpose of organizational improvement.

The main idea of benchmarking is to realize real breakthroughs in performance through the identification of best practices that contribute to performance improvements. Benchmarking stimulates companies to learn quickly from others in order to leap ahead of the competition and create new performance standards (Garvin, 1993). Companies have applied the benchmarking approach for improving specific business processes that ultimately translate to higher profitability. For example, Xerox Corporation, American Express, Kodak, Rover, AT&T, Chevron, and 3M have committed to benchmarking and have successfully used the technique to excel in their respective industries on a global scale (Camp, 1995; Zairi, 1996).

Widely known as an important tool which enables companies to accelerate performance improvements, the concept of benchmarking has continued to grow. Bogan and Callahan (2001) identified three stages in the development of the benchmarking concept, starting from metrical benchmarking, linking the metrical indicators and key operational drivers of performance excellence, and general applications of benchmarking to strategic planning, change management, process re-engineering, knowledge management, and advanced problem-solving. Traditionally, benchmarking uses the measurement process to identify benchmarks. This metric-focused benchmarking enables companies to identify

performance gaps. Benchmarking experts have often been employed to suggest multi-step approaches to the process of metrical benchmarking (Camp, 1995). As the real interest of benchmarking to managers used to be the underlying processes that drive performance metrics, the second generation of benchmarking appeared to include descriptions of the best practices employed by the leading firms. Finally, Bogan and Callahan (2001) identified the advanced application of benchmarking such as strategic planning, change management, process reengineering, knowledge management, and advanced problem solving. They proposed "rapidmarking" that can be used by managers to conduct a benchmarking study within days in the new millennium. Watson (1993) also proposed a similar pattern of benchmarking as a developing science.

Benchmarking in supply chain management

Benchmarking is relevant in studying the supply chain by measuring the company's products, services, and processes and comparing them against the relevant metrics of successful firms (Christopher, 1998). Previous research into supply chain benchmarking shows that it may lead to increased productivity of the supply chain as managers compare their practices to the best in the field. Stewart (1995) reported that Pittiglio Rabin Todd and McGrath (PRTM) generated a comprehensive set of fact-based performance measures that can be used to accurately describe a world-class supply chain of planning, sourcing, making, and delivering activities. The benchmarking scheme covers four areas of performance metrics which are identified as the keys to unlocking supply chain excellence: delivery performance, flexibility and responsiveness, logistics cost, and asset management. This is the first known study that objectively links best practices employed with relative quantitative performance achievements. Additionally, the study results describe relevant trend information indicating the progress that companies have made towards improving their supply chain operations.

The PRTM's concept of supply chain benchmarking has been extended to be the supply chain operations reference (SCOR) model by the Supply Chain Council (Stewart, 1997). The SCOR is the first cross-industry framework for evaluating and improving enterprise-wide supply chain performance and management. It provides standard process

definitions, terminology, and metrics that enable companies to benchmark themselves against others and influence future improvement efforts to ensure real progress. The metrics include key areas such as delivery performance, order fulfillment, production flexibility, and cash-to-cash cycle time. By using the SCOR model, Geary and Zonnenberg (2000) reported that the benchmarking study, conducted by the Performance Measurement Group (PMG), showed that the best-in-class supply chain performers were gaining considerable financial and operating advantages over the rest of the respective groups. The top performers had a clear supply chain strategy that was closely aligned with the overall business objective and customer requirements. The best practice can be decomposed into five primary levers to consider: configuration, enabling practices, supply chain network, organizational structure, and information technology architecture. In this survey, PMG examined the best-in-class industry performance of customer-facing measures and internal-facing measures. Customer facing measures, such as upside production flexibility and delivery performance to request, quantify how well a supply chain delivers product to customers. Internal-facing measures, which include total supply chain management cost and cash-to-cash cycle time, portray how effectively an organization uses resources in creating value for the customer.

Other supply chain benchmarking studies have also attempted to measure supply chain processes and propose ways of identifying and applying ideas for improvements. Gilmour (1999) described a group of benchmark measures based on a set of capabilities, which incorporate process capabilities, information technology capabilities, and organization capabilities. There are four levels representing a continuum of sophistication for each capability component. Using this benchmarking scheme, the participants were able to identify considerable room for improvement. Hanman (1997) argued that supply chain benchmarking is an improvement technique that considers how others perform a similar activity, task, process or function. By comparing the company's operations with those of other organizations, there is potential to learn and improve performance. The leaders-laggers analysis was used to compare a firm's performance to best practice. The benchmarking network program among participating members was explained as a way of assisting companies to implement improvements. Furthermore, Van Landeghem and

Persoons (2001) developed a causal model as a means for identifying initiatives to remedy the performance gap between a given company and the best-in-class performers. This causal model links the use of best practices to the resulting performance. A logistic audit is proposed as a systematic review of logistics performance by using the causal model to explain which best practices are most likely to improve the specific lagging metrics. It thus allows the company to obtain an idea about its rate of use of best practices and its effectiveness based on key metrics.

Benchmarking supply chain collaboration

The previous research mainly relates to benchmarking schemes for a specific single company as a part of the supply chain. Little attention has been paid to tailoring a benchmarking scheme to supply chain collaboration at the inter-company level. The concept of inter-company level means joint activities by chain members that enable the supply chain to be more responsive to customer demands. Christopher (1998) confirms the fact that supply chain performance depends on the quality of the relationship that extends from upstream to downstream partners. It is thus essential for participating members to call for collaborative benchmarking that enables them to understand the linkage between their collaborative practices and the overall aim of improving supply chain performance as a whole. According to Cox *et al.* (1997), collaborative benchmarking has been viewed as a process for facilitating organizational learning amongst participating members. However, the development of such a collaborative benchmark is still at the infant stage. One of the reasons that might explain this fact is that there is no robust method and performance measurement system that would help participating managers to identify areas that need improvement as well as the magnitude of the improvement needed.

There are two studies that propose collaborative benchmarking for the supply chain (Poirier, 1999; Polese, 2002). Both benchmarking schemes acknowledge the importance of the level of implementation of best practice. According to Davies and Kochhar (2002), representing how companies move forward through sequential stages of the implementation process provides a more realistic scheme for benchmarking study. As

regards a benchmarking scheme involving more than one chain member, the study by Poirier (1999) appeared to be the first to move towards addressing the need of collaborative benchmarking in the supply chain. He proposed a progressive framework consisting of four levels of supply chain optimization. The first two levels of progress are internally focused, namely "sourcing and logistics" and "internal excellence". The last two levels (i.e., 'network construction' and 'industry leadership') reflect the collaborative efforts amongst participating members that improve their value chain constellation in which the effectiveness is measured by the ultimate customers in terms of their purchases and continued loyalty.

Polese (2002), likewise, proposed a maturity model that reflects how companies progress in terms of operational capability. There are four stages in the supply chain maturity model. The first two levels are functional focus and internal integration. Collaboration is the key ingredient to reach stages three (i.e., external integration) and four (i.e., cross enterprise collaboration). Based on the SCOR model, the maturity model can be used to measure fact-based benchmarking for determining best-in-class performance opportunities. The performance gap between internal and external benchmark provide performance targets that can be linked to operational levers. These levers are used to implement the best practice that contributes to the most favorable financial outcomes.

This current research addresses the settlement of three primary issues of supply chain benchmarking. One is the task of assuring that the portfolio of performance metrics helps chain members to continuously improve performance in the same direction of optimizing supply chain profitability as a whole from generating sales (Goldratt *et al.*, 2000). Performance metrics should allow the clear linkage between global metrics and individual metrics. This is the issue of the hierarchical nature of performance metrics. Moreover, performance metrics can be time sensitive such as leading or diagnostics metrics, concurrent metrics, and lagging or outcomes metrics (Kaplan and Cooper, 1997). The authors therefore propose a collaborative performance system to facilitate learning amongst the chain members. Another issue relates to the linkage between performance metrics and their enablers that represent actionable underlying drivers of performance. In

extending the emerging benchmarking scheme for supply chain collaboration, this paper thereby proposes three dimensions of collaborative enablers that define the operational interfaces amongst the chain members that contribute to supply chain performance. The third issue involves selecting collaborative enablers to meaningfully determine the collaborative efforts relative to best-in-class collaborative supply chains. A framework of benchmarking scheme is proposed to define the linkage between the collaborative performance system and collaborative enablers. The next section presents performance metrics for supply chain collaboration.

Collaborative performance system

The critical issue in a collaborative relationship is the commitment of participating members to accelerating improvements that contribute to both individual and mutual benefits. Previous research shows that the commitment to improvement amongst chain members is dependent on the selected performance metrics (Caplice and Sheffi, 1995; Gunasekaran *et al.*, 2001; Holmberg, 2000). Performance metrics encourage the participating members to tie improvements to the most profitable customer segments with lowered costs (Geary and Zonnenberg, 2000). The use of key performance indicators to monitor the efficiency and effectiveness of different levels of supply chain operations has been discussed at length by Caplice and Sheffi (1995) and Gunasekaran *et al.* (2001). However, the performance metrics mainly found in the previous literature are focused internally. Lambert and Pohlen (2001) argued that there is little evidence about the existence of the metrics that span across multiple members along the supply chain. Van Hoek (1998) also lamented the lack of aligned performance metrics that direct participating managers to pay attention to areas requiring improvements.

The main concern in addressing collaborative metrics amongst the participating members is to design appropriate metrics that ensure trustworthiness and accountability (Goldratt *et al.*, 2000). The participating companies also have to ensure the usefulness of the selected portfolio of performance metrics and the performance statistics that are derived from the raw performance data. This means that the portfolio should be readily understandable by decision makers to motivate them to support improvement initiatives

that contribute to better customer services and lowered logistics costs as well as providing a guide for action to be taken (Simatupang and Sridharan, 2002a; Van Hoek, 1998).

The authors propose a collaborative performance system (CPS) as the learning process by which to achieve key performance results and strategic objectives amongst participating members. A CPS is the first step toward developing meaningful supply chain collaboration because it establishes a common language for measuring progress in providing mutual services to end customers and giving the participating members the freedom to rapidly or even immediately improve the supply chain operations as a whole. In this sense, a CPS refers to the process of measuring and facilitating collaborative learning to improve overall performance that stimulates win-win relationships (Garvin, 1993; Hyland and Beckett, 2002; Senge, 1990).

The framework for a CPS consists of three dynamic learning cycles (see Figure 1), namely, the exception cycle, the improvement cycle, and the review cycle. Each learning cycle helps the chain members to identify an appropriate set of metrics to examine their supply chain performance at different managerial levels and provides an opportunity to improve supply chain performance. The exception cycle occurs when the chain members act together to provide better mutual rapid response for satisfying customer needs and wants. The improvement cycle takes place when the chain members act together to carry out ongoing improvement initiatives. The review cycle refers to the process of strategy making that guides the improvement cycle.

Take in Figure 1

The three learning cycles are chosen for two reasons. First, performance metrics are hierarchical in nature and time sensitive. Different managerial levels require different types of performance metrics in order to be able to meaningfully assess their actions

towards supply chain profitability. Performance metrics can be distinguished also by their timeliness: leading, concurrent, and lagging indicators (Kaplan and Cooper, 1997). Second, a CPS is often developed at different implementation stages reflecting the strength, depth, and maturity of the inter-firm relationship (Davies and Kochhar, 2002). Initially, the exception cycle, which contains audits of operational metrics, is typically conducted to improve the supplier's delivery capabilities and the retailer's customer service capabilities. As the relationship expands, participating members become involved in the improvement cycle to agree upon mutual improvement levers that have the potential to enhance mutual benefits. Over time, the improvement cycle increases trust and ongoing achievement of high performance standards. Eventually, participating members establish global scorecards that reflect agreement on strategic objectives and improvement calibration. Table 1 provides the detailed attributes of the three collaborative learning cycles.

Take in Table 1

Exception cycle

The exception cycle is designed with explicit learning objectives to improve the process of collaborative order fulfillment and at the same time to protect sales from any market changes and supply disruptions along the supply chain. This cycle integrates collaborative planning with supply chain execution. Chain members jointly gather information about their common customers' needs and wants, plan supply chain activities, execute plans, and manage exceptions. Since the supply chain environment is characterized by an increase in customer expectations, ongoing demand spikes, an increase in product variation, and shorter product lifecycles, it is clear that participating members should adopt the exception cycle to anticipate any change that might occur upstream and downstream of their supply chains before deviations damage customer sales. The exception cycle thus enables chain members to detect deviations from planned supply chain activities and helps them to make better decisions to respond to unplanned

events within their supply chains. Furthermore, learning occurs when a mismatch between plans and outcomes is identified and is corrected by remedial actions - that is, a mismatch is turned into a match (Senge, 1990). Therefore, the exception loop creates value to supply chain collaboration by developing remedial alternatives and notifying responsible parties to carry out the selected remedial actions in response to unplanned supply chain execution level events.

The exception loop consists of activities starting with monitoring key events of supply chain execution, examining performance deviations, tracking problems, providing alternative remedial actions, notifying responsible parties to resolve problems, and implementing remedial action. As shown in Figure 1, the generic components of the exception loop include a monitoring system, an alert system, responsible parties, and corrective actions. A monitoring system observes and records key events of supply chain execution, as well as acquiring relevant data for decision-making. Responsible parties most likely need this relevant data before committing to a remedial action. An alert system provides trends and determines whether or not remedial action is needed. If a performance deviation requires corrective actions, it notifies responsible parties about deviations from planned activities. If a corrective action is needed, responsible parties retrieve information regarding alternatives and conduct risk analysis to select the best remedial action from a list of alternatives. By using a decision support system, participating members will be able to measure the benefits generated by the selected remedial action. After the corrective actions have been carried out, a monitoring system provides an evolving picture of the remedial action being implemented. The loop starts again with a similar pattern.

Performance metrics used in the exception cycle are mainly leading or diagnostics indicators such as delivery performance, inventory velocity, product quality, and product availability. These metrics are used to indicate deviations from delivering the perfect order to end customers during the supply chain execution (Goldratt *et al.*, 2000; Lapide, 2000). At the level of the individual company, the local managers have to make sure customer orders are satisfied and assets are used effectively. The leading metrics provide

detailed feedback information to assist local managers to do the best they can and to engage in focusing corrective efforts to improve supply chain performance (Walker, 1999). Since the metrics indicate the performance of recent activities, the chain members can carry out a root cause analysis of performance gaps based on leading indicators, set an expectation, and monitor their ability to implement remedial actions to achieve this expectation.

As an illustration in a supplier-retailer collaboration, the retailer shares the best forecast about market trends and information about upcoming promotions with its supplier. The supplier shares product planning, production plans, and transportation capabilities. They cooperatively determine the target inventory level at the store. Collaboration between these two parties is based on the fact that as long as the end customer does not buy, no party in the supply chain has sold (Goldratt *et al.*, 2000). If the retailer requires the supplier's products, this means that the retailer will rapidly move those products to end customers. According to Goldratt *et al.* (2000), a good measure is required to bind each party to be accountable to improve supply chain performance as a whole. They propose the inventory-dollar-days (IDD) as a metric to be used to enable the supplier to judge the retailer's inventory performance. IDD equal the sum of the dollars of inventory times the number of days on hand. The supplier can also offer the same measure to its vendors so they can measure the supplier's inventory performance. On the other hand, the retailer can judge the delivery performance of its suppliers by using the throughput-dollar-days (TDD) that equal the sum of sales dollars times the number of days' delay. The retailer then attempts to reach zero TDD with as few IDD as possible. In the same way, the supplier can use TDD to judge the delivery performance of its vendors. The supplier will be responsible for the results as measured by TDD and IDD. In this way, IDD and TDD are performance metrics that help participating members to have uniformity of accountability. This means that if the retailer wants fast delivery of certain products, the supplier will fulfill this request and is able to judge how rapidly the retailer sells the products. At the same time, the supplier can also require its vendors to provide the same delivery service. This chain of accountability stimulates participating members to improve the mutual response to end customers.

The exception cycle encourages the supplier to replenish products sold by the retailer (Goldratt, 1994). In other words, this pull system synchronizes the rate of sales with the rate of replenishment. What the supplier needs to do is to watch the points of sale at the stores. The supplier will ship whatever the retailer sells. The exception cycle also assists participating members to protect sales (i.e., by eliminating lost sales) if supply disruptions and unplanned events strike during the execution process. For example, if the members know there will be a delivery delay but have adequate lead-time to carry out remedial action, then the cost of remedial action can be minimized. This remedial action is less likely to cause more troubles to other planned supply chain activities because it resolves problems locally before they jeopardize sales. In other words, actual demand can be satisfied without increasing emergency shipping costs. Fisher (1997) advocates that the retailer and the supplier need to collaboratively take advantage of early sales data during the selling season to minimize demand and supply mismatch. The retailer observes and shares demand data with the supplier in a timely manner. The supplier then provides a fast product delivery in order to enable the retailer to fulfill demand during the remaining time of the selling season. Both parties reap the benefits of increased profits from matching supply and demand.

However, operational metrics have three inherent pitfalls. First, once the participating members become accustomed to operational metrics, they are most likely to manipulate numbers to meet expectation. Second, since operational metrics indicate immediate deviations from an original plan, the chain members fail to notice concurrent metrics that would help them to improve their response capability. Third, the dynamic nature of demand and supply conditions causes the location of the supply chain constraint to shift and thereby the leading indicators associated with the constraint also need to be relocated to the new constraint (Goldratt, 1994; McNair and Leibfried, 1992). To overcome these pitfalls, the improvement cycle is required to increase the ability of the chain members to concert their ongoing improvement and direct the exception cycle.

Improvement cycle

The improvement cycle provides the ability to continuously learn from implementing new capabilities required to improve supply chain performance. Performance gaps can be identified if there is a lack of capability to satisfy customer demand. The chain members observe the supply chain execution and the changing markets to obtain information for improvement ideas. Ideas should be translated to define improvement levers that can be used to lessen the performance gaps. Improvement levers include mutual capabilities such as accurate response (Fisher, 1997), lean retailing (Abernathy *et al.*, 2000), and ongoing improvement method (Goldratt, 1994) required by the chain members to accelerate the improvement process. Measuring improvement progress indicates how well the interface team is solving problems together with such new capability. Garvin (1993) proposed the half-life curve, originally developed by Analog Devices (Schneiderman, 1988), as a way of measuring improvement progress. A half-life curve measures the time it takes to achieve a fifty per cent improvement in a specified performance metric. This curve can be presented graphically using a logarithmic scale. An improvement metric such as delivery performance, inventory velocity, quoted lead-times, cash-to-cash cycle time, and time-to-market (Farris and Hutchison, 2002; Fisher, 1997; Lapide, 2000) is plotted on the vertical axis and the time scale (e.g., days, weeks, months, quarters) is plotted horizontally. Steeper slopes then represent faster learning. If the participating members take less time to improve supply chain metrics, they must be learning more quickly than their competitors. The same metrics can be used to gauge the impact of acquiring new capabilities on supply chain metrics over time. Moreover, this improvement cycle also assists the chain members to identify and remove conflicting operational metrics and redefine appropriate metrics that motivate them to engage in the exception cycle.

Review cycle

The review cycle is dedicated to monitoring lagging performance metrics and competition environment that can be analyzed to assess and modify collaborative strategy. Lagging performance metrics are measurement of results collected only after an event has occurred – for example, growth, sales, profits, return on investment, cash flows,

and inventory turns. These metrics are meaningful for the executives of participating members to track monthly or quarterly progress in achieving mutual strategic objectives (Lambert and Pohlen, 2001). The outcome of this evaluation can be addressing important issues that inhibit the chain members from achieving their mutual objectives, identifying and removing outdated polices, and conducting the continuous recalibration of improvement targets (Neely and Al Najjar, 2002; Simatupang and Sridharan, 2002a). New improvement targets are used to translate the strategic objectives into meaningful performance gaps that help to guide the improvement planning. For example, Dell Computer regularly reviews and displays the inter-company scorecard for all suppliers to see (Dell and Fredman, 1999).

In summary, a CPS is designed to enable the participating members to define and choose appropriate performance metrics at three different managerial levels relevant to their collaborative efforts. However, the implementation of CPS requires collaborative enablers (i.e., information sharing, decision synchronization, and incentive alignment) that drive the supply chain operations to be performed in the same direction as the overall supply chain goal. The next section discusses the components of collaborative enablers.

Collaborative enablers

Traditional benchmarking enables companies to compare their own performance metrics against those of their competitors. This metric-focused benchmarking provides incomplete comparisons as they merely describe performance gaps without explaining why the gaps exist (Bogan and Callahan, 2001). Collaborative benchmarking needs to go beyond metrical benchmarking to the critical process enablers that underlie and drive performance metrics. In this way, performance gaps analysis can provide a real foundation for identifying enablers that contribute to better supply chain performance. Therefore, the participating members should learn how to tie performance metrics to collaborative enablers. The clear linkage between performance metrics and enablers determines what must be changed to eliminate performance gaps.

The authors propose three collaborative enablers to reflect the intensity of operational interfaces amongst the participating members, namely information sharing, decision synchronization, and incentive alignment (Simatupang and Sridharan, 2002b). Collaborative enablers dictate the amount of mutual actions used to drive supply chain performance. Figure 2 depicts the linkage between these three collaborative enablers and a collaborative performance system. A collaborative performance system requires information sharing, incentive alignment, and decision synchronization to facilitate the improvement process. For example, decision synchronization uses key operational metrics to drive the process of improvement. Information sharing provides visibility of the performance metrics and process status used to make better decisions. Incentive alignment motivates participating members to make decisions that contribute to the mutual strategic objectives. These three collaborative enablers drive the shared supply chain processes that lead to better supply chain performance. Eventually, actual performance will provide feedback to the collaborative performance system.

Take in Figure 2

Information sharing

Information sharing refers to the ability to see private data in a partner's systems and monitor the progress of products as they pass through each process in the supply chain (Simatupang and Sridharan, 2002b). This activity covers monitoring (data capturing), processing, and dissemination of customer data, end-to-end inventory status and locations, order status, costs-related data, and performance status. Visibility of key performance metrics enables participating members to address production and quality issues more quickly, and thereby permits more agile demand planning to take place. Information sharing ensures that participating members will be able to make use of shared information to help fulfill demand more quickly with shorter order cycle times. For example, sharing timely promotional information can be used to reduce out of stocks on the store shelves. In addition, delivery lead-time can be reduced because demand

visibility substitutes inventory. Information sharing generally facilitates the decision-making process, the collaborative progress assessment, and incentive alignment. For example, demand and inventory visibility can be used to eliminate stock-outs and remove products that are not selling (Fisher, 1997). Several criteria, such as speed, accuracy, timeliness, and reliability, can be used to judge the contribution of information sharing to supply chain integration. Advanced technology such as the Internet can be used to convey up-to-date data about product movements, workflow, costs, and performance scoreboard.

Decision synchronization

Decision synchronization can be defined as the ability to orchestrate decisions at different managerial levels and time horizons for pursuing the common goal of optimizing the supply chain profitability (Simatupang *et al.*, 2002). This activity covers aligning strategic objectives, policies, and metrics amongst the chain members (the review cycle), synchronizing mutual improvements (the improvement cycle), and synchronizing supply chain planning and execution (the exception cycle). The way to judge the act of decision synchronization can be based on the responsiveness of the chain members towards fulfilling customer demands and the effectiveness of joint decisions in enhancing supply chain profitability. Advanced technology such as a decision support system and virtual discussion forum can be used to implement decision synchronization effectively. For example, the use of an automated alert system in the exception cycle supports mutual response across the supply chain for satisfying customer demands.

Incentive alignment

Incentive alignment refers to the process of sharing costs, risks, and benefits amongst the participating members (Simatupang and Sridharan, 2002b). This scheme motivates the members to act in a manner consistent with the mutual strategic objectives such as making decisions that are optimal for the overall supply chain and revealing truthful private information. It covers calculating costs, risks, and benefits as well as formulating incentive schemes such as pay-for-performance (Simatupang and Sridharan, 2002a). The contribution of incentive alignment can be judged based on compensation fairness and accountability. Compensation fairness ensures that aligned incentives motivate the chain

members to share equitably loads and benefits that result from collaborative efforts. An effective incentive scheme means that the chain members are accountable for aligning individual decisions with the mutual objective of improving the total profits. Expert system, activity-based costing, and web-based technology can be used to trace, calculate, and display incentive scores (Simatupang and Sridharan, 2002a).

The three collaborative enablers can be used to measure the level of the best enabling practice. For example, real-time information sharing is expected to drive better performance than piecemeal information sharing. Since supply and demand conditions often change over time, the participating members need to assess the best practice of their collaborative enablers regularly. This necessity leads to the use of internal assessment of collaborative enablers and relating the assessment results to the performance gaps. The next section presents collaborative benchmarking that can be used by participating members to link the internal assessment of collaborative enablers to a benchmark database.

A conceptual framework for benchmarking collaboration

The participating members involved in supply chain collaboration are not interested only in measuring the status of their collaboration but also in how it can be improved. Benchmarking supply chain collaboration provides a means for them to measure and compare their collaborative efforts against best-in-class performers. This benchmarking process implies the presence of a collaborative process amongst participating companies. Therefore, collaborative benchmarking can be defined as the process of investigating the metrical gaps and associated collaborative enablers that drive performance excellence. This benchmarking is a kind of learning from others activity (Cox *et al.*, 1997; Garvin, 1993). The chain members look outside their practice to gain a new perspective from the best-in-class performers (Geary and Zonnenberg, 2000). To conduct collaborative benchmarking, the chain members need to carry out the collaborative audit that aims to describe the collaborative enablers and their contributions to produce superior results. Studying the best practices of collaborative enablers, rather than results only, provides the opportunity to uncover, analyze, and implement the best collaborative relationship.

A framework for collaborative benchmarking in the supply chain is shown in Figure 3. It contains three components: internal assessment report, collaborative performance system, and external benchmarking. There are four steps that need to be taken to integrate the three components of collaborative benchmarking. First, the chain members need to conduct an internal assessment to obtain clear understanding about the current collaborative enablers used by the participating members to drive their shared supply chain processes. The internal assessment report portrays the extent to which the participating members use the best-in-class practices of collaborative enablers. Second, the chain members need to monitor their collaborative performance system to assess the current level of collaborative performance. The current levels of performance metrics include operational scorecards (diagnostics metrics), improvement scorecards (concurrent metrics), and global scorecards (outcomes measures). Third, the chain members need to conduct external benchmarking to identify and reveal the current level of best-in-class performance. Fourth, the chain members need to analyze any gap between current performance and best-in-class performance in order to monitor and control the exception process at the exception cycle, drive ongoing improvement at the improvement cycle, and achieve alignment with collaborative strategic objectives at the review cycle.

Take in Figure 3

As depicted in Figure 3, the chain members conduct external benchmarking to obtain a benchmarking database collected from surveying customers, competitors, and world-class practices. Surveying customer wants and needs can provide up-to-date product data, quality expectations, competitive comparisons, insight into changing preferences, and immediate feedback about service and pattern of use. The chain members need this customer information at all levels from the executive suite to the retail floor because this information can be used to deduce target levels that need to be met by the chain members (Garvin, 1993). More ambitious targets can be set from benchmarking data that exist in

competitor supply chains. These data can be surveyed through the use of consultants. Moreover, the chain members can obtain data about competition requirements from respective trade associations. The ultimate performance target is based on best-in-class benchmarks. However, most of these data are available only inside private companies and access can be very costly. Chain members could employ third party services to conduct a world-class survey as well as to provide a critical analysis of their current supply chain performance.

The conceptual framework for collaborative benchmarking helps the chain members to choose the performance metrics which are most appropriate to the context of their collaborative arrangements. For example, the exception cycle promotes metrics that span cross-functional supply chain operations such as inventory-dollar-days and throughput-dollar-days (Goldratt *et al.*, 2000). Once participating members agree on appropriate performance metrics, they will be able to compare the current level of their collaborative performance with benchmarking data in order to identify any performance gaps at the three managerial levels. First, the review cycle adopts outcomes metrics that align with the mutual strategic objectives. In this way, the chain members are able to create integrated metrics rather than maintain functional-cost-oriented metrics that are often achieved at the expense of another member (Simatupang and Sridharan, 2002a). Second, the improvement cycle helps to focus on learning capability, such as responsiveness and flexibility, required to improve performance. Third, the exception cycle can be used to improve the execution level by adopting new operational metrics necessary to ensure rapid response to customer needs. Any performance gaps at these three managerial levels provide a list of improvement initiatives. Chain members deduce from the internal assessment report which will enable them to prioritize improvement initiatives on the list. Some thinking tools, such as thinking process (Goldratt, 1994), systems dynamics (Senge, 1990), and the causal model (Van Landeghem and Persoons, 2001), can be used to justify and select the most effective enablers to support improvement initiatives. In doing this, the participating members are able to translate initiatives into required enablers used to drive supply chain processes in achieving performance excellence.

The real value of collaborative benchmarking lies in addressing problems that prevent participating members from responding effectively to customer needs. Otherwise, collaborative benchmarking can fall into implementing best practices which are good only in the other supply chains' circumstances and thereby it fails to address actual problems inside the supply chain. Collaborative benchmarking therefore requires mutual inquiry and actions to find where performance gaps are and how they should be bridged or filled. The process of mutual inquiry is a way of providing significantly different perspectives to explore improvement ideas and create better practices that work for their supply chain's circumstances. In this sense, collaborative benchmarking not only identifies performance gaps relative to competitors but also encourages the chain members to find and solve core problems that inhibit them from improving the overall performance.

Goldratt (1994), for instance, provides a generic inquiry process that consists of identifying problems, finding effective solutions, and implementing the solutions. In this sense, a collaborative performance system can be seen as the way of implementing the proposed solution at the three learning loops. The exception cycle helps the members to concentrate on ways to improve rapid response to customer needs and wants. The improvement cycle enables the chain members to debate the current practice of the exception loop and define improvement levers that they should choose. The review cycle covers approaches on the appropriateness of improvement directions by asking, why this target and/or that lever. By combining these three learning cycles, the chain members will be able to focus improvement process and remove outdated policies and conflicting metrics that lead to counterproductive behavior.

Conclusion

This paper has provided an extension of the benchmarking scheme for supply chain collaboration that incorporates the collaborative performance system and collaborative enablers. The collaborative performance system has been proposed to outline interactions among performance metrics ranging from diagnostics metrics and concurrent metrics to outcomes metrics. These metrics are important to enable the chain members to evaluate

progress and measure the value of collaboration. The framework also provides the way to choose an appropriate set of metrics to guide decision-making and align metrics with mutual strategic objectives. It addresses primarily three important learning issues. First, the exception cycle aims to protect value creation for generating sales through mutual rapid response. Generic activities of this cycle include monitoring key events and operational scorecards, examining performance deviations, tracking problems and building alternative remedial actions, and notifying responsible parties to carry out remedial actions. Second, the improvement cycle assesses ongoing improvement levers. Third, the review cycle examines the changing competitive environment, the progress of achieving strategic objectives, and inter-organizational policies. The hierarchic evaluation of the three learning cycles brings opportunities to conduct global benchmarks for mutual improvement.

Collaborative enablers assist the chain members to examine the current enabling practices that drive performance metrics. There are three collaborative enablers proposed in this paper, namely decision synchronization, information sharing, and incentive alignment. The chain members use these three enablers to identify enabling practice deficiency and design new levels of enablers. Finally, collaborative benchmarking has been proposed to outline the mechanism of linking best enabling practices to the performance gaps. This benchmarking scheme helps the chain members to determine the levels of performance they plan to achieve and the means by which to achieve them. This benchmarking scheme serves to answer the question of how companies can move to more scientifically managed supply chain practices and to improved performance through assessing collaborative enabling practices, measuring competitors and best-in-class performers, and measuring customer expectations. Therefore, collaborative benchmarking addresses not only the questions “how do we compare to others?” but also that of “what areas need to be improved?”

Compared to the previous research in benchmarking that focused mainly on the intra-company level, this study promotes a benchmarking scheme at the inter-company level, which involves joint activities of the participating members in improving their supply

chain processes. The basic argument is that supply chain benchmarking should address the inter-company level activities that incorporate collaborative enablers and collaborative performance metrics in order to allow the chain members to achieve better supply chain performance as a whole. The contribution of this study thus could provide some very useful managerial insights into the evaluation and improvement of collaborative practices in the supply chain that involves more than one company. Other extensions to this study include elaborating the characteristics of enablers into a list of questions probing the use of collaborative enablers and conducting an empirical study to investigate collaborative practices and obtain more statistically valid results.

References

Abernathy, F.H., Dunlop, J.T, Hammond, J.H. and Weil, D. (2000), "Control your inventory in a world of lean retailing", *Harvard Business Review*, Vol. 78 No. 6, pp. 169-76.

Bogan, C. and Callahan, D. (2001), "Benchmarking in rapid time", *Industrial Management*, Vol. 43 No. 2, pp. 28-33.

Bowersox, D.J., Closs, D.J., Stank, T.P. and Keller, S.B. (2000), "How supply chain competency leads to business success", *Supply Chain Management Review*, Vol. 4 No. 4, pp. 70-7.

Boyson, S., Corsi, T.M., Dresner, M.E. and Harrington, L.H. (1999), *Logistics and the Extended Enterprise: Benchmarks and Best Practices for the Manufacturing Professional*, Wiley, New York.

Camp, R.C. (1995), *Business Process Benchmarking: Finding and Implementing Best Practices*, ASQC Quality Press, Milwaukee, WI.

Caplice, C. and Sheffi, Y. (1995), "A review and evaluation of logistics performance measurement systems", *International Journal of Logistics Management*, Vol. 6 No. 1, pp. 61-74.

Christopher, M. (1998), *Logistics and Supply Chain Management*, Financial Times Management, London.

Cox, J.R.W., Mann, L. and Samson, D. (1997), "Benchmarking as a mixed metaphor: disentangling assumptions of competition and collaboration", *Journal of Management Studies*, Vol. 34 No. 2, pp. 285-314.

Davies, A.J. and Kochhar, A.K. (2002), "Manufacturing best practice and performance studies: a critique", *International Journal of Operations & Production Management*, Vol. 22 No. 3, pp. 289-305.

Dell, M. and Fredman, C. (1999), *Direct from Dell*, Harper Collins Business, London.

Farris, M.T. and Hutchison, P.D. (2002), "Cash-to-cash: the new supply chain management metric", *International Journal of Physical Distribution & Logistics Management*, Vol. 32 No. 4, pp. 288-98.

Fisher, M.L. (1997), "What is the right supply chain for your product?", *Harvard Business Review*, Vol. 75 No. 2, pp. 105-16.

Garvin, D.A. (1993), "Building a learning organization", *Harvard Business Review*, Vol. 71 No. 4, pp. 78-81.
Geary, S. and Zonnenberg, J.P. (2000), "What it means to be best in class", *Supply Chain Management Review*, Vol. 4 No. 3, pp. 42-8.
Gilmour, P. (1999), "Benchmarking supply chain operations", *International Journal of Physical Distribution & Logistics Management*, Vol. 29 No. 4, pp. 283-90.
Goldratt, E.M. (1994), *It's Not Luck*, North River Press, Great Barrington, MA.
Goldratt, E.M., Schragenheim, E. and Ptak, C.A. (2000), *Necessary But Not Sufficient*, North River Press, Great Barrington, MA.
Gunasekaran, A. (2002), "Editorial: benchmarking in logistics", *Benchmarking: An International Journal*, Vol. 9 No. 4, pp. 324-5.
Gunasekaran, A., Patel, C. and Tirtiroglu, E. (2001), "Performance measures and metrics in a supply chain environment", *International Journal of Operations & Production Management*, Vol. 21 No. 1/2, pp. 71-87.
Hanman, S. (1997), "Benchmarking your firm's performance with best practice", *International Journal of Logistics Management*, Vol. 8 No. 2, pp. 1-18.
Holmberg, S. (2000), "A system perspective on supply chain measurements", *International Journal of Physical Distribution & Logistics Management*, Vol. 30 No. 10, pp. 847-68.
Horvath, L. (2001), "Collaboration: key to value creation in supply chain Management", *Supply Chain Management: An International Journal*, Vol. 6 No. 5, pp. 205-07.
Hyland, P. and Beckett, R. (2002), "Learning to compete: the value of internal benchmarking", *Benchmarking: An International Journal*, Vol. 9 No. 3, pp. 293-304.
Kaplan, R.S. and Cooper, R. (1997), *Cost and Effect*, Harvard Business School Press, Boston, MA.
Lambert, D.M. and Pohlen, T.L. (2001), "Supply chain metrics", *International Journal of Logistics Management*, Vol. 12 No. 1, pp. 1-19.
Lapide, L. (2000), "True measures of supply chain performance", *Supply Chain Management Review*, Vol. 4 No. 3, pp. 25-8.
McNair, C.J. and Leibfried, K.H.J. (1992), *Benchmarking: A Tool for Continuous Improvement*, Oliver Wight Publications, Essex Junction, VT.
Neely, A. and Al Najjar, M. (2002), "Linking financial performance to employee and customer satisfaction", in Neely, A. (Ed.), *Business Performance Measurement: Theory and Practice*, Cambridge University Press, Cambridge, pp. 295-303.
Parks, L. (2001), "Wal-Mart gets onboard early with collaborative planning", *Drug Store News*, Vol. 23 No. 2, p. 14.
Poirier, C.C. (1999), *Advanced Supply Chain Management*, Berret-Koehler, San Francisco.
Polese, W.T. (2002), "Measuring the success of collaboration across the virtual supply chain through performance measurement systems and benchmarking", *Supply Chain World Conference and Exposition*, April 23, New Orleans, LA.
Schneiderman, A.M. (1988), "Setting quality goals", *Quality Progress*, Vol. 21 No. 4, pp. 51-7.
Simatupang, T.M. and Sridharan, R. (2002a), "The collaborative supply chain", *International Journal of Logistics Management*, Vol. 13 No. 1, pp. 15-30.

Simatupang, T.M. and Sridharan, R. (2002b), "Supply chain discontent: sources and remedies", under review in *Supply Chain Management: An International Journal*.

Simatupang, T.M., Wright, A.C. and Sridharan, R. (2002), "The knowledge of coordination for supply chain integration", *Business Process Management Journal*, Vol. 8 No. 3, pp. 289-308.

Senge, P.M. (1990), *The Fifth Discipline*, Doubleday Currency, New York.

Spendolini, M.J. (1992), *The Benchmarking Book*, Amacom, New York.

Stewart, G. (1995), "Supply chain performance benchmarking study reveals keys to supply chain excellence", *Logistics Information Management*, Vol. 8 No. 2, pp. 38-44.

Stewart, G. (1997), "Supply-chain operations reference model (SCOR): the first cross-industry framework for integrated supply chain management", *Logistics Information Management*, Vol. 10 No. 2, pp. 62-7.

van Hoek, R.I. (1998), "Measuring the unmeasurable – measuring and improving performance in the supply chain", *Supply Chain Management: An International Journal*, Vol. 3 No. 4, pp. 187-92.

van Landeghem, R. and Persoons, K. (2001), "Benchmarking of logistical operations based on causal model", *International Journal of Operations & Production Management*, Vol. 21 No. 1/2, pp. 254-66.

Walker, W.T. (1999), "Use global performance measures to align the enterprise trading partners", in Anderson, D.L. (Ed.), *Achieving Supply Chain Excellence Through Technology*, Montgomery Research, San Francisco, CA.

Watson, G.H. (1993), *Strategic Benchmarking*, Wiley, New York.

Zairi, M. (1996), *Benchmarking for Best Practices*, Butterworth-Heinemann, Oxford.

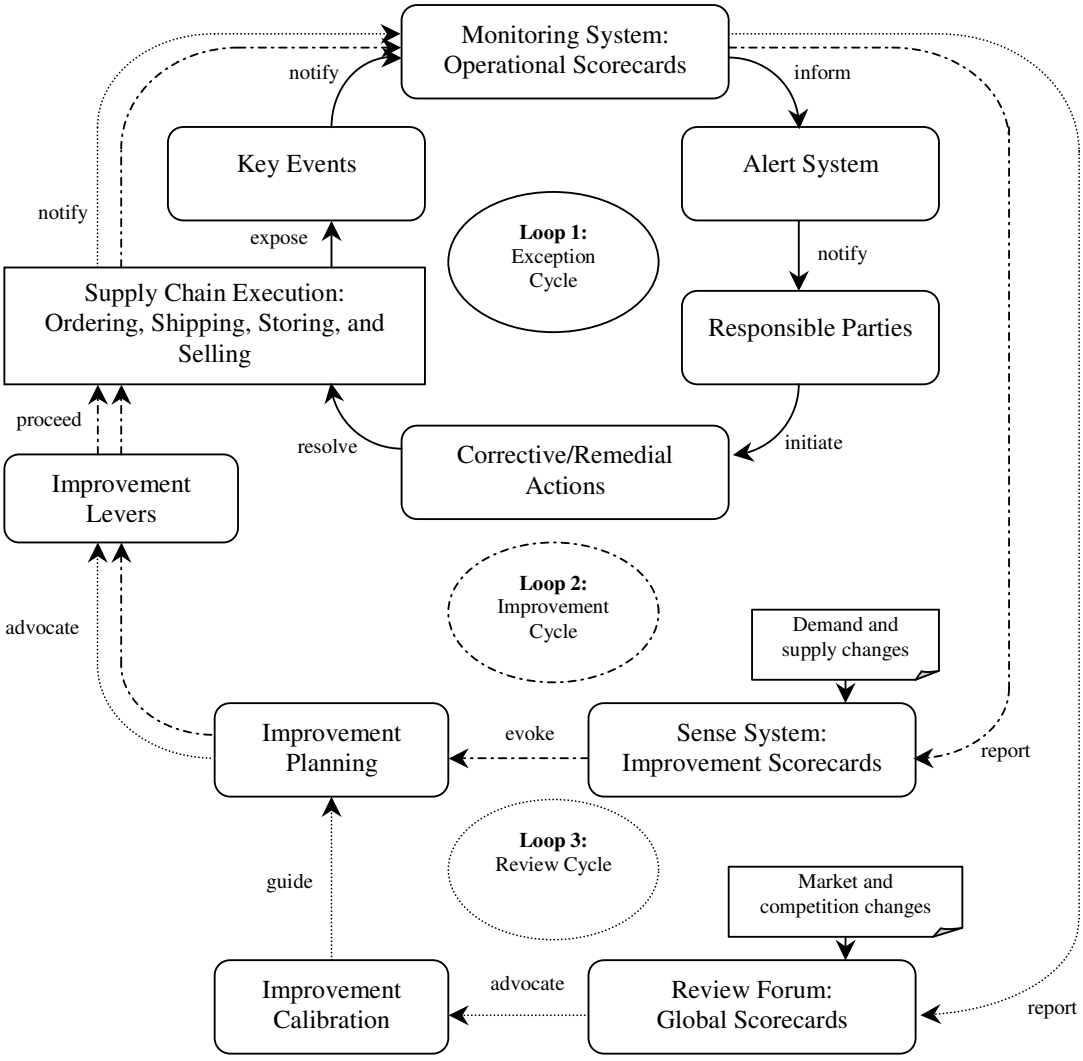

Figure 1. A conceptual model for collaborative performance system

Table 1. Characteristics of collaborative performance system

Attributes	Collaborative Learning		
	Loop 1: Exception Cycle	Loop 2: Improvement Cycle	Loop 3: Review Cycle
Aim	Controlling supply chain operations for ensuring value creation.	Accelerating the process of value creation.	Recalibrating the improvement target.
Definition	The shared process of mutual response to define and satisfy end customer needs and wants.	The shared process of carrying out ongoing improvement and directing the exception cycle.	The shared process of strategy making for guiding the improvement cycle.
Mechanism	Monitoring key events, diagnostics metrics, and buffer status at the critical points; using a root cause analysis to identify problems; and carrying out corrective actions.	Reflecting from the exception cycle; agreeing upon improvement levers (i.e. acquiring new capabilities); and measuring the impact of levers on concurrent metrics.	Reflecting from the improvement cycle; observing competition environment; monitoring outcomes metrics; and advocating performance target recalibration.
Rationale	Monitoring leading or diagnostics indicators about customer needs, demand changes, and supply disruptions provides anticipatory actions to protect profit.	Learning from the exception experience and focusing on collective improvement levers help in removing conflicting metrics and accelerating the improvement progress.	Recognizing the shift of competitive imperative and inertia especially obsolete policies would help in focusing on growth.
Advantage	Creating quick response before disruptions and unplanned events damage total profits.	Continuously redefining performance levers that positively impact supply chain performance and encouraging co-problem solving.	Identifying breakthrough improvement, removing outdated policies, and facilitating co-evaluation of the collaborative progress.
Actors	Intra-functional team and interface team.	Interface team and cross-company managers.	Cross-company managers and executives.
Typical metrics	Operational Scorecards: On-time delivery, product availability, inventory velocity, quality, customer satisfaction, throughput-dollar-days, inventory-dollar-days.	Improvement Scorecards (the half-life curve): Forecast accuracy, responsiveness (e.g., quoted lead times), flexibility, and cash-to-cash cycle.	Global Scorecards: Common (inter-company) scorecards and individual company scorecards such as growth, profits, sales, and inventory turns.
Primary references	Fisher (1997); Goldratt *et al.* (2000); Lapide (2000); Walker (1999)	Farris and Hutchison (2002); Fisher (1997); Garvin (1993); Lapide (2000)	Lambert and Pohlen (2001); Simatupang and Sridharan (2002a)

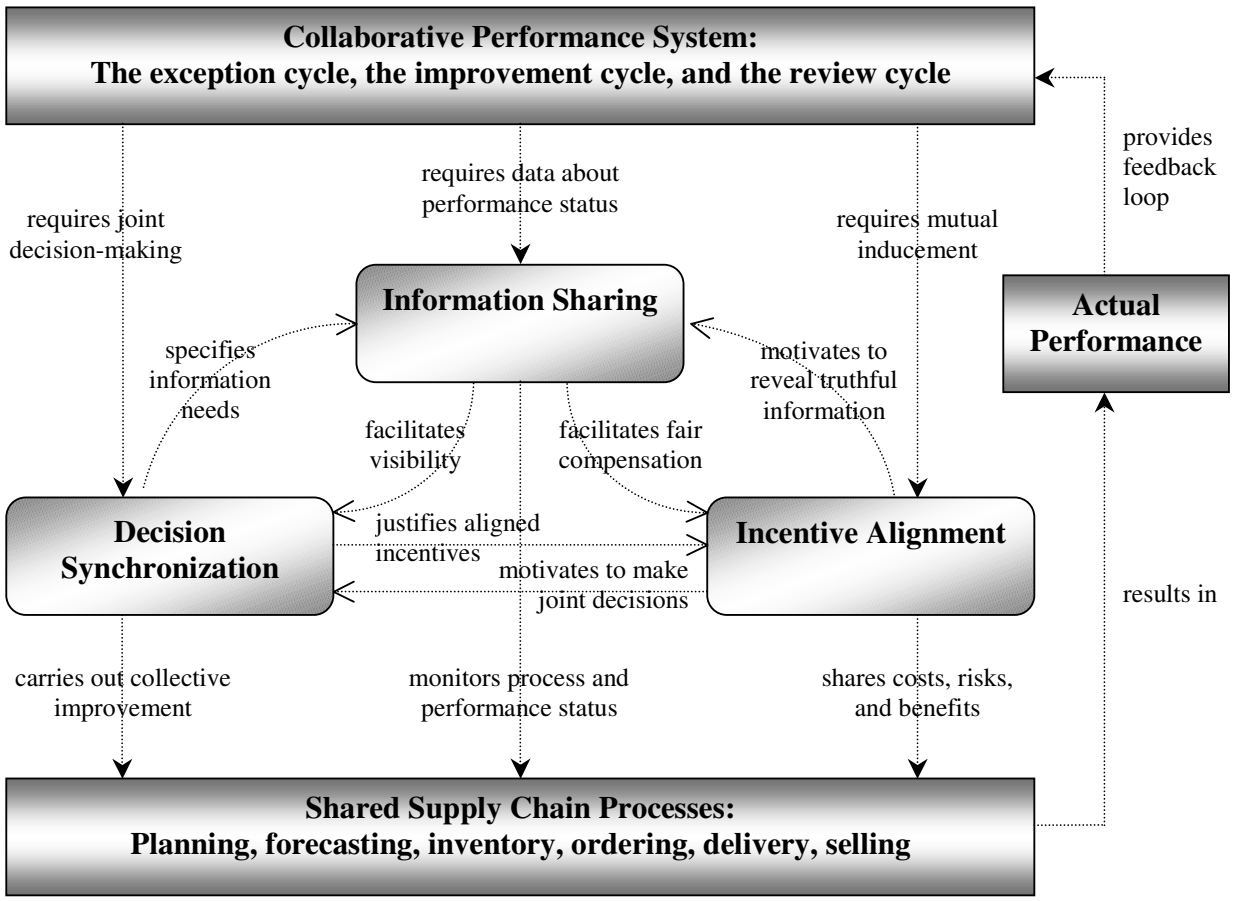

Figure 2. The framework for collaborative enablers

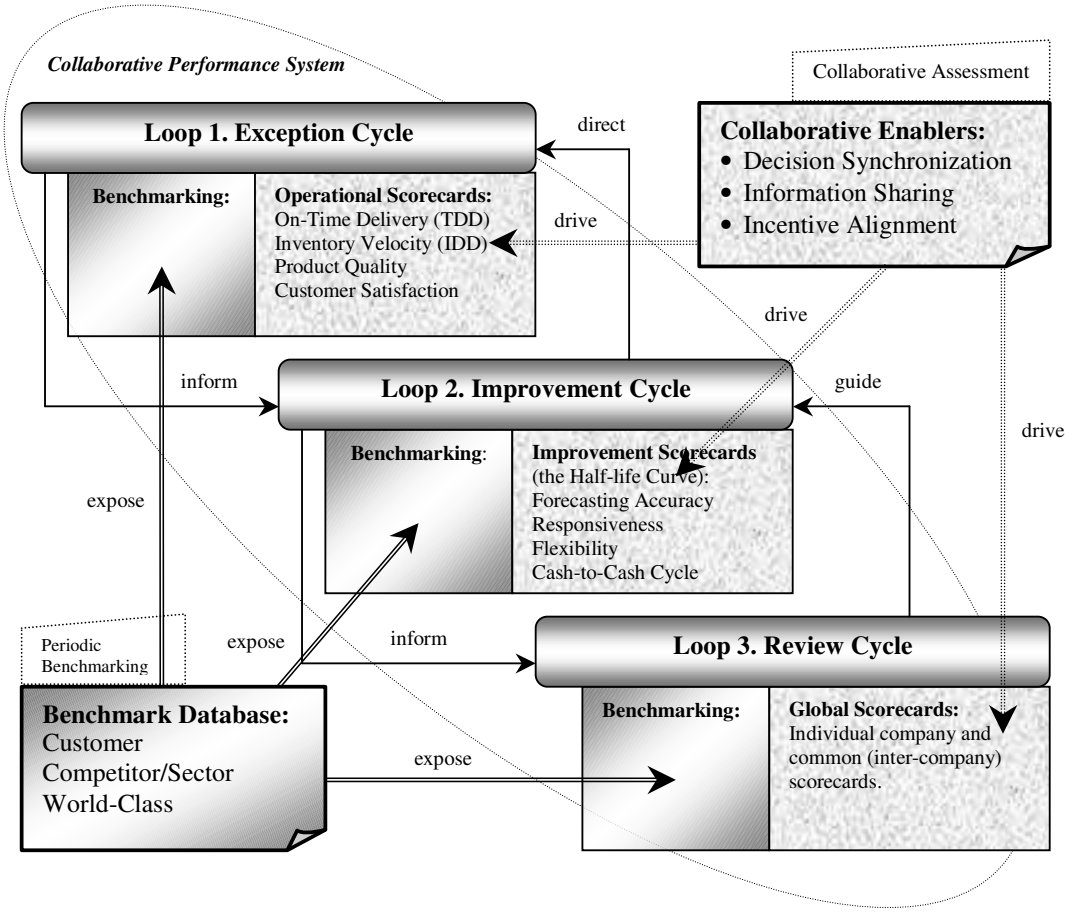

Figure 3. A conceptual framework for collaborative benchmarking