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A framework for evaluating supply chain performance

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A FRAMEWORK FOR EVALUATING SUPPLY CHAIN PERFORMANCE

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ABSTRACT

Managers require measures spanning multiple enterprises to increase supply chain competitiveness and to increase the value delivered to the end-customer. Despite the need for supply chain metrics, there is little evidence that any firms are successfully measuring and evaluating interfirm performance. Existing measures continue to capture intrafirm performance and focus on traditional measures. The lack of a framework to simultaneously measure and translate interfirm performance into value creation has largely contributed to this situation. This article presents a framework that overcomes these shortcomings by measuring performance across multiple firms and translating supply chain performance into shareholder value.

The ability to measure supply chain performance remains an elusive goal for managers in most companies. Few have implemented supply chain management or have visibility of performance across multiple companies (Supply Chain Solutions, 1998; Keebler et al. 1999; Simatupang and Sridharan, 2002). Supply chain management itself lacks a widely accepted definition (Akkermans, 1999), and many managers substitute the term for logistics or supplier management (Lambert and Pohlen, 2001). As a result, performance measurement tends to be functionally or internally focused and does not capture supply chain performance (Gilmour, 1999; *Supply Chain Management*, 2001). At best, existing measures only capture how immediate upstream suppliers and downstream customers drive performance within a single firm. Development of supply chain metrics measures requires extensive collaboration and trust between companies due to the sensitivity of the exchanged information (Kirby, 2003). In many instances, performance information is not exchanged or linked to the attainment of supply chain outcomes due to this sensitivity. Despite these obstacles, managers have continued to pursue performance measurement as a means to exert control or provide direction across the supply chain (Reese, 2001).

Effective management of the supply chain requires a framework capable of measuring the performance of multiple companies from source of supply to the final end user (Holmberg, 2000; Ramdas and Spekman, 2000; and *Supply Chain Management*, 2001). These measures enable managers to better evaluate which initiatives will be best for the overall corporation (Ellram and Liu 2002) and assess how each firm contributes to achieving supply chain objectives. However, managers lack an adequate framework for designing suitable metrics and developing incentives to align behavior (Narayanan and Raman, 2000). Most companies are only at the "tip of the iceberg" in terms of examining cost drivers, building cross-enterprise strategies, and sharing cost and performance results (Monczka and Morgan, 2000). Measures are required to obtain an understanding of how well the supply chain is performing and where to focus management attention to improve performance and plan competitive-enhancing efforts (Supply Chain Solutions, 1998; van Hoek, 1998; Lapide, 1999); Lummus and Vokurka; 1999; Reese, 2001; Stank, Keller, and Closs, 2001). Managers need measures that depict a cause-and-effect relationship between performance and strategic outcomes at the supply chain and corporate levels. The linkage between cause and effect enables the development of measures that align corporate and functional performance with the objectives for the supply chain (Walker, 1999).

The purpose here is to present a framework for evaluating supply chain performance. The framework provides a technique for evaluating how collaborative action drives shareholder value across multiple firms and for developing performance measures that are aligned with supply chain objectives. A combined economic value added (EVA®)[1] analysis is used to determine how supply chain collaboration simultaneously creates value in the supplier and customer firms. Activity-based costing (ABC) is employed to develop operational performance measures that are aligned with overall supply chain objectives and to translate nonfinancial into financial performance and shareholder value. The framework incorporates the results of several previous research efforts examining supply chain costing and performance including La Londe and Pohlen (1996), van Hoek (1998), Lambert and Pohlen (2001), Dekker and van Goor (2000), and Dekker (2003). The first section reviews the existing literature and what is needed to evaluate supply chain performance. In the second section, the framework is presented and applied to the supplier-customer interface within the supply chain. The article concludes with a summary of the framework, implications for supply chain managers, and potential directions for future research.

BACKGROUND

Despite widespread interest in measuring supply chain performance, a review of the existing literature reveals that only a limited amount of research has occurred on this topic. There is little consensus on how to measure supply chain performance or on what factors are needed for high performance (Ramdas and Spekman, 2000). Previous research has focused largely on single firm performance (*Supply Chain Management*, 2001; Dekker, 2003) and on categorizing existing measures and frameworks, analyzing their utility or effectiveness, and developing measures at the task or functional level (Neely, Gregory, and Platts, 1995; Otto and Kotzab, 2003). Several models for developing system-wide measures have been developed (Kaplan and Norton, 1996; Lambert and Pohlen, 2001; Supply Chain Council, 2003);

however, none provide a complete solution—a means for directly translating nonfinancial into financial performance, simultaneously measuring performance across multiple companies, and linking supply chain objectives with measures at the operational level. Supply chain managers are left without a roadmap to determine which measures are appropriate for particular circumstances and should be adopted. Existing performance measurement literature also falls short by not establishing a clear linkage between the determinants of performance and the resulting effect on customer and shareholder value in each of the firms comprising the supply chain (Lambert and Pohlen, 2001).

The Need for Supply Chain Performance Measures

Supply chain management requires performance measures that differ from those used by individual firms (Lambert and Pohlen, 2001). Suppliers and buyers are linked through a sequence of interdependent value-added activities resulting in a sale to the final consumer. Supply chain success depends on the performance of the extended enterprise rather than on the transactions occurring within a single firm (Ramdas and Spekman, 2000). As a result, managers need measures that indicate how the supply chain has performed collectively—not how individual members have performed—in meeting the expectations of the end user and maximizing supply chain profit (Supply Chain Solutions, 1998; Lambert and Pohlen, 2001; Reese, 2001; Simatupang and Sridharan, 2002). An overall view of performance is required for executives to extend their "line of sight" over activities not under their direct control (Lummus and Vokurka, 1999). They can use this visibility to identify where new opportunities may exist to obtain an incremental competitive advantage or to differentiate service offerings (Reese, 2001).

The complexity of the supply chain drives the need for a different set of measures (Beamon, 1999). Firms typically operate within multiple supply chains as well as multiple channels. Managers must understand these cause-and-effect relationships and what each channel or potential supply chain means from an economic standpoint: "the profits they deliver as well as the potential costs" (Supply Chain Solutions, 1998). Measures segmented by supplier or customer are needed to determine how the operational characteristics of customers, suppliers, and alternate distribution channels drive supply chain performance and corporate profitability. The complexity problem is further exacerbated by the large number of related and interdependent activities with the effects of certain actions separated from their cause both in time and place. This complex network of interrelated activities makes it difficult for managers to describe and depict how activity performance is related and influences one another (Holmberg, 2000).

This insight cannot be obtained through a single internal measure or a standard set of prescribed measures (Fisher, 1997; Van Donselaar, Kooke, and Allessie, 1998). Performance measures must reflect the organization's goals while considering the integration of inter- and intra-functional process activities (Sherman, 1992). Goals and measures will vary based on how processes are performed and the collective goals of the trading partners. Fisher (1997) argues that the recipe for success will vary by product and type of supply chain (Ramdas and Spekman, 2000). Functional products with predictable demand and lower margins will require physically efficient supply chains to reduce total costs. Innovative products with

unpredictable demand and high margins will require responsible supply chains to respond quickly to changes in consumer purchasing behavior. Managers cannot use the same metrics in these scenarios. They must develop measures and evaluate performance based on the type of product and supply chain employed.

Measures are also needed to effectively keep the trading partners' performance aligned with the goals of the supply chain (Walker, 1999). Managers within each firm must align their actions, strategies, and measurements with those of the supply chain (Tan, Kannan, and Handfield, 1999). The exchange of performance information greatly diminishes opportunistic behavior by a single trading partner. Managers must not only understand their activities and costs but also those of their suppliers and customers as well "...so all efforts can be synchronized and optimized to deliver the greatest impact at the end of the supply chain—that is, the greatest value to the final customer. Ultimately, that's the only way for business organizations to create lasting value for their own organizations as well" (*Supply Chain Solutions*, 1998).

Lack of Supply Chain Measures

Despite the apparent need for supply chain performance measures, little evidence exists to indicate that any measures actually exist for an entire supply chain (Lee and Billington, 1992; Levy et al., 1995; Lambert and Pohlen, 2001; Simatupang and Sridharan, 2002, Dekker and van Goor, 2003). The measures applied to supply chain management are frequently oversimplified and counterproductive by focusing strictly on cost reduction rather than on maximizing value to the end user (Simatupang and Sridharan, 2002). In many instances, the measures identified as supply chain metrics are measures of internal logistics operations as opposed to measures of supply chain performance (Gilmour, 1999; Keebler et al., 1999; Lambert and Pohlen, 2001). For many firms the only way they know whether they are meeting their supply chain goals "...is after the fact, by diagnosing poor financial results or when they lose an important customer..." (Lapide, 1999).

Most performance measures are internally and functionally focused (Dekker, 2003). Individuals tend to drive toward improving their own area's performance, often in a direction that runs counter to increasing the efficiency of the total supply chain (Lapide, 1999). Too many firms rely on only internal performance measures and are out of synch with what their customers truly want (Kallio et al., 2000). What are often identified as supply chain measures tend to focus on isolated companies rather than on processes spanning the supply chain. The Supply Chain Operations Reference (SCOR) model represents an inter-industry attempt to identify boundary spanning processes and measures (Supply Chain Council, 2003). The processes within the SCOR model—plan, make, buy, delivery, and return—do span firm boundaries. However, the measures are internally focused and taken from the perspective of an individual firm rather than measuring performance across multiple firms or the overall supply chain.

Traditional measures that rely heavily on financial performance comprise the key measures used in a majority of firms (Walters, 1999). Considerable criticism has focused on traditional systems due to their almost exclusive focus on financial measures and failing to measure and monitor multiple dimensions of performance (Brignall and Ballantine, 1996). Financial measures are lagging indicators that offer a narrow and incomplete picture of business performance.

These measures are the result of management action and not the cause of it. They do not provide sufficient insight into what drives customer satisfaction and the creation of future business value (Hasan and Tibbits, 2000). Due to these shortcomings, approaches such as the balanced scorecard (BSC) have emerged to incorporate non-financial performance measures and to view performance from multiple perspectives— learning and growth, customer, financial, internal business process (Kaplan and Norton, 1996). Although the BSC can be applied to inter-enterprise processes (Brewer and Speh, 2000), it does not provide a framework for developing performance measures for interdependent activities or linking corporate with supply chain performance.

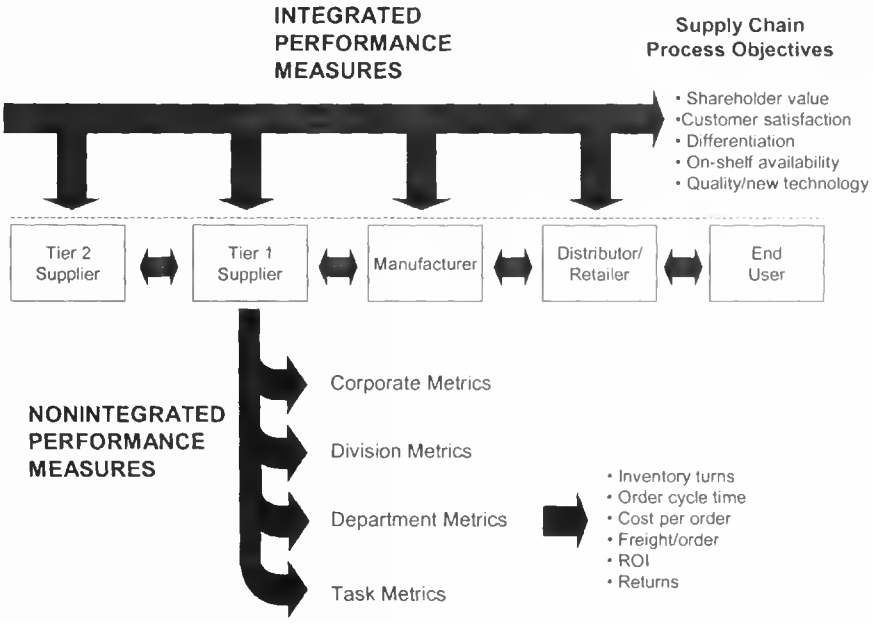
What Is Needed

Based on a review of the literature, a framework is needed for consistently developing supply chain performance measures that can be replicated between firms. The process would lead managers to the most appropriate set of measures based on their supply chain and corporate strategies. The framework would not prescribe a set of measures that each firm should track, since different strategies and participation in multiple supply chains would require a different set of metrics to guide performance toward the accomplishment of strategic objectives.

The framework should establish a hierarchy of measures, extending from the supply chain process level to activity levels within the functional areas of each firm. The hierarchical linkage ensures the alignment of performance measures within and across multiple firms. The hierarchy of measures enables broad strategic process measures to be translated into precise measures that can be used to evaluate individual performance at the task level. Managers can use this linkage to determine how each firm contributes to and affects the supply chain metrics. Supply chain measures additionally need to be translatable into shareholder value, the ultimate corporate measure, within each firm. The framework must provide managers with the capability to show how internal actions affect shareholder value for the corporation. The framework of measures must be able to demonstrate how each firm contributes to value proposition viewed from the consumer's perspective. Finally, the measures must be capable of portraying how each company's performance affects shareholder value of the other firms within the supply chain.

A combination of integrated and nonintegrated measures (Figure 1) is necessary for measuring cross-organizational interfaces within the supply chain (van Hoek, 1998). As firms share information, exchange knowledge, and integrate their processes, it will become extremely difficult to measure performance internally (Lee, 2000). Integrated measures provide the capability to measure performance across the firms comprising the supply chain while nonintegrated measures enable managers to determine the performance within individual firms. The combination of integrated and nonintegrated measures provides the capability to quantify the impact of each firm's decisions/actions on the overall success of the supply chain. Once the performance measures are established, managers can intelligently determine the most cost effective levers across the supply chain for achieving a desired service level (*Performance Measurement*, 1994). In some instances, the measures may appear similar. Firms may continue to capture information on on-time delivery, returns, or perfect

FIGURE 1
RELATIONSHIP OF INTEGRATED AND
NONINTEGRATED PERFORMANCE MEASURES IN THE SUPPLY CHAIN



orders, but the focus shifts to how the entire supply chain has performed (Reese, 2001).

Framework

Measurement of interfirm performance is much more complex than measuring the performance within a single firm. However, managers can develop measures that align the performance of individual trading partners with the objectives of the overall supply chain. The framework proposed here employs a combined economic value added (EVA) model and activity-based costing (ABC) to measure supply chain performance. A combined supplier-customer EVA analysis enables managers to evaluate the factors driving value in each firm and to determine how collaborative action leads to the attainment of supply chain outcomes. ABC is used to examine the interdependence of supply chain activities and to quantify performance into specific activity costs and measures. The use of EVA and ABC enables management to use the cost and value driver information to optimize and better coordinate the performance of activities across the entire supply chain (Porter, 1985; Dekker 2003).

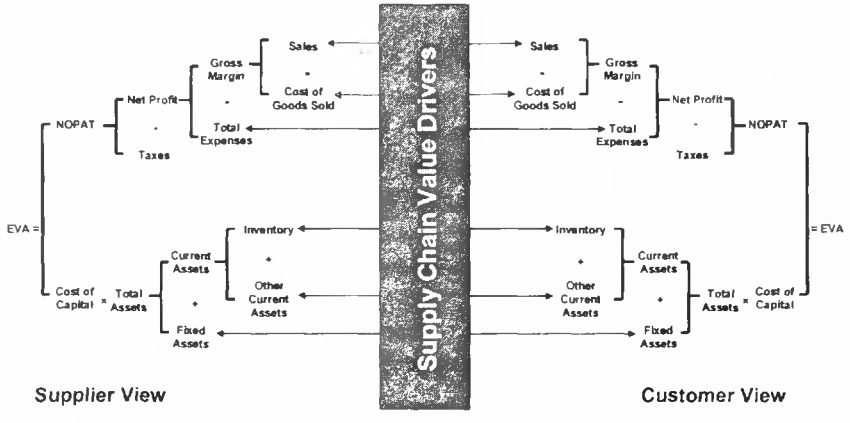
Combined Value Analysis of the Supplier-Customer Interface

The supplier-customer interface incorporates multiple supply chain processes (Croxton, et al., 2002), and the interface can be used to demonstrate the outcomes resulting from collaborative action in the supply chain (Lambert and Pohlen, 2001). From the supplier's perspective, the processes span-

ning this interface define the structure for interacting with the customer. Through these processes, the supplier attempts to manage the relationship with the customer to improve performance, reduce operating expenses, and increase profitability. The downstream customer is simultaneously attempting to manage its relationship with the supplier, and the customer's perspective of these boundary spanning processes can be viewed as a mirror image of the supplier's perspective. The customer manages these processes to strengthen relationships with its suppliers and to efficiently manage the inbound flow of materials.

A combined EVA-based analysis of the value created at the supplier-customer interface (Figure 2) provides the capability to simultaneously evaluate the effect of the relationship from both perspectives. Supply chain management does more than just reduce cost, it creates value for the company, its supply chain partners, and its shareholders (Lee, 2000). The application of a value-based approach moves away from a strict cost-based analysis to considering any effects on revenue, cost of goods sold (COGS), expenses, current assets, and fixed assets. An EVA-based approach provides the linkage between process performance and the end results reflected in shareholder value. This linkage is important in determining what a strategy will contribute and which of several possible strategies is most likely to be successful (Monczka and Morgan, 2000). A combined EVA analysis extends the analysis by identifying how process changes will drive shareholder value within the supplier's firm and simultaneously tracing the effect to shareholder value within the customer's firm. As a result, management can obtain a complete depiction of how value is created, where to deploy capital to increase value creation, and where any resulting benefits and burdens will occur.

FIGURE 2
COMBINED EVA ANALYSIS OF THE SUPPLIER-CUSTOMER INTERFACE



Adapted from Stern, Joel M. and John S. Shiely with Irwin Ross, *The EVA Challenge*, New York: John Wiley & Sons, Inc., 2001, Figure 7.2, p. 120 and Pohlen, Terrance L. and Thomas J. Goldsby, "VMI and SMI Programs: How Economic Value Added Can Help Sell the Change," *International Journal of Physical Distribution and Logistics Management*, forthcoming.

An EVA-based analysis from the supplier's viewpoint demonstrates the value created through the relationship with the customer (Table 1). Key value drivers affect each of the major components of the EVA calculation. Revenue drivers indicate how process changes occurring within the relationship affect the revenues generated with this customer. Revenue drivers that will improve value for the supplier include increased sales volume, larger share of customer purchases, retention of customer sales, sale of higher margin products, and a more profitable mix of products and services. COGS value drivers include material cost reductions and improved manufacturing productivity resulting from

TABLE 1
COMBINED EVA ANALYSIS FROM THE SUPPLIER'S PERSPECTIVE

EVA Component:	Effect on EVA	Value Drivers:
Sales	⬆	Increase sales volume Increase end-user satisfaction Obtain larger share of customer purchases Gain access to new markets Gain access to customer technology Sell more profitable mix of products and services Reduce retailer stockouts Retain customer sales
Cost of Goods Sold	⬇	Improve operations productivity Reduce product development costs Improve product quality Integrate plans and schedules with customer
Expenses	⬇	Align services with cost to serve Manage planning, production, and shipment Eliminate product returns Reduce sales and target marketing expenses Optimize logistics network Increase freight consolidation
Inventory	⬇	Reduce inventory investment Reduce cycle times Integrate customer demand information Reduce or eliminate demand variability
Other Current Assets	⬇	Improve cash flow
Fixed Assets	⬇	Improve plant and equipment utilization Increase other asset utilization

Adapted from Rappaport (2001).

more accurate demand management and by the supplier exchanging information with its upstream suppliers. The expense value drivers include the cost-to-serve a specific customer and reflects the many cost trade-offs occurring at the supplier-customer interface. For example, reconfiguring the order fulfillment process could result in the supplier experiencing higher costs due to the holding of more inventory and shipping more frequently. However, retailer use of electronic data interchange (EDI) could simultaneously result in fewer sales calls, lower order processing costs, and increased freight consolidation. The expense value drivers would capture the costs of these process changes from the supplier's viewpoint. Expense value drivers include costs such as information technology, inventory management, forecasting, sales, promotions, warehousing, transportation, and order fulfillment.

Asset utilization may improve due to process improvements occurring within the supplier-customer relationship and can be demon-

TABLE 2
COMBINED EVA ANALYSIS FROM THE CUSTOMER'S PERSPECTIVE

EVA Component:	Effect on EVA	Value Drivers:
Sales	⬆	Increase sales through lower prices Increase sales volume (higher on-shelf availability) Generate additional sales through new products Introduction of new technology
Cost of Goods Sold	⬇	Improve manufacturing processes and productivity Improve product quality
Expenses	⬇	Improve order tracking and tracing Reduce product development costs Leverage new or alternative distribution channels Reduce lead times Eliminate forecasting and source development costs Reduce in-bound freight and distribution costs
Inventory	⬇	Reduce purchased goods inventories Reduce inventory investment Reduce cycle times
Other Current Assets	⬇	Reduce working capital
Fixed Assets	⬇	Improve equipment and plant utilization Increase other asset utilization

Adapted from Rappaport (2001)

strated by value drivers. The supplier may experience reductions in inventory as the exchange of point-of-sale data or other collaborative efforts provide more accurate demand information resulting in improved forecasts, smoothed production, reduced safety stock, and lowered finished goods inventory. Current assets may be affected through a reduction in accounts receivable due to the customer agreeing to pay in less time and by electronic funds transfer. Value drivers for fixed assets are affected and include improved capital investment and increased plant and equipment utilization resulting from better information exchange and collaborative planning with the customer.

An EVA analysis looking upstream at the supplier-customer interface provides the mirror image of how collaborative action within the supply chain drives shareholder value for the customer (Table 2). Revenue value drivers include increased sales generated by lower prices, increased availability, introducing new technology, co-development of new products with the supplier, and improved customer service. In some instances, gross revenue may remain constant, but cost reductions will generate an increase in net margins for the customer. Revenue and profitability may increase as the customer allocates more shelf space or production to faster moving and higher margin products. Price reductions represent a potential value driver for the COGS component as the supplier passes along a lower price reflecting the reduced costs of doing business with the customer. Expense value drivers for the customer also reflect several potential cost trade-offs. The customer may order and receive product more frequently. However, storage, order placement, and inspection costs may decrease. Value drivers for current assets will reflect changes in inventory levels resulting from the supplier assuming greater responsibility for inventory management and continuously replenishing the customer. The customer may have the opportunity to rationalize its asset base by eliminating distribution centers and improved utilization of retail space.

The use of a combined EVA analysis enables management to obtain a complete assessment by incorporating all of the components of the shareholder value equation. From the supplier's perspective, the combined analysis identifies the value attained by conducting business with a specific customer. The combined analysis provides a complete picture by including only the revenues generated in the relationship, the costs directly attributable to conducting business with the customer, and any directly traceable asset charges including inventory carrying costs, accounts receivable, and equipment utilization. The supplier can benchmark the value achieved by working with a specific customer to the value obtained by selling to other customers using different supply chain strategies. The combined analysis provides a similar capability for the customer. The customer can identify the revenue generated from selling the supplier's products, the cost of doing business with the supplier, and charges for asset use. The combined EVA analysis enables managers to evaluate how their performance will drive changes in shareholder value simultaneously in both firms.

Managers can apply the combined EVA analysis even when one of the supplier or customer firms does not currently use profitability or value analysis. In these instances, management can usually estimate with a reasonable degree of accuracy the sales, expenses, costs, and assets employed by the other firm. Even though this approach

may be too rough to give exact calculations of changes, it does provide useful indications of expected changes in the EVA calculation. This approach is similar to the use of T-accounts proposed by Narus and Anderson (1996), but it provides a more complete depiction by focusing on shareholder value. A combined EVA analysis can then be used to demonstrate how changes in the value drivers will affect value creation in the other firm. This approach proves especially useful when attempting to sell process changes to managers in the firm currently lacking this information. Without the analysis, management tends to focus strictly on the added costs and investment and may perceive an inequitable distribution of resulting benefits and burdens between the supplier and customer. However, a combined EVA analysis expands the discussion to include revenue and asset value drivers such as inventory carrying costs. In many instances, actions that would increase sales and reduce costs for one of the firms will create additional value in the other firm as well.

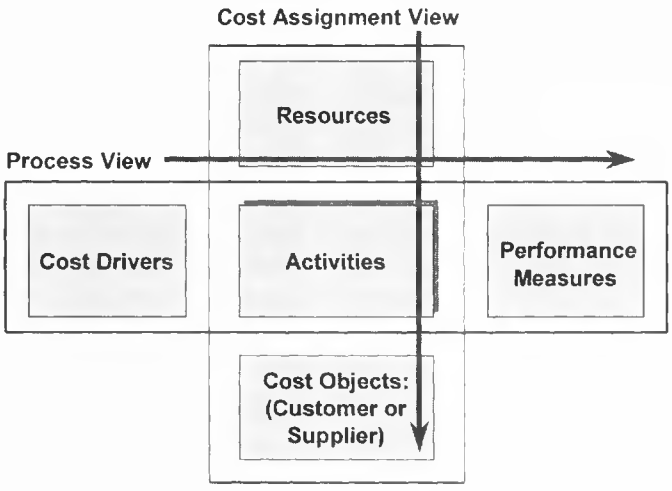
The combined EVA analysis identifies the key levers driving value creation in the supplier and customer firms; however, it does not go far enough. The analysis does not provide the capability to determine the specific costs associated with any proposed or actual actions. The capability to translate the supply chain into performance measures is needed to align behavior at the task and activity levels within each firm. The measures must establish a clear cause and effect linkage from individual performance to the levers that create value at the interfirm level. The application of activity-based costing (ABC) provides the capability to develop performance measures at the activity level and to determine the activity costs (La Londe and Pohlen, 1996; Dekker and van Goor, 2000).

Developing and Costing Performance Measures

ABC is a technique for assigning the direct and indirect resources of a firm to the activities consuming the resources and subsequently tracing the cost of performing these activities to the products, customers, or supply chains consuming the activities (La Londe and Pohlen, 1996). An activity-based approach increases costing accuracy by using multiple drivers to assign costs whereas traditional cost accounting frequently relies on a very limited number of allocation bases. The use of multiple drivers recognizes different relationships between activity performance and resource consumption and is especially important when tracing the consumption of indirect resources where resource consumption does not follow traditional allocation basis such as per labor hour or sales dollar. The assignment of cost based on activity consumption enables product, customer, or supply chain profitability analyses.

ABC provides both a financial and performance view of the activities comprising the supply chain processes at the supplier-customer interface (Figure 3). The processes affected by changes in the value drivers can be mapped to determine the activities within each process. Once these activities are defined, the vertical, or cost view, of ABC can be used to assign the cost of the resources consumed to each of these activities, and the activity costs can be assigned to the specific customer or supplier based on the cost per unit of activity and actual usage. The horizontal, or process, view is used to develop measures for each activity to achieve a desired level of performance. Measures may be expressed in terms such as cost, time, quality, or productivity. The cost drivers are the factors affecting performance and

FIGURE 3
THE COST AND PROCESS VIEW OF ACTIVITY-BASED COSTING[1]



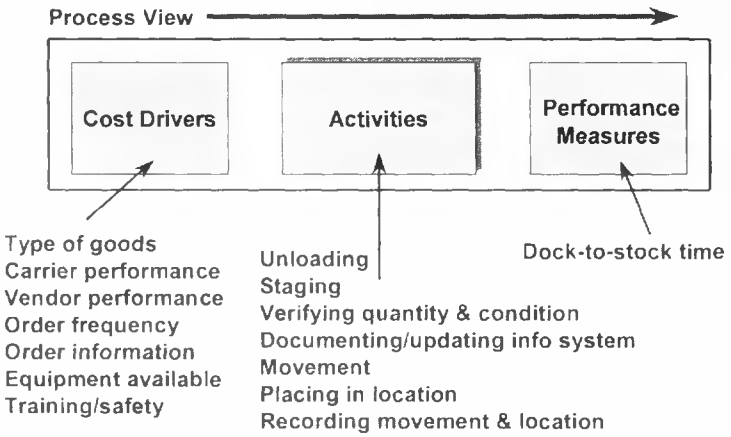
[1]Adapted from Turney, 1991.

causing costs to be incurred at the activity level.

This activity-based information provides the foundation for performing a value chain analysis of the processes spanning the supplier-customer interface. The value chain is decomposed into strategically relevant activities, and costs, revenues and assets are assigned to these activities (Dekker, 2003). Management can use the horizontal view to analyze the behavior of the activities, how they consume resources, and whether they produce a source of differentiation. When extended across multiple firms, insight is gained regarding how supplier-customer activities are interrelated. Supply chain improvements can be viewed in the context of changes at the process and activity level. For example, order cycle time may be a key value driver to the end-user and a potential source of competitive advantage. Order cycle time can be measured as an integrated supply chain process measure and can be decomposed into the activities spanning the supplier-customer interface to create non-integrated performance measures at the activity and task levels. Part of the order cycle time will be the time required for the customer to receive, put away, and make the inventory available for order release—the dock-to-stock time. The customer's perspective of the overall dock-to-stock process is shown in Figure 4.

Management can use this analysis to develop performance measures to determine the existing resource (cost) and time requirements in the customer firm. The integrated supply chain measure of order cycle time is translated into a non-integrated performance measure at the operational level—dock-to-stock time. This measure can further be decomposed into activity and task measures

FIGURE 4
USING THE HORIZONTAL VIEW OF ABC TO DEVELOP PERFORMANCE AND TO IDENTIFY OPPORTUNITIES TO REDUCE COSTS AND IMPROVE PERFORMANCE

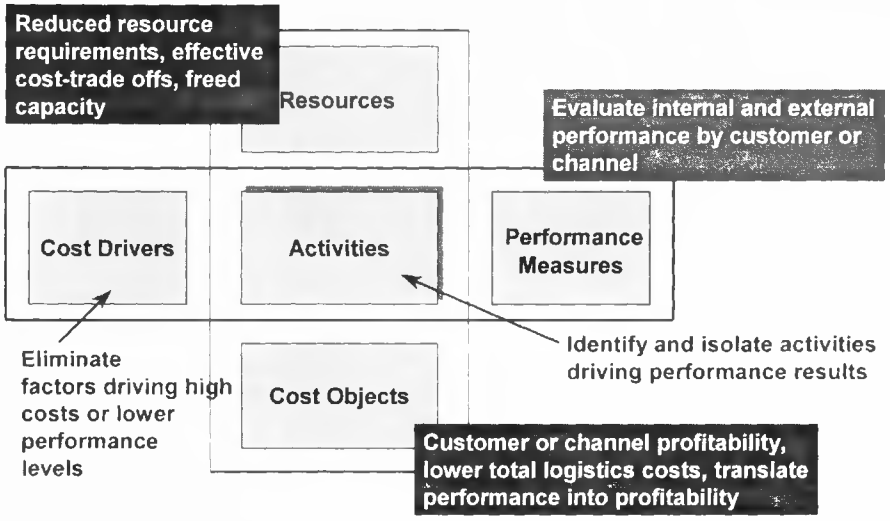


within the warehouse such as the time and cost to unload a truck, stage and inspect the order, and put-away. ABC can be used to assign the resources consumed by each of the activities in the customer firm based on the consumption of warehouse labor, equipment, and supplies.

The performance and cost of these activities are influenced by several cost drivers. The supplier influences several cost drivers based on the accuracy and timeliness of information. These drivers affect the scheduling of the warehouse labor and the cost of processing errors. More frequent deliveries by the supplier may reduce the customer's inventory carrying costs, but receiving costs may increase. The carrier drives cost and performance through on-time arrival rates, damage, and type of equipment. These affect the customer's labor, equipment, facility, and administrative costs and performance. Management actions by the customer also drive cost and performance at the activity level. The level of training and safety awareness, maintenance of equipment, availability of the proper equipment, and facility constraints will affect the level of resources consumed and asset productivity.

The outcomes obtained from this analysis can be used to reconfigure the process and improve cost control resulting in reduced order cycle time and possibly a sustainable competitive advantage (Figure 5). For example, EDI could be used to eliminate the cost drivers associated with vendor performance and order accuracy. The supplier's use of EDI and providing advanced ship notices to the customer could reduce the customer's receiving and administrative costs through better scheduling, reduced paperwork, and the elimination of claims. ABC traces the effect of these changes on customer cost and profitability. Improved performance results in decreased activity costs. The lower activity

FIGURE 5
TRANSLATING THE EFFECT OF MANAGEMENT ACTION
TO FINANCIAL AND NONFINANCIAL PERFORMANCE USING ABC



costs can be traced to a reduction in resource requirements that can be eliminated or freed-up for other uses. The customer's ABC analysis reflects the reduced costs of doing business with this supplier. Incorporating these results into the combined EVA analysis would demonstrate the value created in both firms through a reduction in order cycle time. Other benefits resulting from a reduced order cycle time would also have to be included in the combined EVA analysis. By better satisfying the customers' needs through a reduction in order cycle time, increased sales and lower inventory levels should accrue to both the supplier and customer firms.

An extension to the combined EVA analysis can be used to demonstrate the linkage from integrated supply chain performance measures to the nonintegrated operational performance measures within a single firm. The extended EVA analysis provides the necessary linkage to align activity performance with shareholder value objectives (Tables 3 and 4). Collaborative action triggers multiple value drivers: reduced inventory investment, improved product quality, faster deployment of new technology, and increased sales volume. Directional changes in the value drivers represent the outcomes of specific activities occurring within the functional areas of the firm. Management can develop measures at the operational level that align the behavior of each activity with the value drivers. The value driver "reduction in order cycle time" would be linked to performance measures such as dock-to-stock time, number of trucks/pallets/cases received per day, put-away time, and inventory accuracy. These measures focus on aligning individual behavior with the performance necessary to achieve the desired outcome reflected in the value

driver. The linkage establishes a cause and effect relationship between the performance of the individual receiving and putting away the order and shareholder value. The relationship fosters the individual's understanding of how they contribute to customer service and the organization's overall performance.

The EVA analysis identifies how collaborative action improves shareholder value in each firm—and when extended across multiple firms, the entire supply chain—by leveraging specific value drivers. The analysis can be accomplished initially across the supplier-customer interface to improve performance and align behavior. Once accomplished, the combined analysis can be expanded across multiple relationships. A combined EVA analysis of a tier one supplier-manufacturer-distributor relationship could be evaluated simultaneously to evaluate alternative go-to-market strategies, identify additional opportunities to differentiate services and lower costs, consider alternative channel structures, and to determine the combination of firms that will produce the maximum value for the end user.

CONCLUSIONS AND SUMMARY

The framework provided in this paper overcomes the shortcomings identified in previous research for measuring and evaluating supply chain performance. The combined EVA analysis provides an understanding of the interdependence between activities at the supplier-customer interface and how reconfiguring supply chain processes simultaneously affects key value drivers in both firms. The linkage of supply chain objectives with value drivers enables managers to develop integrated, interfirm performance measures that align the behavior of trading partners with goals of the enterprise-wide supply chain. Managers can answer questions regarding where performance must improve and how improved performance will lead to increases in shareholder value across the supply chain. The ability to measure and communicate value creation enables managers to effectively "sell" their strategy to reluctant trading partners.

ABC provides the mechanism for developing nonintegrated, intrafirm performance measures that are aligned with supply chain objectives. Processes are disaggregated into the interdependent activities where cost and performance data can be determined. The disaggregation of processes provides a detailed understanding of how process activities are performed, the resources consumed, and what drives performance and cost. This information can build stronger interfim relationships. Each firm understands the other's intentions, needs, and processes. As the consequences of changes in supply chain operations and outcomes become transparent, managers perceive less risk of ending up with negative outcomes or of opportunistic behavior by the other firm. And lastly, the analysis may lead to fresh ideas for improving the supply chain, obtaining a sustainable competitive advantage, and producing additional increases in value.

Management Implications

The information obtained through this framework poses several implications for managers across the supply chain. The information requirement may pose a "barrier to entry" to some firms. Management will need to upgrade their cost management and performance measurement systems to participate in supply chains where the framework, or a similar approach, has been adopted. Without this information, management cannot demonstrate the value they

TABLE 3
DEVELOPING VALUE-BASED PERFORMANCE MEASURES FOR THE SUPPLIER

EVA Component:	Effect on EVA	Value Drivers:	Performance Measures
Sales	⬆	• Increase sales volume • Increase end-user satisfaction • Obtain larger share of customer purchases • Gain access to new markets • Gain access to customer technology • Sell more profitable mix of products and services • Reduce retailer stockouts • Retain customer sales	• Sales volume; revenues by customer • Percent increase sales volume with customer • Cost to serve customer or customer profitability • Percent sales increase on new versus existing products • On-shelf availability; fill rates • Percent sales to existing customers; churn rate • Sales generated from new markets
Cost of Goods Sold	⬇	• Improve operations productivity • Reduce product development costs • Improve product quality • Integrate plans and schedules with customer	• Plant productivity measures • Raw material or component prices • Product returns • Six sigma process measures • Reduction in purchase price of raw materials or components
Expenses	⬇	• Align services with cost to serve • Manage planning, production, and shipment • Eliminate product returns • Reduce sales and target marketing expenses • Optimize logistics network • Increase freight consolidation	• Forecast accuracy; forecasting cost • Inventory turns; inventory management cost • Cost per order; cost to serve; perfect orders • Reduced cost to serve; reduced sales calls • Order fulfillment and inventory costs • Transportation and distribution costs; full truckload shipments • Reduce sales, general, and administrative expenses
Inventory	⬇	• Reduce inventory investment • Reduce cycle times • Integrate customer demand information • Reduce or eliminate demand variability	• Inventory turns; inventory carrying costs • Order cycle time • Reduction in safety stock • Eliminate/reduce excess and obsolete inventory
Other Current Assets	⬇	• Reduce working capital	• Cash-to-cash cycle; days accounts receivable • Working capital investment • Reduce accounts receivable
Fixed Assets	⬇	• Improve plant and equipment utilization • Increase other asset utilization	• Return on investment; reduction in fixed assets • Utilization rate; throughput time; percent idle time

TABLE 4
DEVELOPING VALUE-BASED PERFORMANCE MEASURES FOR THE CUSTOMER

EVA Component:	Effect on EVA	Value Drivers:	Performance Measures
Sales	↑	• Increase sales through lower prices • Increase sales volume (higher on-shelf availability • Generate additional sales through new products • Introduction of new technology	• Revenue per unit sold; margin per unit sold • Revenue generated by supplier's products; on-shelf availability • Product and supplier profitability • Percent sales of existing versus new customers • Sales from new products • End user customer satisfaction
Cost of Goods Sold	↓	• Improve manufacturing processes and productivity • Improve product quality	• Number of set-ups; operating costs; overtime • Price of direct materials or products sold • Six sigma process measures
Expenses	↓	• Improve order tracking and tracing • Reduce product development costs • Leverage new or alternative distribution channels • Reduce lead times • Eliminate forecasting and source development costs • Reduce in-bound freight and distribution costs	• Cost per order; percent electronically placed; number of orders • Percent reduction in personnel • Landed cost by channel; product availability • Overhead costs • Cycle time • No. of personnel; forecast accuracy; inventory turns; availability • Freight and inventory costs; utilization
Inventory	↓	• Reduce purchased goods inventories • Reduce inventory investment • Reduce cycle times	• Inventory turns; inventory carrying cost • Amount of WIP inventory • Turn rate; investment; excess inventory
Other Current Assets	↓	• Reduce working capital	• Cash-to-cash cycle; working capital investment
Fixed Assets	↓	• Improve equipment and plant utilization • Increase other asset utilization	• Plant, warehouse, capacity utilization • Utilization; return on assets, ROI

create for their potential trading partners—they cannot answer what value they will add to the supply chain. Managers without this information will be at a loss to determine whether process changes or functional realignments within the supply chain are increasing value to the end user or are simply evidence of opportunistic behavior by another firm with no value-creation for the end user. The maximization of supply chain effectiveness may require the shifting of functions or activities to the least-cost

partners—often referred to as functional shiftability—within the supply chain (La Londe, 1999). Managers must be prepared to demonstrate to senior executives the value created for the supply chain, and the firm, when functions shift from one enterprise to another. The visibility provided by the framework will expose companies that add little to no value to the supply chain. Management within these firms will be compelled to act or face the possibility of being replaced or disintermediated from the supply chain. Likewise, customers or suppliers that incur a high cost of doing business may find their market share eroding as their trading partners reallocate their business to less costly or higher value creating alternatives. The exchange of performance and cost information raises the potential for opportunistic behavior by larger firms that dominate the supply chain. Incentives and penalties may need to be put in place to engender the initial trust required for exchanging information and aligning behavior (La Londe, 1999; Kirby, 2003).

Future Research

Empirical research is required to validate the framework. A review of the literature found that the vast preponderance of the research focused on developing intrafirm performance measurement and did not examine performance across multiple firms. One notable exception is Dekker and van Goor (2000) where activity-based cost information was obtained across three firms in a supply chain; however, the study was limited to logistics costs and did not examine other costs or value drivers. The development of interfirm performance was not specifically addressed. Further case study research is needed to investigate the techniques used for exchanging and standardizing performance information, the effect of the information on management decision-making, how the participating firms fostered sufficient trust to exchange the information, and whether application of the framework resulted in increased value for the firms and the supply chain end-user. The linkage of performance metrics to supply chain strategy represents a major gap in the supply chain literature. Case study research is required to determine how multiple firms can collaborate to develop a joint strategy, what mechanism the firms adopted for translating this strategy into metrics to guide the supply chain, and whether shareholder value is a major factor in guiding strategy development. Future research is also needed to develop a means to equitably allocate the benefits and burdens resulting from process changes or functional shiftability. In some instances a function should shift to a trading partner due to being the low cost provider to maximize value for the supply chain, but the resulting value created within the firm is not sufficient for management to accept the function. A mechanism incorporating transaction costs, pricing, or a fee-for-service approach should be developed that can equitably allocate the resulting benefits and burdens between firms.

Summary

Effective supply chain management requires measures to control costs and align performance across an extended enterprise. There is little evidence that any firms have developed measures that measure interfirm performance or capture the effect of supply chain performance on shareholder value for each trading partner. The problem stems from the lack of a framework to guide managers in the development of interfirm measures, translating performance into shareholder value, and aligning intrafirm performance with supply chain objectives.

The framework described in this paper provides an approach using a combined EVA analysis and ABC to develop measures and evaluate performance across multiple firms. Application of the framework enables managers to develop interfirm performance capable of evaluating supply chain performance and demonstrating the value created to the end user and each of the participating trading partners.

ENDNOTE

1. EVA is a registered trademark of Stern Stewart & Company.

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