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From the Editor...

First, welcome back to my senior associate editor, Steve Rutner! Steve has been a visiting professor at the University of Arkansas for the past two years while his wife, Paige, pursues her doctoral degree in information systems there. We hope to have her back with us as well by the Fall of 2004.

In this issue of the *JTM*, while the substantial topic variety touches on all but one mode of transportation, the underlying theme is best summarized by the terms "benchmarking" and "process re-engineering." Any logistics or transportation decision maker can find something in this issue with direct application in his or her company or industry.

In the first article, Terry Pohlen suggests a framework for measuring supply chain performance that combines economic value-added (EVA) analysis with activity-based costing (ABC). He argues that the use of both EVA and ABC enables management to control both cost and performance across the entire supply chain. The second article, by Hokey Min and Seong Jong Joo, utilizes data envelopment analysis to develop benchmarks for use in improving the operational efficiency of trucking companies. In the third article, Kay Dobie and Jerry Wilson revisit the customer service, inventory, and transportation triad. The authors point out that, with increasingly tight security measures and supply chain uncertainty, managers need to reassess inventory and transportation cost relationships and critically evaluate contingency plans. The fourth article, by Karl Manrodt, identifies six major drivers of logistics excellence and offers insights to carriers on how to incorporate these drivers into carrier operations. In the final article, Padmapriya Baboo and Evelyn Thomchick investigate the impact of recent regulatory reforms on pricing in both the air and ocean transportation markets. The authors conducted a survey to identify factors affecting price negotiation strategies and the circumstances under which multiple strategies are employed.

Both the authors and the participating editorial board reviewers worked hard to put this issue together for you. I hope that you appreciate their efforts and enjoy the reading. Share this copy of the *Journal* with colleagues and encourage them to support future issues by subscribing today.

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OBJECTIVES

Editorial Policy. The primary purpose of the *JTM* is to serve as a channel for the dissemination of information relevant to the management of transportation and logistics activities in any and all types of organizations. Articles accepted for publication will be of interest to both academicians and practitioners and will specifically address the managerial implications of the subject matter. Articles that are strictly theoretical in nature, with no direct application to the management of transportation and logistics activities, would be inappropriate for the *JTM*.

Acceptable topics for submission include, but are not limited to carrier management, modal and Intermodal transportation, international transportation issues, transportation safety, marketing of transportation services, domestic and international transportation policy, transportation economics, customer service, and the changing technology of transportation. Articles from related areas, such as third party logistics and purchasing and materials management are acceptable as long as they are specifically related to the management of transportation and logistics activities.

Submissions from industry practitioners and from practitioners co-authoring with academicians are particularly encouraged in order to increase the interaction between the two groups. Authors considering the submission of an article to the *JTM* are encouraged to contact the editor for help in determining relevance of the topic and material.

The opinions expressed in published articles are those of the authors and do not necessarily reflect the opinions of the Editor, the Editorial Review Board, Delta Nu Alpha Transportation Fraternity, or Georgia Southern University.

PUBLISHING DATA

Manuscripts. Four (4) copies of each manuscript are to be sent to Dr. Jerry W. Wilson, Southern Center for Logistics and Intermodal Transportation, Georgia Southern University, P. O. Box 8154, Statesboro, GA 30460-8154. Manuscripts should be no longer than 25 double-spaced pages. Authors will be required to provide electronic versions of manuscripts accepted for publication. Guidelines for manuscript submission and publication can be found in the back of this issue.

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A FRAMEWORK FOR EVALUATING SUPPLY CHAIN PERFORMANCE

Terrance L. Pohlen
University of North Texas

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.

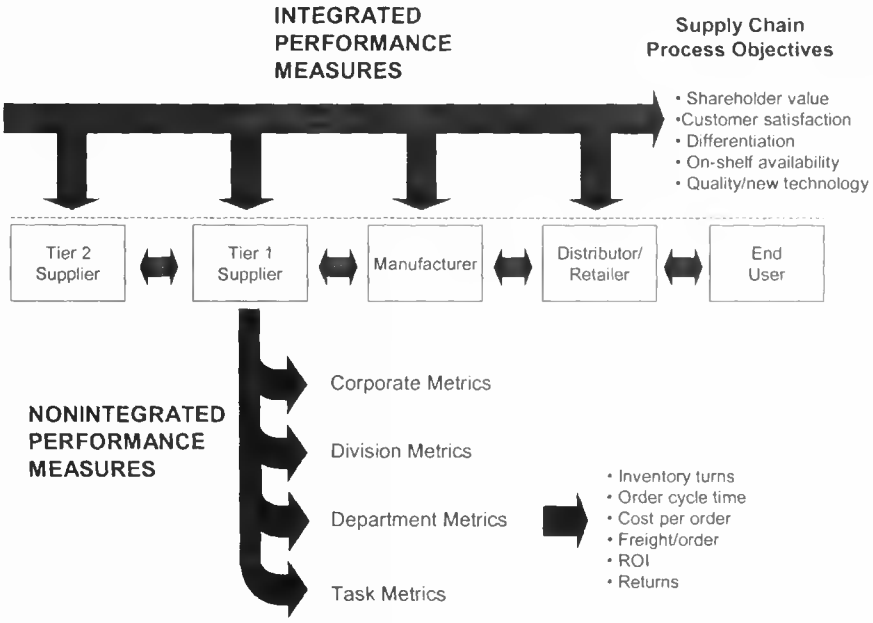
What Is Needed

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).

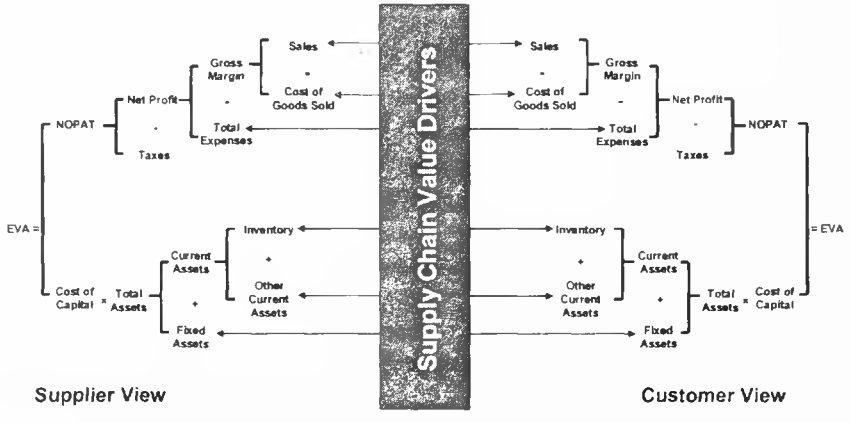
Combined Value Analysis of the Supplier-Customer Interface

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.

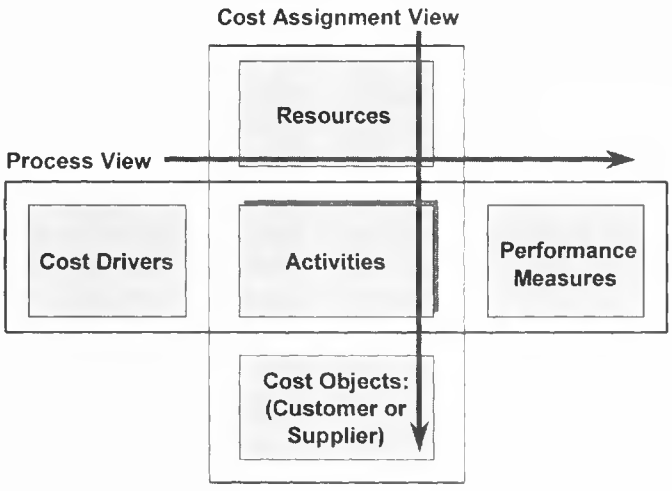
The combined EVA analysis identifies the key levers driving value creation in the supplier and customer firms; however, it does not go far enough. The analysis does not provide the capability to determine the specific costs associated with any proposed or actual actions. The capability to translate the 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]



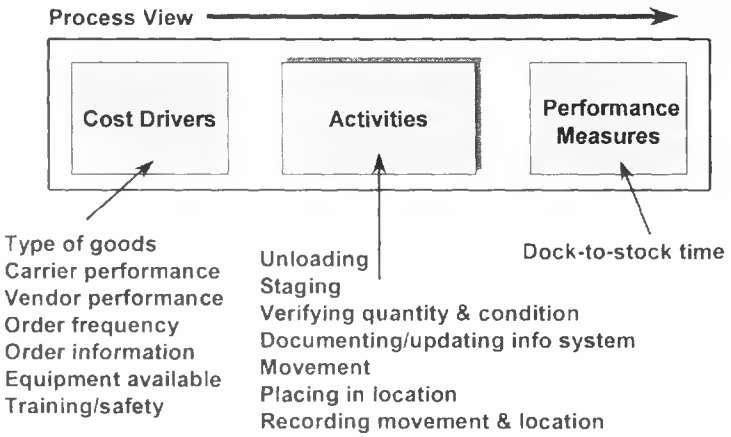
[1]Adapted from Turney, 1991.

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

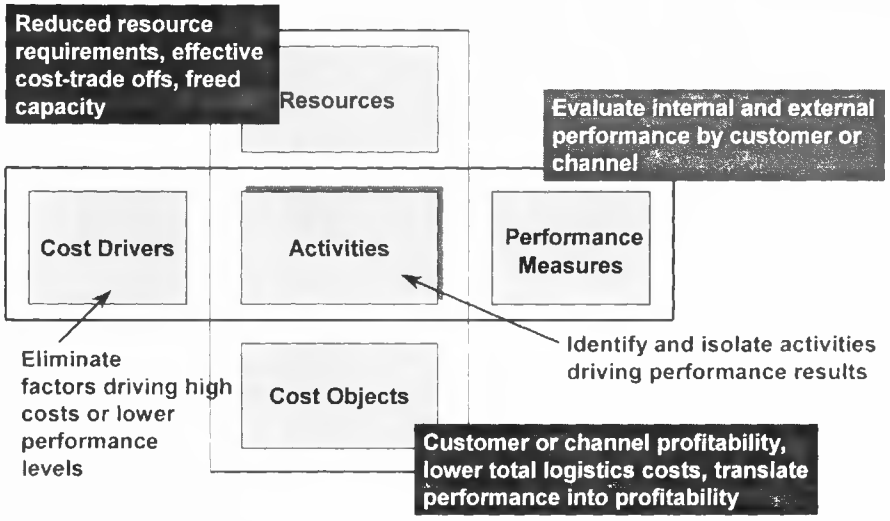


within the warehouse such as the time and cost to unload a truck, stage and inspect the order, and put-away. ABC can be used to assign the resources consumed by each of the activities in the customer firm based on the consumption of warehouse labor, equipment, and supplies.

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.

REFERENCES

Akkermans, Henk, Bogerd, Paul, and Vos, Bart (1999), "Virtuous and Vicious Cycles on the Road Towards International Supply Chain Management," *International Journal of Operations & Production Management*, 19(5/6): 565-581.

Atkinson, Anthony A., Waterhouse, John H., and Wells, Robert B. (1997), "A Stakeholder Approach to Strategic Performance Measurement," *Sloan Management Review*, 38(2): 25-37.

Beamon, Benita M. (1999), "Measuring Supply Chain Performance," *International Journal of Operations and Production Management*, 19(3): 275-292.

Brewer Peter C. and Speh, Thomas W. (2000), "Using the Balanced Scorecard to Measure Supply Chain Performance," *Journal of Business Logistics*, 21(1): 75-93.

Croxton, Keely L., Garcia-Dastugue, Sebastian J., Lambert, Douglas M., and Rogers, Dale S. (2001), "The Supply Chain Man-agement Processes," *The International Journal of Logistics Management*, 12(2): 13-36.

Dekker, H. C. (2003), "Value Chain Analysis in Interfirm Relationships: A Field Study," *Management Accounting Research*, 14(1): 1-23.

Dekker, Henri C. and Van Goor, Ad R. (2000), "Supply Chain Management and Management Accounting: A Case Study of Activity-Based Costing," *International Journal of Logistics: Research and Applica-tions*, 3(1): 41-52.

Ellram, Lisa M. and Liu, Baohong (2002), "The Financial Impact of Supply Management," *Supply Chain Management Review*, 6(6): 30-37.

Fisher, Marshall L. (1997), "What is the Right Supply Chain for Your Product?" *Harvard Business Review*, 75(2): 105-116.

Francella, Kevin and Doherty, Katherine (Ed) (1998), "Supply Chain Solutions: Linking the Chains," A Supplement prepared by Andersen Consulting for *Food Logistics*.

Gilmour, Peter (1999), "A Strategic Audit Framework to Improve Supply Chain Performance," *Journal of Business and Industrial Marketing*, 14(5/6): 355-363.

Hasan, Helen and Tibbits, Hendrika (2000), "Strategic Management of Electronic Commerce: An Adaptation of the Balanced Scorecard," *Internet Research: Networking Applications and Policy*, 10(5): 439-450.

Holmberg, Stefan (2000), "A Systems Perspective on Supply Chain Measurements," *International Journal of Physical Distribution and Logistics Management*, 30(10): 847-868.

Joint Industry Project on Efficient Consumer Response (1994), *Performance Measurement: Applying Value Chain Analysis to the Grocery Industry*.

Kallio, Jukka, Saarinen, Timo, Tinnila, Markku, and Vepsalainen, Ari P. J. (2000), "Measuring Delivery Process Performance," *International Journal of Logistics Management*, 11(1): 75-87.

Kaplan, Robert S. and Norton, David P. (1996), "Using the Balanced Scorecard as a Strategic Management System," *Harvard Business Review*, 74(1): 75-85.

Keebler, James S., Manrodt, Karl B., Durtsche, David A., and D. Michael Ledyard (1999), *Keeping Score*, Oakbrook, IL: Council of Logistics Management.

Kirby, Julia (2003), "Supply Chain Challenges: Building Relationships," *Harvard Business Review*, 81(7): 64-73.

La Londe, Bernard J. (1999), "The Costs of 'Functional Shiftability,'" *Supply Chain Management Review*, 3(3): 9-10.

La Londe, Bernard J. and Pohlen, Terrance L. (1996), "Issues in Supply Chain Costing," *The International Journal of Logistics Management*, 7(1): 1-12.

Lambert, Douglas M. and Pohlen, Terrance L. (2001), "Supply Chain Metrics," *International Journal of Logistics Management*, 12(1): 1-19.

Lapide, Larry (1999), "What About Measuring Supply Chain Performance?" In *Achieving Supply Chain Excellence Through Technology*, Montgomery Research, 287-297.

Lee, Hau L. (2000), "Creating Value Through Supply Chain Integration," *Supply Chain Management Review*, 4(4): 30-40.

Lee, Hau L. and Billington, Corey (1992), "Managing Supply Chain Inventory: Pitfalls and Opportunities," *Sloan Management Review*, 33(3): 65-73.

Levy, Paul, Bessant, John, Sang, Bob, and Lamming, Richard (1995), "Developing Integration Through Total Quality Supply Chain Management," *Integrated Manufacturing Systems*, 6(3): 4-12.

Lummus, Rhonda R. and Vokurka, Robert J. (1999), "Managing the Demand Chain Through Managing the Information Flow: Capturing 'Moments of Information,'" *Production and Inventory Management Journal*, 40(1): 16-20.

Mentzer, John T. (Ed) (2001), *Supply Chain Management*, Thousand Oaks, CA: Sage Publishing.

Monczka, Robert M. and Morgan, James P. (2000), "Competitive Supply Strategies for the 21st Century," *Purchasing*, 128(1): 48-80.

Narayanan, V. G. and Raman, Ananth (2000), "Aligning Incentives for Supply Chain Efficiency," Harvard Business School Case 9-600-110, Boston, MA: Harvard Business School Press.

Neely, Andy, Gregory, Mike and Platts, Ken (1995), "Performance Measurement System Design," *International Journal of Operations and Production Management*, 15(4): 80-116.

Otto, Andreas and Kotzab, Herbert (2003), "Does Supply Chain Management Really Pay? Six Perspectives to Measure the Performance of Managing a Supply Chain," *European Journal of Operations Research*, 144(2): 306-320.

Porter, Michael E. (1985), *Competitive Advantage*, New York: The Free Press.

Ramdas, Kamalini and Spekman, Robert E. (2000), "Chains or Shackles: Understanding What Drives Supply-Chain Performance," *Interfaces*, 30(4): 3-21.

Rappaport, Alfred (1987), "Linking Competitive Strategy and Shareholder Value Analysis," *The Journal of Business Strategy*, 7(4): 58-67.

Reese, Andrew K. (2001), "Metrics Mentality," *iSource Business,* June, pp. 67-70.

Simatupang, Togar M. and Sridharan, R. (2002), "The Collaborative Supply Chain," *International Journal of Logistics Management*, 13(2): 15-30.

Stank, Theodore P., Keller, Scott B., and Closs, David J. (2002), "Performance Benefits of Supply Chain Logistical Integration," *Transportation Journal*, 42(2/3): 32-46.

Stern, Joel M. and Shiely, John S. with Irwin Ross (2001), *The EVA Challenge*, New York: John Wiley & Sons, Inc.

Supply Chain Council (2003) *Supply-Chain Operations Reference-model: Overview of SCOR Version 6.0*, [Online]. Available: http://www.supply-chain.org. Accessed: 6/27/03.

Tan, Keah-Choon, Kannan, Vijay R., Handfield, Robert B., and Ghosh, Soumen (1999), "Supply Chain Management: An Empirical Study of Its Impact on Performance," *International Journal of Operations and Production Management*, 19(10): 1034-1052.

Van Donselaar, Karel, Kokke, Kees, and Allessie, Martijn (1998), "Performance Measurement in the Transportation and Distribution Sector," *International Journal of Physical Distribution and Logistics Management*, 28(6): 434-450.

van Hoek, Remko I. (1998), "Measuring the Unmeasureable—Measuring and Improving Performance in the Supply Chain," *Supply Chain Management*, 3(4): 187-192.

Walker, William T. (1999), "Use Global Performance Measures to Align the Enterprise Trading Partners," *Achieving Supply Chain Excellence Through Technology*, Vol. 1, [Online]. Available: http://www.ascet.com/documents.asp?d_ID=238. Accessed: 07/1/03.

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BENCHMARKING THE OPERATIONAL EFFICIENCY OF MAJOR U.S. TRUCKING FIRMS USING DATA ENVELOPMENT ANALYSIS

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ABSTRACT

In an era of downsizing and financial cutbacks, the operational efficiency of trucking firms dictates their competitiveness and survival. In an effort to help trucking firms develop a winning formula in the fiercely competitive logistics industry, this research aims to develop a meaningful set of benchmarks that will set the tone for best practices. In particular, a data envelopment analysis (DEA) is described. DEA has proven to be useful for measuring the operational efficiency of various profit or non-profit organizations. Using the examples of major trucking businesses in the United States, the usefulness of data envelopment analysis for the continuous improvement of trucking services is illustrated.

INTRODUCTION

The trucking industry in the United States has historically operated on profit margins as low as 3 to 4 cents on every dollar of sales after taxes, compared to the 7 to 9% average profit margin experienced by the heavy manufacturing industry (Dun and Bradstreet, 1999; Lambert and Min, 2000). Recently, the profit margin of the industry declined further, from 3.08% in 1994 to 2.60% in 1999 (American Trucking Associations Economics and Statistic Group, 2001). With tight profit margins and increasing competition, a key to a trucking firm's survival is its ability to keep trucking operations "lean." Sustaining lean operations, however, is not easy given mounting cost pressures from rising fuel costs, taxes, insurance, and labor. For example, the national average price of diesel fuel spiked to $1.491 per gallon in 2000 from $1.044 per

gallon in 1998. In addition, for-hire carriers paid 8.4% more in federal highway-user taxes in 1999 than in 1998 (American Trucking Associations Economics and Statistics Group, 2001). Those trucking firms that could not handle steep cost increases outpacing revenue growth failed to survive in the end. In 2000 alone, 3,670 trucking firms went out of business. This alarming statistic represents an increase of 205.8% in trucking business failures from the previous year (American Trucking Associations Economics and Statistics Group, 2001).

One way of improving the operational efficiency of trucking firms is to learn from best practice firms that can be identified by setting a reliable financial performance standard. Examples of such a standard are a financial audit, an industry norm, and a benchmark. Since a trucking firm needs to measure its financial performance relative to its competitors to constantly strengthen its market position, benchmarking seems to be the most effective way of setting a reliable financial standard and then measuring the operational efficiency of the trucking firm.

In general, benchmarking is a continuous quality improvement process by which an organization can assess its internal strengths and weaknesses, evaluate comparative advantages of leading competitors, identify the best practices of industry leaders, and incorporate these findings into a strategic action plan geared to gain a position of superiority (Min and Galle, 1996). The main goals of benchmarking are to:

- Identify key performance measures for each function of a business operation;
- Measure one's own internal performance levels as well as those of the leading competitors;
- Compare performance levels and identify areas of comparative advantages and disadvantages;
- Implement programs to close a performance gap between internal operations and the leading competitors (Furey 1987, p.30).

In setting the benchmark, this paper will measure the operational efficiency of trucking firms relative to prior periods and their competitors. The operational efficiency measured by input/output ratios can reflect the true overall productivity of trucking firms better than traditional financial ratios that tend to focus on myopic aspects of financial performance. As a way of comparatively assessing the productivity of trucking firms with multiple inputs and outputs, this research uses data envelopment analysis (DEA), which was successfully explored in measuring the operational efficiency of banks (e.g., Thanassoulis, 1999), hospitals (Valdmanis, 1992), nursing homes (Kleinsorge and Karney, 1992), purchasing departments (Murphy et al., 1996), cellular manufacturing (Talluri et al., 1997), travel demand (Nozick et al., 1998), information technology investments (Shafer and Byrd, 2000), customer service performances of less-than-truckload (LTL) motor carriers (Poli and Scheraga, 2000) and international ports (Tongzon, 2001). For further details on other DEA applications, interested readers should refer to Seiford (1990).

In general, DEA is referred to as a linear programming (non-parametric) technique

that converts multiple incommensurable inputs and outputs of each decision-making unit (DMU) into a scalar measure of operational efficiency, relative to its competing DMU's. Herein, DMU's refer to the collection of private firms, non-profit organizations, departments, administrative units, and groups with the same (or similar) goals, functions, standards and market segments. DEA is designed to identify the best practice DMU without *a priori* knowledge of which inputs and outputs are most important in determining an efficiency measure (i.e., score), and assess the extent of inefficiency for all other DMU's that are not regarded as the best practice DMU's (e.g., Charnes et al., 1978). Since DEA provides a relative measure, it will only differentiate the least efficient DMU from the set of all DMU's. Thus, the best practice (most efficient) DMU is rated as an efficiency score of one, whereas all other less efficient DMU's are scored somewhere between zero and one. To summarize, DEA determines the following (Sherman and Ladino, 1995):

- The best practice DMU tha t uses the least resources to provide its products or services at or above the quality standard of other DMU's;
- The less efficient DMU's compared to the best practice DMU;
- The amount of excess resources used by each of the less efficient DMU's;
- The amount of excess capacity or ability to increase outputs for less efficient DMU's without requiring added resources.

In measuring the operational efficiency of trucking firms, DEA was chosen over other alternative techniques (such as Cobb Douglas functions and analytic hierarchy process (AHP)) because DEA reflects the multiple aspects of organizational performances, does not require *a priori* weights of performance measures, and provides valuable insights as to how operational efficiency can be improved.

SPECIFICATION OF INPUT AND OUTPUT MEASURES

The assessment of operational efficiency using DEA begins with the selection of appropriate input and output measures that can be aggregated into a composite index of overall performance standards. Although any resources used by the DMU should be included as input, six different metrics were selected as inputs. These are: account receivables, revenue equipment (e.g., trucks, trailers, containers), buildings (e.g., truck terminals), land, salaries and wages (including fringe benefits) of employees, and operating expenses other than salaries and wages. Since trucking firms often sell their services on credit rather than cash, account receivables can be a key resource for increasing sales and the subsequent revenue. Thus, account receivables reflect an efficiency of short-term asset management and should be chosen as one of the inputs. The revenue equipment is viewed as a resource, because the utilization of a truck's loading capacity can increase the efficiency of trucking firms in filling the needs of their customers. Other fixed assets such as buildings and lands (estimated in book values) are considered to be resources given that they can add value to trucking services by increasing the opportunity to consolidate freight, provide preventive vehicle maintenance, and provide critical part storage.

Due to the labor-intensive nature of the business, trucking firms hire a large number of personnel, consisting of managers, dis-

patchers, drivers, and cargo handlers, among others, on either a part-time or full-time basis. Their payroll represents one of the major costs of doing business. Indeed, as of 1999, salaries, wages and fringe benefits accounted for more than half (52.1%) of general operating expenses and, subsequently, were separated from general operating expenses (American Trucking Associations Economics and Statistics Group, 2001). Thus, salaries and wages (including fringe benefits) reflect the efficiency of direct investment in human resources. Operating expenses (excluding personnel cost) include many elements of variable costs, such as fuel, oil, lubricants, vehicle parts, tires, tubes, license fees, utilities, taxes and insurance premiums that comprise another key resource for maintaining equipment and keeping a fleet operational. Thus, operating expenses were included as input.

On the output side, the overall performance of trucking firms can be measured by operating income that best reflects operational efficiency. Other well-known financial ratios such as profit margin and return-on investment were not considered relevant, because a less profitable firm may be more efficient in utilizing its personnel and equipment than the more profitable firm. For example, a favorable change in fuel price and tax rate can increase profitability, but not necessarily the operational efficiency (e.g., equipment utilization or labor productivity) of trucking firms. In fact, Sherman (1984) observed that profit measure was not a good indicator of how efficiently resources were used to provide customer services.

The input and output data were obtained from the annual scoreboard report of *Business Week* magazine (2001) and a series of annual 10-K reports required by the Securities Exchange Act of 1934 (Edgar Online, 2003). These reports listed six years of data for major trucking firms including Arkansas Best, Consolidated Freightways, JB Hunt Transport Services, Swift Transportation, Werner Enterprises, and Yellow Corporation. To keep the homogeneity of these firms for equitable comparisons, we excluded other major carriers, such as United Parcel Service and FedEx, that offer more comprehensive and diverse services (e.g., air express delivery services, customs brokerage, equipment leasing) and are considerably larger in scale (annual revenue of approximately 20 to 30 billion dollars) from the current DEA analysis.

DATA ENVLEOPMENT ANALYSIS MODEL DESIGN AND TESTING

The DEA model, with the inputs and output summarized in Tables 1 and 2, was adopted for this study. The DEA model is mathematically expressed as

Maximize efficiency score (jp) =

$$\frac{\sum_{r=1}^{t} u_r y_{rjp}}{\sum_{i=1}^{m} v_i x_{ijp}} \qquad (1)$$

Subject to

$$\frac{\sum_{r=1}^{t} u_r y_{rj}}{\sum_{i=1}^{m} v_i x_{ij}} \le 1, \quad j = 1, \ldots, n, \qquad (2)$$

$$u_r, v_i \ge \varepsilon, \quad \forall \text{and } i, \qquad (3)$$

where

y_{rj} = amount of output r produced by DMU j,

x_{ij} = amount of input i used by DMU j,

TABLE 1
DESCRIPTIVE STATISTICS FOR INPUT AND OUTPUT MEASURES

	Number of annual reports	Minimum (in thousand dollars)	Maximum (in thousand dollars)	Mean (in thousand dollars)	Standard Deviation (in thousand dollars)	Type
Operating income	36	-91,087.00	152,529.00	64,373.83	51,926.90	Output
Accounts receivables	36	67,928.00	349,999.00	199,344.36	81,403.75	Input
Revenue equipment	36	207,471.00	1,401,646.00	718,509.86	329,110.32	Input
Building and other properties	36	30,127.00	607,104.00	252,355.97	207,425.80	Input
Land	36	7,351.00	228,051.00	77,812.94	73,867.17	Input
Salaries, wages and employee benefits	36	192,572.00	2,210,505.00	997,870.47	635,700.66	Input
Operating expenses	36	316,108.00	1,327,643.00	786,760.03	298,096.66	Input

TABLE 2
EFFICIENCY SCORES FOR OPERATING INCOME

Company	Year					
	1996	1997	1998	1999	2000	2001
ABFS	N/A	77.06%	73.21%	92.97%	100.00%	77.47%
CFWY	N/A	33.06%	37.87%	5.81%	N/A	N/A
JBHT	41.70%	27.68%	61.35%	38.36%	32.37%	37.40%
SWFT	89.93%	99.39%	100.00%	98.72%	73.56%	38.23%
WERN	100.00%	100.00%	100.00%	100.00%	68.88%	65.34%
YELL	N/A	41.77%	38.86%	48.37%	74.31%	29.34%

N/A represents negative operating income, which is not suitable for the DEA output measure.

u_r = the weight given to output r,

v_i = the weight given to input i,

n = the number of DMU's,

t = the number of outputs,

m = the number of inputs,

ε = a small positive number.

By solving these equations, the efficiency of DMU (*jp*) is maximized subject to the efficiencies of all DMU's in the set with an upper bound of 1. The model is solved n times to evaluate the relative efficiency of each DMU. Notice that the weights u_r and v_i are treated as unknown variables whose values will be optimally determined by maximizing the efficiency of the targeted DMU (*jp*). An efficiency score of 1 indicates that the DMU under consideration is efficient relative to other DMU's, while an efficiency score of less than 1 indicates the DMU under consideration is inefficient. In a broader sense, an efficiency score represents a trucking firm's ability to transform a set of inputs (given resources) into a set of outputs. The above model also identifies a peer group (efficient DMU with the same weights) for the inefficient DMU (Boussofiane et al., 1991).

A complete DEA analysis was conducted by applying a non-linear fractional program formulated in equations (1)-(3) to actual data containing a sample of six major trucking firms with six consecutive years of performance measures. The results obtained from the use of Frontier Analyst software (1998) indicate that Werner Enterprises consistently recorded an efficiency score of 1 (100%) in 1996 through 1999. However, Werner Enterprises experienced a decline in efficiency in both 2000 and 2001 (see Table 2). Swift Transportation and Arkansas Best achieved an efficiency score of 1 (100%) in 1998 and 2000, respectively. On a year-to-year basis, at least one of the trucking firms is considered efficient, with the exception of 2001. In 2001, the relative efficiency scores ranged from 29.34% to 77.47%, suggesting that there is room for substantial improvement in operating income (see Tables 2 and 3). Surprisingly, Consolidated Freightways, J.B. Hunt Transport Services and Yellow Corporation, which ranked in the top 15 revenue generators among U.S. trucking firms in 2000-2001, never rated as efficient throughout the sample period (Bearth, 2001). For example, Consolidated Freightways recorded an efficiency score of only 5.81% in 1999, leaving ample room for improvement. In 1999, it could have improved its efficiency in operating income by as much as 16 times (see Table 3). This may explain why Consolidated Freightways eventually filed for bankruptcy protection. In particular, its buildings and other properties (e.g., office equipment and furniture) were poorly utilized, compared to other competing trucking firms throughout the period (see Table 4). In fact, after liquidating equipment and terminals, Consolidated Freightways still had 21 surplus properties for sale as of December 31, 2001 (Edgar Online, 2003). Also, CF salaries and wages were above the industry average, reflecting its underutilization of labor. CF was also involved in several unsettled labor disputes with various labor unions, which represented 81% of domestic employees as of December 31, 2001. Yellow Corporation shows similar patterns, causing concern for its declining efficiency. Its utilization rate of buildings and other properties has declined significantly over the last five years (1997-2001).

Overall, 2001 was the worst year for every trucking firm studied. Figure 1 displays the decline in efficiency scores for all but J.B. Hunt Transport Services in 2001. In fact, every investigated trucking firm shows a relatively low efficiency score that may have resulted from ever-rising operating expenses and a nationwide economic downturn. For example, the total operating expenses of a benchmark firm such as Werner Enterprises rose from 101 cents per mile in 1996 to 111.53 cents per mile in 1999, while those of the top 20 general freight carriers increased

TABLE 3
POTENTIAL IMPROVEMENTS IN OPERATING INCOME

Company	Year					
	1996	1997	1998	1999	2000	2001
ABFS	N/A	29.77%	36.59%	7.56%	0.00%	29.08%
CFWY	N/A	202.46%	164.06%	1,621.84%	N/A	N/A
JBHT	139.83%	261.68%	63.00%	160.68%	208.92%	167.40%
SWFT	11.20%	0.61%	0.00%	1.30%	35.94%	161.56%
WERN	0.00%	0.00%	0.00%	0.00%	45.17%	53.06%
YELL	N/A	139.42%	157.35%	106.74%	34.57%	240.84%

* N/A represents negative operating income, which is not suitable for the DEA output measure.

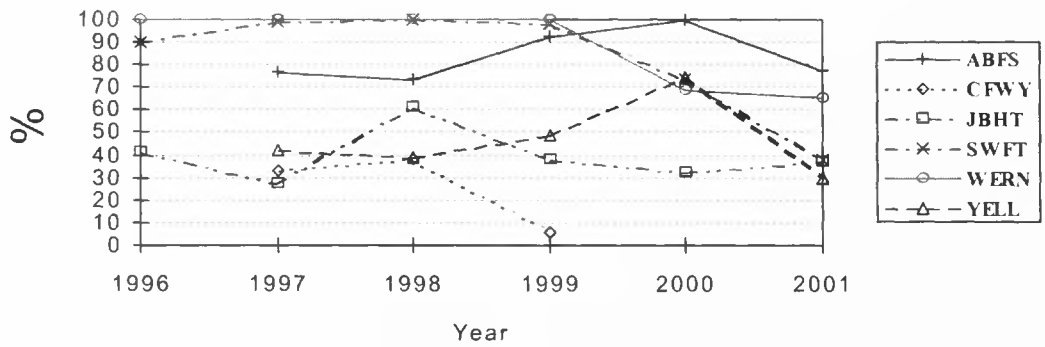
TABLE 4
RESOURCE (INPUT) UTILIZATION RATES IN PERCENTAGE

Resources	Company	Year					
		1996	1997	1998	1999	2000	2001
Accounts Receivable	*ABFS*	N/A	-41.03	-28.95	-22.24	0.00	0.00
	CFWY	N/A	-48.21	-44.68	-52.89	N/A	N/A
	JBHT	0.00	0.00	0.00	-5.33	0.00	-3.90
	SWFT	-8.57	-3.32	0.00	-7.65	-6.68	0.00
	WERN	0.00	0.00	0.00	0.00	-0.87	0.00
	YELL	N/A	-18.12	-4.55	0.00	0.00	0.00
Revenue Equipment	*ABFS*	N/A	0.00	-7.63	0.00	0.00	0.00
	CFWY	N/A	0.00	0.00	0.00	N/A	N/A
	JBHT	-12.22	-9.69	-18.15	0.00	-4.49	0.00
	SWFT	-1.07	0.00	0.00	-4.16	-6.42	0.00
	WERN	0.00	0.00	0.00	0.00	0.00	0.00
	YELL	N/A	0.00	-4.11	0.00	0.00	0.00
Buildings and Other Properties	*ABFS*	N/A	-42.70	-41.13	-32.65	0.00	-34.99
	CFWY	N/A	-73.53	-73.86	-75.93	N/A	N/A
	JBHT	-28.38	-20.62	-17.10	0.00	-8.35	0.00
	SWFT	-6.25	-.059	0.00	-8.75	-8.40	-33.77
	WERN	0.00	0.00	0.00	0.00	0.00	0.00
	YELL	N/A	-62.91	-63.85	-69.71	-78.12	-81.21

Table 4
(continued)

Resources	Company	Year					
		1996	1997	1998	1999	2000	2001
Land	*ABFS*	N/A	-41.58	-34.94	-21.18	0.00	-44.26
	CFWY	N/A	0.00	0.00	0.00	N/A	N/A
	JBHT	-0.41	0.00	0.00	0.00	0.00	0.00
	SWFT	-30.94	0.00	0.00	-21.97	-48.86	-19.87
	WERN	0.00	0.00	0.00	0.00	0.00	0.00
	YELL	N/A	0.00	0.00	0.00	0.00	-2.55
Salaries, Wages, and Employee Benefits	*ABFS*	N/A	-29.33	-17.04	-12.37	0.00	-28.88
	CFWY	N/A	-54.96	-52.86	-54.38	N/A	N/A
	JBHT	0.00	-3.66	-13.37	-11.42	-16.71	-19.56
	SWFT	0.00	-0.52	0.00	0.00	0.00	0.00
	WERN	0.00	0.00	0.00	0.00	-5.37	-9.46
	YELL	N/A	-48.03	-45.99	-48.85	-54.92	-53.65
Operating Expenses	*ABFS*	N/A	-41.32	0.00	-5.93	0.00	-20.72
	CFWY	N/A	-17.40	-16.62	-28.88	N/A	N/A
	JBHT	-28.94	-26.67	-29.16	-27.74	-31.84	-27.23
	SWFT	-12.96	-12.63	0.00	-3.35	-13.13	-14.86
	WERN	0.00	0.00	0.00	0.00	-19.58	-23.50
	YELL	N/A	-2.23	0.00	-6.89	-24.44	-23.05

Figure 1
The Efficiency Trend of Operating Income



from 130.82 cents per mile in 1996 to 145.15 cents per mile in 1999 (American Trucking Associations, 2001).

It is also noted that large LTL carriers such as Yellow Corporation and Consolidated Freightways struggled throughout the sample period, whereas more niche-oriented (e.g., dry van and flatbed) TL carriers such as Werner Enterprises and Swift Transportation fared better. Since today's shippers often require more specialized

services (including online freight exchange services) rather than generic one-way loads, carriers that find niche-markets most profitable for them are likely to perform better and survive in this fiercely competitive environment.

CONCLUSIONS AND MANAGERIAL IMPLICATIONS

At the end of 2000, there were more than half a million trucking firms operating in the U.S., which reflects the highly fragmented nature of the trucking industry (American Trucking Associations Economics and Statistics Group, 2001). Over the last two decades, this fragmentation resulted in intense competition and low profit margins for commercial trucking firms that struggled to develop survival strategies. In an effort to help these firms formulate survival strategies, this research proposed a data envelopment analysis designed to analyze the operational efficiency of trucking firms, identify potential sources of inefficiency, and provide useful information (hindsight) for the continuous improvement of operational efficiency. Several major findings of this benchmarking study are presented and practical guidelines for improving the operational efficiency of trucking firms are delineated.

First, while trucking services continued to dominate the U.S. freight transportation market, all investigated trucking firms but one (J.B. Hunt Transport Services) showed a declining operational efficiency in 2001 (see Figure 1). This declining efficiency within trucking firms coincides with a decline (3.4% decrease from the previous year) in the average annual growth of the manufacturing industry, which is commonly regarded as one of the key drivers for freight transportation (American Trucking Associations, 2002). In particular, Swift Transportation, which was considered relatively efficient during most of the investigation period (1996-2000), registered a steep decline in efficiency score in 2001. Part of the reason for such a decline in efficiency may be an underutilization of fixed assets during 2000 and 2001 (see Table 4). This can be explained by the fact that Swift Transportation engaged in a stock-financing merger with M.S. Carriers in 2001, while joining forces with other carriers, such as J.B. Hunt Transport Services and Werner Enterprises, to form an Internet-based transportation service called Transplace.com in 2000. As a result, Swift Transportation acquired many assets and did not have enough time to translate such an investment into substantial growth in operating income in 2001.

Similarly, Werner Enterprises, which was considered to be the benchmark firm in this study, has experienced declining efficiency for the last two years of the investigation period due to rising salaries, wages, and other operating expenses. Although most elements (e.g., taxes, insurances, maintenance, utilities, depreciation and amortization) of operating expenses seemed to be stable, Werner Enterprises suffered from substantial rises in salaries, wages, operating supplies, and equipment rents for the investigation period (American Trucking Associations, 2001). That is to say, the trucking firm's utilization of personnel and indirect resources needed for equipment maintenance and service operations seems to be correlated to its operational efficiency.

A second finding is that the operating ratio (a measure of profitability based on operating expenses as a percentage of gross revenue) is somewhat (but not directly) correlated to the operational efficiency of trucking firms. For example, Arkansas Best

had the best operating ratio (90.1%) and the most efficient score (100%) among the six trucking firms evaluated in 2000. On the other hand, Swift Transportation had the best operating ratio (89%), but did not have the best score (98.72%) in operational efficiency in 1999 (see Table 2 and Bearth, 2001). In other words, the operating ratio may be a good indicator of a trucking firm's profitability, but does not necessarily reflect the utilization of fixed assets that the trucking firm owned for its operation. Thus, although the American Trucking Association (2001) often uses the operating ratio to benchmark the performances of trucking firms, it should not be the sole performance metric for measuring the true operational efficiency of trucking firms.

Finally, two of the under-achievers (Consolidated Freightways and Yellow Corporation) are large less-than-truckload (LTL) carriers, whereas the two best performers (Werner Enterprises and Swift Transportation) are large truckload (TL) carriers. This can be partially explained by the fact that the TL sector accounted for 44.9% of truck revenue, while the LTL sector represented only 10.3% of truck revenue in 2001 (American Trucking Associations, 2002). TL carriers may have a greater chance to sell their equipment and services, and, therefore, better utilize their resources than LTL carriers. However, such a finding cannot be generalized because Arkansas Best performed relatively well, despite being in the LTL sector. Also, given that the LTL sector is projected to grow faster than the TL sector for the next ten years (up to 2013), the revenue growth opportunity cannot be directly tied to the operational efficiency of trucking firms. More interestingly, during the investigated period, a poor performing peer group (Consolidated Freightways, Yellow Corporation, and J.B. Hunt Transport Services) outperformed its corresponding good performing counterpart (Arkansas Best, Swift Transportation, and Werner Enter-prises) by generating significantly larger revenue and expanding its service offerings (e.g., air freight forwarding, customs broker-age, warehousing, global intermodal services). This finding implies that the size of the trucking firm and the lack of focus on its core competency could hurt its operational efficiency.

Thus, the authors suggest the following survival strategies:

- Focus on the fast-growing or niche-oriented segments of the trucking market. Examples of this include small to intermediate package delivery and the delivery of high tech equipment (e.g., computers and communications equipment);

- Consider leasing fixed assets such as equipment, buildings, and land to increase cash flow and the fixed asset turnover ratio that can, in turn, improve operational efficiency in the long run;

- Control salaries and wages by better managing human resources (e.g., drivers);

- Eliminate unnecessary waste (e.g., indirect costs) in service activities by implementing activity based costing principles that enable management to focus on the activities driving the income.

To conclude, this research differentiates between surviving and struggling groups of trucking firms on the basis of DEA efficiency scores. The DEA efficiency score gives management a warning signal that the lower the DEA score, the greater the likelihood that the trucking firm will fail. Thus, DEA is very useful for identifying less efficient trucking

firms which require the closest attention. However, the proposed DEA model can be extended to include multiple outputs (including non-financial measures) and a greater number of trucking firms in homogeneous business sectors and organizational settings.

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REFERENCES

American Trucking Associations (2001), *2000 Twenty from the Top: Benchmarking Guide to the Operations of For-Hire Truckload Carriers*, Alexandria, VA: Trucking Information Services, Inc.

American Trucking Associations (2002), *U.S. Freight Transportation Forecast...To 2003: Economic Forecasting and Analysis Prepared by DRI-WEFA Inc.*, Alexandria, VA: Transport Topics Press.

American Trucking Associations Economics and Statistics Group (2001), *American Trucking Trends 2002: Findings and Comments Series*, Alexandria, VA: Transport Topics Press.

Bearth, Daniel, P. (2001), "The 2000-2001 Transport Topics 100: Annual Trucking Company Rankings," *Transport Topics*, July 23: 4-14.

Boussofiane, A., Dyson, R. G., and Thanassoulis, E. (1991), "Applied Data Envelopment Analysis," *European Journal of Operational Research* 52: 1-15.

Business Week (2001), "Corporate Scorecard," May 21: 85-108.

Charnes, A., Cooper, W.W., and Rhodes, E. (1978), "Measuring the Efficiency of Decision Making Units," *European Journal of Operational Research* 2: 429-444.

Dun and Bradstreet Information Services (1999), *Industry Norms and Key Business Ratios*, 1998-1999, Murray Hill, NJ: Dunn and Bradstreet, Inc.

Edgar Online (2003), *Form 10-K: Annual Report Pursuant to Section 13 or 15(d) of the Securities Exchange Act of 1934*, Washington, DC: Securities and Exchange Commission.

Frontier Analyst (1998), *Efficiency Analysis Software User's Guide*, Professional Edition, Glasgow, Scotland: Banxia Software Ltd.

Furey, T.R. (1987), "Benchmarking: the Key to Developing Competitive Advantages in Mature Markets," *Planning Review* 15(5): 30-32.

Kleinsorge, Ilene K. and Karney, Dennis F. (1992), "Management of Nursing Homes using Data Envelopment Analysis," *Socio-Economic Planning Sciences* 26(1): 57-71.

Lambert, Thomas and Min, Hokey (2000), "The Impact of State Taxes on the Development and Growth of Trucking Industry," *Journal of Transportation Management*, 12(2): 33-46.

Min, Hokey and Galle, William, P. (1996), "Competitive Benchmarking of Fastfood Restaurants using the Analytic Hierarchy Process and Competitive Gap Analysis," *Operations Management Review* 11(2/3): 57-72.

Murphy, David J., Pearson, John, N., and Siferd, Sue P. (1996), "Evaluating Performance of the Purchasing Department using Data Envelopment Analysis," *Journal of Business Logistics* 17(2): 77-91.

Nozick, Linda K., Borderas, Hector, and Meyburg, Arnim, H. (1998), "Evaluating of Travel Dema nd Measures and Programs: A Data Envelopment Analysis Approach," *Transportation Research A* 32(5): 331-343.

Poli, Patricia M. and Scheraga, Carl, A. (2000), "The Relationship between the Functional Orientation of Senior Managers and Service Quality in LTL Motor Carriers," *Journal of Transportation Management* 12(2): 17-31.

Seiford, Lawrence M. (1990), "A Bibliography of Data Envelopment Analysis (1978-1990)," Unpublished Working Paper, Department of Industrial Engineering and Operations Research, University of Massachusetts, Amherst.

Shafer, Scott M. and Byrd, Terry, A. (2000), "A Framework for Measuring the Efficiency of Organizational Investments in Information Technology using Data Envelopment Analysis," *Omega* 28: 125-141.

Sherman, H. David (1984), "Improving the Productivity of Service Businesses," *Sloan Management Review* 125: 11-23.

Sherman, H. David and Ladino, George (1995), "Managing Bank Productivity using Data Envelopment Analysis," *Interfaces* 25(2): 60-73.

Talluri, S., Hug, F., and Pinney, W. E. (1997), "Application of Data Envelopment Analysis for Cell Performance Evaluation and Process Improvement in Cellular Manufacturing," *International Journal of Production Research* 35(8): 2157-2170.

Thanassoulis, Emmanuel (1999), "Data Envelopment Analysis and Its Use in Banking," *Interfaces* 29(3): 1-13.

Tongzon, Jose (2001), "Efficiency Measurement of Selected Australian and Other International Ports using Data Envelopment Analysis," *Transportation Research* A 35: 113-128.

Valdmanis, Vivian (1992), "Sensitivity Analysis for DEA Models: An Empirical Example using Public vs. NFP Hospitals," *Journal of Public Economics* 48: 185-205.

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BALANCING THE LOGISTICS COST-OF-SERVICE EQUATION IN AN INCREASINGLY UNCERTAIN BUSINESS ENVIRONMENT

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ABSTRACT

The emphasis in the press, trade publications, and even academic publications is increasingly on supply chain operations, collaboration, and software. There is no argument that these are important considerations as companies struggle to compete in highly competitive markets and an economically difficult environment. This emphasis on "lean" or "JIT" operations presupposes the ability of the firm to operate on a minimum level of inventory and deliver a high level of service. Too often, the basic and vital interdependency between transportation and inventory, necessary to support this objective, is forgotten in the emphasis on the total picture as embodied by the supply chain. It has been said that "the devil is in the details." It may be time for many firms to take another look at inventory, transportation and the cost of service.

INTRODUCTION

Companies today are operating in an environment of increasing complexity on many fronts. Prices are soft owing to a mix of over-capacity, heightened competition, and a sluggish economy. Customers are demanding higher quality, more technologically advanced products, value-added services, and dependable, on-time transportation in an effort to achieve their own organizational goals. Companies are responding to the increasing pressure on the bottom line by keeping inventory carrying costs to the minimum and reducing their exposure to potentially shorter product life cycles. To further complicate matters, these and other activities are being carried out in a global arena where the emphasis is on total supply chain coordination, cost reduction, and high levels of customer service.

Since September 11, 2001, another element has been introduced into the mix—the effects of supply chain failures resulting from specific targeted activities with the potential to cause wide-spread disruption of transportation and, subsequently, manufacturing. Many companies have already factored into their strategic planning process a "Plan B." Such contingency plans are common in the event of unexpected incidents, or acts of nature, such as earthquakes or hurricanes and floods which might lead to service disruptions. While events such as these can be damaging, they tend to be localized and the return to normalcy is swift. Even in the case of an extended shut-down of an individual port, such as that experienced recently in California, other port facilities were available for firms with the ability, and time, to re-route cargo. However, the events of September 11, 2001, demonstrated to many firms that the typical contingency plan was extremely deficient under such globally shocking circumstances.

In an effort to improve domestic security and prevent the occurrence of further incidents such as those experienced on September 11, 2001, Congress created the Department of Homeland Security. Increased emphasis has also been placed on transportation safety and security through the activities of the Transportation Safety Administration, the Department of Transportation and other government agencies. The proposal and implementation of new laws and policies, such as C-TPAT, the 24-Hour Rule, and the Known Shipper Rule, are designed to reduce the exposure of transportation infrastructure, equipment, personnel, and cargo to incidents of targeted terrorism ("Adjusting to New Cargo Rule Takes Time," 2003). Concurrently, strategic planners have been forced to review and restructure to avoid exposure to such events in the future. Many are taking a closer look at the vulnerabilities in their individual operations, supply chain and supply chain operations. An increased emphasis on risk management has resulted in the need to reevaluate the adequacy of the original "Plan B."

As part of the reevaluation effort, strategic planners must take a new look at inventory flow to/from their individual company as well as throughout the supply chain. Cost constraints imposed by a mixture of customer expectations and global competition demand that the delicate balance between inventory holding costs and transportation costs be maintained. The location of current supply chain members must be assessed relative to the costs of security, maintaining inventory levels, and managing transportation costs. The result of these efforts will undoubtedly lead to the alteration of previously established inventory level policies, and to reconsideration of transportation modes, carriers and routes for normal as well as abnormal operations.

INVENTORY, TRANSPORTATION, AND THE COST OF SERVICE

$$I + T = C_s$$

Even as corporate-level strategic plans for supply chain design and operations are being reviewed, the basic procedures for providing an unbroken stream of product into, within, and out of the organization should be under review. The goal of the review and subsequent change in procedures is to ensure that customer service is not compromised. In the most basic terms, customer service is dependent upon maintaining an appropriate balance between inventory and transportation services to meet the service needs of customers—both internal and external. Anything that has the potential to alter or interrupt the interaction of supply chain

components also has the potential to disrupt the balance between customer perceived value [of product], total delivered cost, and the final selling price of the product.

The contribution of the two most basic elements, inventory and transportation, to costs and customer service will be briefly examined. This discussion will provide a reference point for the strategic reexamination of transportation and inventory management policies, given the need to reduce the risk of supply chain disruption and to maintain a strong competitive position.

The Role of Inventory in the Cost of Service Equation

Inventory has traditionally been the first line of defense in markets characterized by high variation in demand on a regular and continuing basis. Considered an asset for accounting purposes, finished goods inventory is used to protect the firm from stock-outs resulting from fluctuating customer demand, relative distance from markets served, and the need for sustained production volume. On the supply side, inventory protects the firm from late or missed deliveries, short-term variations in product pricing, availability, quality variations, and last-minute production changes. In today's competitive operating environment, the costs associated with holding extra supply- and/or finished-goods inventory can exceed margins and place the firm in an uncompetitive position.

In many firms, the focus today is on coordinating product specifications, performance characteristics and availability with customer needs. The impact of obsolescence becomes an important consideration as well. The ability to quickly adjust to the needs of the market, and rapidly changing needs and wants of customers, is negatively impacted by high levels of product inventory. This same situation applies equally to the build up of supply-side inventory. Liquidating large amounts of parts/component inventories for products that are no longer being made can be very costly. The transition to "just-in-time" production and inventory management practices is a direct result of escalating inventory holding costs and the need for better inventory management in general.

Lowering the cost of inventory is a goal common to many firms. Throughout the supply chain, within individual firms and between supply chain partners, the emphasis is on inventory-in-motion. Inventory in a static state is vulnerable to the threat of obsolescence, loss, theft, damage, and natural deterioration. Inventory build-up means high costs associated with inventory investment, cost-of-capital, and taxes, in addition to the costs associated with protection and storage. The needed strategic emphasis is on having just enough inventory transported to just the right location at just the right time to meet internal and external customer needs in order to minimize total logistics cost.

The Role of Transportation in the Cost of Service Equation

The transportation function is integral and integrated throughout the entire supply chain. Prior to 1980, there was little recognition given to the transportation professional who held the position of traffic manager, responsible for seeing that the product was moved in a timely manner to various customer groups. Often this traffic manager had no formal training for the job, and learned by doing. The primary objective was often simply

to keep costs as low as possible. Transportation was viewed as just a cost of doing business, rather than a source of core competency or competitive advantage (Keebler, 2002).

As a result of deregulation in the transportation industry, shippers and carriers were propelled into a new era of operational and strategic thinking. Competition among logistics and transportation service providers increased, intermodal service options became very common, and shippers suddenly were faced with more complex and difficult decisions for moving their freight. Transportation assumed a much more important role in firms' efforts to provide the higher levels of service and lower prices demanded by customers in negotiated contracts. In this same period of time, the movement to "just-in-time" production and inventory management strategies with the requirement for smaller, more frequent deliveries, placed greater demands on transportation to be more accurate and reliable. The search for the appropriate combination of inventory and transportation intensified.

Many transportation managers found themselves trying to convince corporate strategic planners that transportation plays a key role in efforts to improve production efficiency and customer service with lower average levels of inventory. At the same time, they were trying to develop transportation networks with more flexibility in meeting customer needs and challenging the age-old premise that the best transportation alternative moves the largest amount of product the longest distance to take advantage of lower rates for high volume.

Whether performed by private carrier, under contract with individual carriers, or through the use of other third party arrangements, modern transportation strategy is generally focused on providing more efficient and effective transportation at lower total cost. Common strategies include the integration of inbound and outbound transportation at the individual plant/division level, integration of transportation needs of multiple plants/divisions, integration of the transportation needs of multiple members of the supply chain, and the use of core carriers. This has resulted in improved levels of service, greater responsiveness, and lower costs and prices for both internal and external customers.

INTEGRATING TRANSPORTATION AND INVENTORY STRATEGIES TO PROVIDE THE "BEST" SERVICE AT THE "BEST" PRICE

It is evident that great strides have been made in improving the productivity of investments in inventory and transportation. From 1981 to 2002, total logistics costs in the United States, measured as a percent of nominal Gross Domestic Product (GDP), have declined by an astounding fifty-four percent! Contributing to the decrease, transportation costs have declined by twenty-four percent, and inventory carrying costs have declined by sixty-six percent. While this improvement is very impressive, the current economic situation, marked by slow economic growth and falling interest rates, has continued to focus pressure on logistics as a source of increased efficiency and cost reduction (Table 1).

TABLE 1
TRENDS IN LOGISTICS COSTS: 2000 - 2002*

Element	1981	1985	1990	1995	1996	1997	1998	1999	2000	2001	2002
Logistics	16.2	12.4	11.5	10.4	10.3	10.2	10.1	10.0	10.2	9.5	8.7
Transportation	7.3	6.5	6.0	6.0	6.0	6.0	6.0	6.0	6.0	5.8	5.5
Inventory	8.3	5.4	4.9	4.1	3.9	3.8	3.7	3.6	3.8	3.4	2.8
Administrative	.6	.5	.6	.3	.4	.4	.4	.4	.4	.3	.4

* measured as a percent of nominal GDP
Data Sources: Survey of Current Business, March 2003
U.S. Statistics Abstract, U.S. Department of Commerce
ENO Transportation Foundation

Efforts to reduce inventory costs in isolation often result in a reduction in efficiency and an increase in the cost of transportation. Focusing on reducing transportation cost, without considering the impact upon inventory, would have a similar negative result. As an old classroom example demonstrates, a product that has been produced but not yet sold is either moving or at rest—it is a matter of physics. The state of the object can be changed, but cost will continue to accumulate regardless.

A more appropriate approach to the problem is to craft a strategy that addresses the inventory and transportation service required to meet the needs of customers, and provide that service at the lowest total cost. As can be seen in Table 1, it was a reduction in both transportation and inventory costs which contributed to the decline in total logistics costs over time. It would not have been possible to maintain the level of service expected by customers while reducing inventory costs without the use of efficient, well managed transportation. It is within the context of reevaluating the total logistics strategy that transportation managers are expected to find new ways to increase transportation effectiveness and efficiency. The ability to deliver exceptional service levels to internal and external customers, while reducing costs, can be the source for developing an enduring market advantage over the competition. Transportation managers, however, must be willing to accept the challenge of making the changes required to develop the transportation and inventory strategy that will accomplish this objective.

Accepting the Challenge

The initial step in determining the strategy required to balance cost of service with inventory and transportation requirements ($I + T = C_s$), is to determine just what "service" means, in measurable terms for both internal and external customers. Without a clear understanding by all parties involved, it is unlikely that the objective will be achieved, and the result could even bring higher cost and an increase in customer attrition. A second requirement is an evaluation of the existing inventory and transportation strategy to make an accurate determination of costs and the current "track record" for meeting customer needs. It is at this point that inventory and transportation managers can begin the task of pairing inventory requirements and transportation

resources to produce the most cost effective strategy. Generating additional product value by making improvements in warehousing and transportation is a daunting challenge for the logistics area of any organization.

Reevaluation

It is in this phase that the transportation manager will be called upon to reexamine mode and routing choices as decisions are made regarding the appropriate trade-offs between inventory and transportation costs. In earlier times, this would probably have involved fairly easy decisions. Answering the questions of what modes and infrastructure were available, and the cost for each option, would have made the choices readily apparent for some organizations and some industries. Such is not the case for most businesses in this country today. Shifts in the share of international trade allocated to individual modes since 1997 reflect this reality (Table 2).

The transportation manager has more to consider than simply choosing the mode which has historically been considered most appropriate based upon cargo type, time sensitivity, destination, and cost. Keeping inventory in motion is the goal in today's competitive operating environment. Mode and carrier choices are made even more difficult by the availability of a wide array of intermodal service options and the need for international outsourcing. Therefore, previous rules of thumb will often not result in the most appropriate decisions. Inventory at rest in warehouses and in transportation bottlenecks is more vulnerable to obsolescence, tampering, and theft. The requirement of modern transportation can be characterized as "maximizing motion while minimizing rest."

To accomplish this task, the transportation manager must look beyond mode-in-general to mode-in-traffic-lane. Each lane has its own characteristics, stemming from variations in traffic volume, number and size of the carrier

TABLE 2
VALUE OF U.S. INTERNATIONAL MERCHANDISE TRADE BY MODE OF TRANSPORTATION IN CURRENT U.S. DOLLARS AS A PERCENT (BILLIONS)

	Exports		Imports		Total Trade	
Mode	**1997**	**2001**	**1997**	**2001**	**1997**	**2001**
Water	32.7	27.2	46.1	45.5	40.2	38.4
Air	32.0	34.4	24.5	23.4	27.8	27.7
Truck	24.3	26.3	18.0	17.8	20.8	21.1
Rail	2.7	3.2	5.9	6.1	4.5	4.9
Pipeline	0.04	.1	1.6	2.3	0.9	1.4
Other	8.3	8.9	4.0	5.0	5.9	6.5

U.S. Department of Transportation, Bureau of Transportation Statistics, May 2002
U.S. Department of Transportation, Bureau of Transportation Statistics, Transborder Surface Freight Data, 1997 and 2001

pool, infrastructure availability and security requirements. All of this comes at a monetary and time-related cost that might be dependent upon time of use. These and other general considerations that apply to the shipping lane can be applied to individual modes and ultimately, specific carriers.

Care should be taken, however, not to generalize the capabilities of any mode to deliver the needed level of service. Such generalizations can ultimately be counter-productive, resulting in missed opportunities to improve service using a lower- or same-cost inventory/transportation combination. The objective of the modal choice decision is to take advantage of unique modal characteristics and overcome location-specific infrastructure weaknesses. It should be noted that individual carriers sometimes develop a level of flexibility and or speciality which enables them to overcome commonly perceived mode-related limitations. The growth in the air cargo sector resulting from the combination of more plane capacity with the ability to haul larger and heavier cargo is an excellent example of changing modal strengths and weaknesses. Increasing competition in the air cargo industry has led to greater service availability at more competitive prices ("Forecast Correction," 2003; "The Top 50 Cargo Airports," 2003)(See Table 3).

Coupled with the ability to operate with lower inventory levels attributable to reduced transit times, air cargo may prove to be a viable alternative when providing a solution to a specific customer service request. Such a solution might have previously been considered "too expensive" without closer examination. An examination of the average annual growth rate of the use of air transportation in the U.S. merchandise trade serves to illustrate this point (Table 4).

TABLE 3
GROWTH IN THE AIR CARGO SECTOR:
FREIGHT AND EXPRESS TON MILES (MILLIONS)

	1981	1985	1990	1995	1996	1997	1998	1999	2000	2001	2002
Domestic	3,350	3,144	5,075	6,397	6,596	7,169	7,002	7,289	7,953	7,332	9,796
International	2,336	2,887	5,471	8,181	8,705	10,789	11,129	12,028	13,490	12,787	13,364

Source: Stats@airlines.org, 7/3/2003 2:54:00pm

TABLE 4
VALUE OF U.S. MERCHANDISE TRADE BY AIR TRANSPORTATION: 1970 - 2001 MEASURED IN CURRENT DOLLARS (BILLIONS)

Year	Total Air Trade	Exports	Imports
1970	10	6	3
1975	24	15	9
1980	74	46	28
1985	104	52	51
1990	201	111	91
1995	355	181	174
2000	593	284	309
2001*	519	251	267

U.S. Department of Transportation, Bureau of Transportation Statistics, May 2002
*After September 11, 2001 air transportation was slow to recover

Cooperation and Strategy Development

With a greater understanding and appreciation of the opportunities afforded by the use of specific modes and traffic lanes, the transportation manager is better equipped to provide critical input as strategies are developed combining transportation and inventory requirements that provide cost effective service solutions to internal and external customers. Transportation managers must be knowledgeable of and ready to recommend routes and modes that leverage unique modal characteristics and infrastructure availability. Alternative routing and/or modal usage should be proposed when infrastructure and/or intermediary inadequacy in a given market or supplier location precludes the use of a more common transportation alternative.

Using the input provided by customers and transportation managers, it would then be possible to construct a comprehensive strategy designed to meet market needs. Once this new strategy is in place, the level of service achieved would be difficult to duplicate, providing a competitive advantage to the firm and contributing to firm profitability.

IMPLICATIONS FOR TRANSPORTATION MANAGERS

The transportation manager's role in the organization has always been important. Recently, the pressure and responsibility associated with the role has increased dramatically, owing to such factors as greater levels of competition, an unstable economy, and higher costs of doing business. The need to maintain the security and integrity of international supply lines with increasing political uncertainty and government instability adds an additional element of risk to the mix. As the need to outsource to more and more international suppliers increases, the responsibilities associated with the transportation management position will increase at the same rate. The same is true for firms

that, instead of outsourcing, are transporting their products to more and more countries to reach new markets. This organizational role will continue to gain in importance and scope as operations expand beyond the traditional domestic focus. The transportation manager, in order to meet these challenges, must have vision, and the ability to develop creative, integrative solutions with little lead time.

The need to reevaluate and reconfigure the supply chain and internal support processes includes determining the most productive use of the transportation/inventory mix. The responsibility for this rests on the shoulders of the transportation manager as part of a multi-disciplinary team charged with maintaining or improving service levels while concurrently stabilizing or reducing costs. As part of the reevaluation of existing transportation and inventory strategies, the transportation manager must be prepared to redesign the transportation network and practices. The modes, carriers, routing and other factors that worked well a decade ago must be critically examined for "goodness of fit" in the current business environment.

An important decision that must be made is who is to be responsible for the transportation process. If the decision is to outsource any or all of the transportation function, the choice of partners is of the utmost importance. Partner performance will have an enormous impact on the level and cost of service. This is also an opportune time for the inbound and outbound transportation systems to be analyzed and reintegrated. Again, this may be accomplished within the organization or through the use of an external, or third-party provider.

The transportation manager must also be prepared to utilize the various technology-driven options for enhanced visibility, increased security, and improved communication as deemed appropriate (Supply Chain Challenge, 2003). The use of the Internet and various software productivity tools, such as transportation management systems (Rutner and Gibson, 2002) may be used to enhance daily operations and improve internal and external communications. This approach will add value for customers by empowering them to consign and track their products, improving their ability to coordinate delivery and product use.

Whatever the situation, the far sighted transportation manager must approach it with an open mind regarding the possibilities of various alternatives. He/she must also have the flexibility to embrace change as needed to enhance performance. It is the availability of efficient and economical transportation choices that provides the basis for sound inventory level decision making and the ability of the organization to achieve that delicate balance between logistics cost control and maintaining the service levels that differentiate them from the competition.

CONCLUSIONS

Evidence shows that through the considerable efforts of logistics professionals, the cost of transportation as a percentage of nominal GDP has steadily dropped since 1981. The increased productivity in this area of business has assisted firms in their efforts to remain cost competitive and able to provide the high service levels expected in today's business environment.

Transportation has contributed significantly in recent years to the firm's ability to reduce inventory and its related costs, and provide time-sensitive delivery. Many firms have turned to transportation which affords a

time-sensitive element, e.g., expedited truckload or airfreight, to reduce the time that inventory is in transit, reducing the total inventory requirement for customers. The investment in information technology to facilitate tracking and tracing has greatly improved the ability of shippers and carriers to develop cost effective strategies which meet the needs of company and customer. This has also enhanced secure goods movements as the shipment is "in view" at all times. The use of the Internet has improved communication and planning. Inbound and outbound transportation can be combined into a single network, improving equipment utilization rates and reducing costs. The result has been the creation of additional value for both the company and the customer at lower total cost.

Following the events of September 11, 2001, and the subsequent efforts to improve transportation and cargo security, many have questioned whether or not it would be possible to maintain the improvements in logistics efficiency. There has been speculation that firms would have to resort to higher inventory levels as "protection" against supply interruption and extended delays due to security concerns and procedures. They might also turn to slower, high volume transportation providers where lower cost would be substituted for time sensitive service. If this were indeed to happen, with transportation and inventory level strategy coordination reverting to the practices of 1981, over $1 trillion would be added to the costs of logistics. This figure does not even include the costs attributable to the loss of competitive advantage in the global marketplace (Delaney and Wilson, 2003).

Fortunately, this scenario is not likely to occur. There may be a moderate increase in inventory levels in the short term, and there are certainly costs associated with the new security initiatives. However, the obvious benefits of improved logistics performance will not be lightly given up by company or customer (Delaney, 2002).

In spite of all the speculation regarding changes that may or may not take place, transportation remains the force that keeps inventory in motion, supporting the value proposition of an integrated transportation and inventory strategy at the lowest cost of service for company and customer.

REFERENCES

"Adjusting to New Cargo Rule Takes Time," (2003). *APICS-The Performance Advantage*, April , p.9.

Delaney, Robert V. and Wilson, Rosalyn. (2003), "14th Annual 'State of Logistics Report,'" National Press Club, Washington DC, June 2.

Delaney, Robert V. (2002), "'Just In Time' Will Bend But Not Break," Cass Information Systems, Inc.

"Forecast Correction," (2003). *Air Cargo World*, Commonwealth Business Media, Washington DC, pp. 22-23.

Keebler, James S. (2002). "Trends in the Transportation of Goods in the U.S.," *Journal of Transportation Management*, Vol 13, No2 (Fall), pp. 1-14.

Rutner, Stephen M. and Gibson, Brian J. (2002). "An Examination of the Impacts of Transportation Management Systems," *Journal of Transportation Management*, Vol. 13, No 1, (Spring), pp. 41-50.

"Supply Chain Challenge," (2003). *APICS-The Performance Advantage*, April, pp.43-56.

"The Top 50 Cargo Airports," (2003). *Air Cargo World*, Commonwealth Busi-ness Media, Washington DC, pp.24-30.

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DRIVERS OF LOGISTICS EXCELLENCE: IMPLICATIONS FOR CARRIERS

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ABSTRACT

Technological advances have increased customer expectations during an era of increasing cost controls. Shippers are becoming more demanding as technologies being developed offer greater visibility and control in the supply chain. The question remains, however, as to what are the key drivers of this technological change, and where is the market headed. Will these changes merely add cost or will they enable carriers to compete effectively in the market? The purpose of this article is to highlight six major drivers of logistics excellence, and to provide the carrier community with some thoughts as to how to respond to these emerging trends.

INTRODUCTION

The transportation industry is facing tremendous change. According to Delaney and Wilson (2003) the spending on transportation has declined for the last three years, as a percent of gross domestic product. They also note that overall, motor carrier services have slipped during this period, with LTL carriers falling the most. According to the authors, Donald A. Broughton, an analyst with A.G. Edwards in St. Louis, reports that more than 10,000 motor carriers have failed since 2000. Some of the larger firms that have filed for bankruptcy include: Consolidated Freightways, Simon Trucking, the Morgan Group and A-P-A Trucking. Cooke (2003) reports that newer, cleaner burning engines and new hours-of-service rules are significantly reducing already slim profits. In addition, insurance costs have also seen significant increases since September 11, 2001.

Cost issues are only part of the challenges facing the transportation industry. Another area of change has been the continued development of new tools that enable both shippers and carriers to increase the visibility of their operations. The required investment for visibility comes at a steep price for many shippers and carriers.

These challenges are taking place under the broader initiative of supply chain management. Here, firms are working to manage their entire channel to be more effective in the market. In a study by Morash (2001), customer service and quality were two of the

most important capabilities in a supply chain, followed by information support and distribution flexibility. Clearly, transportation providers can impact these capabilities for their customers.

It is clear that technological advances have been coupled with increased customer expectations. For instance, Kent, Manrodt, and Parker (2000) found that 68% of respondents in their study used some form of mobile communication system in their firm. This indicates that shippers are becoming more demanding with respect to the need for real-time (or near real-time) information about product flows and technologies are becoming increasingly suited to meet that demand. The question remains, however, as to what are the key drivers of this technological change, and where is the market headed. Will these changes merely add cost or will they enable carriers to compete more effectively and efficiently in the market? The purpose of this article is to highlight six major drivers of logistics excellence, and to provide the carrier community with some thoughts as to how to respond to these emerging trends.

RESEACH BACKGROUND AND METHODOLOGY

Examining how the largest companies in the U.S. are meeting the transportation-buying challenges of the 1990's has been the focus of a twelve-year, joint research effort between Georgia Southern University (2000–present), the University of Tennessee, Mercer Management Consulting (1992-1996), and Cap Gemini Ernst & Young, LLP (1997-present). The project has involved an annual survey of the largest domestic companies for the purpose of profiling the transportation and logistics services that these firms seek from providers. Each year since its inception, the study group has grown to more accurately determine unique and common transportation and logistics characteristics across dimensions such as industry type, amount of expenditure on transportation, and even the organizational view of these functional areas. Previous year's respondents (from the company perspective) were targeted and encouraged to participate in the current year's research.

The longevity of this research has enabled a significant accumulation of data from which numerous descriptive statistics have been compiled. The business environment, however, has experienced several unexpected events that have significantly altered strategy and operations. In 2000, the economy began to soften. On September 11, 2001, the terrorist attacks added to the uncertain business environment. Economic malaise on a global basis remains a challenge today. These circumstances have dramatically changed the nature of doing business. The research presented in this paper will only focus on the years 2000 through 2002 in an attempt to better understand how the business environment since 2000 has impacted and continues to impact transportation providers. The continuity of research questions and respondents during this time period has allowed some degree of inference and association to be made.

The original starting point for selecting target study companies was the top 500 revenue producers as listed in Fortune. These firms were initially identified, and names of logistics executives were collected, from the Council of Logistics Management (CLM) membership directory, as well as the Official Directory of Industrial and Com-mercial Traffic Executives (or "Bluebook"). The respondents were senior transportation and logistics managers, with job titles ranging from vice president to manager. A requirement for inclusion in the first study was that the transportation structure be

centralized to ensure that the results would also reflect the corporate perspective.

An examination of this influential segment of transportation and logistics purchasers (as defined by the firm's revenue base), makes it possible to gain valuable insight concerning trends and issues that are reflective of the entire population. Given their unique size and presence in the marketplace, expectations and requirements of this group will impact carriers as well as other shippers. In fact, this information has also been used as a benchmark for smaller firms as they mature and integrate these functions into their firm's core competencies. Overall, the compilation of the annual profiles enables the measurement of change that has occurred in the past. Given the documented, rapid change of technology—and its importance to transportation and logistics—it is essential to understand how quickly these functional areas are changing as they adapt to their "new" environments.

Each year the study has used the previous year's participants as the starting point for developing the current study sample. In subsequent years, the *Fortune* listing and the CLM directory have been supplemented by utilizing *Logistics Management* to locate an individual who had moved, or when a contact name was needed for a particular company. The overall goal of this process remains the identification of the most senior person in the company responsible for purchasing transportation services. In fact, most individuals completing the study instrument are at the senior management level. A significant number of individuals have participated every year since the beginning of this research effort.

After the individual(s) within each company was identified, a letter was sent requesting assistance in this study. If an individual could not be contacted after a reasonable number of attempts (via both letter and telephone), that individual was deleted from the distribution list. In the past, since the majority of the study participants preferred returning the survey in the mail, this was the principal method used. Facsimile was an alternate method used by many of the respondents. In general, this method and the Internet will be employed much more widely in future efforts.

STUDY PARTICIPANTS

A breakdown of the respondents by industry classification for 2000–2002 is shown in Table 1. The majority of respondents across the annual studies have been involved in manufacturing. It should be noted that the percentage of respondents from the manufacturing sector reflects their proportion of the population in the Fortune 500 listing. This industry sector spends a larger fraction of the revenue dollar on transportation and logistics. They also account for a sizable share of the total dollars spent on transportation in the U.S. As such, it is important to capture a significant component of this sector due to its influence on trends and future innovations.

In addition to industry classification, the study participants were also categorized by size of company (based on annual revenues). These data are presented in Table 2 for the time period 2000 through 2002.

TABLE 1
RESPONDENTS BY INDUSTRY

Industry	*2002*	*2001*	*2000*
Manufacturing–Consumer Products	17.5%	23.1%	19.7%
Manufacturing–Industrial Products	16.0%	11.9%	10.5%
Manufacturing–General	15.7%	12.8%	14.1%
Consumer Products/Retail	15.7%	8.9%	17.0%
Manufacturing–High Technology	8.9%	4.2%	5.8%
Transportation	8.0%	11.2%	9.7%
Energy/Chemical Utilities	7.4%	6.5%	5.1%
Life Sciences	3.1%	0.9%	1.9%
Communication/Media/Entertainment	2.2%	2.3%	1.7%
Mining or Petroleum	1.5%	1.4%	1.0%
Service–distribution	NA	NA	4.6%
Other	4.0%	16.8%	8.9%

TABLE 2
RESPONDENTS BY TOTAL ANNUAL SALES

Total Annual Sales	*2002*	*2001*	*2000*
< $250 million	24.0%	28.1%	33.7%
$250 - $500 million	13.0%	14.4%	16.0%
$500 - $1 billion	13.0%	12.5%	16.2%
$1 - $2 billion	12.0%	13.1%	13.2%
$2 - $3 billion	10.0%	6.3%	7.0%
$3 - $5 billion	6.0%	7.5%	4.7%
$5 - $9 billion	5.0%	6.3%	2.0%
> $9 billion	17.0%	11.8%	7.2%

RESEARCH FINDINGS

Given the changes over the past several years as related to transportation spending, a key question to ask is "What are some of the factors that may be related to these changes? That is, how is the shippers' world changing, and what are the implications of these changes to carriers across the industry?"

Manrodt, Holcomb, and Thompson (2000) identified six key drivers to fulfillment excellence. They suggested that customer demand and technology advances would drive the implementation of adaptive networks that would provide greater visibility and control over supply chain, transportation and distribution activities. They also predicted a continued migration toward the

application service provider (ASP) model, in which providers host and maintain leading software applications on the Internet, enabling firms to collaborate with suppliers and logistics partners on a common, ubiquitous platform.

While these trends have shown considerable progress, actual implementation of newer tools and methods have fallen short of expectations set during the height of stock market growth. Since then, the softening U.S. economy has introduced uncertainty into the technology sector, leading some firms to delay spending increases of any kind.

Despite the cautious tone, many leading firms are investing more aggressively in newer logistics systems in an effort to trim costs, improve efficiency and respond faster to changes in market conditions. In fact, the focus on costs has increased during the past several years. This has been paired with increased consolidations within the software market, and a decrease in new technology entrants.

Regardless of the economic conditions, these drivers are still critical to firms that are attempting to be more responsive and flexible in a dynamic environment. These drivers—collaboration, optimization, connectivity, execution, speed and visibility—and their impact on transportation providers, are provided below.

Collaboration

Collaboration is the act of leveraging supply chain assets with key customers and suppliers to achieve a common goal. Its value is realized throughout the supply chain, as it enables companies to improve their operations and more efficiently serve customers. A necessary first step for collaboration is to identify key suppliers and customers that are critical to the long-term success of the firm. These firms will link together to form a complete "supply chain to supply chain." This first step is realized in part through supplier rationalization and customer profitability analysis. This critical assessment of suppliers and customers will enable the firm to determine which companies they should engage in collaboration. Because it is not possible to collaborate with every supplier and customer, the firm needs to ascertain which key suppliers and customers will result in the creation of greater value for all members of the supply chain.

Survey participants were asked whether they had evaluated their products, customers and suppliers over the last two years to determine which were most beneficial to the firm. The results are shown in Table 3. Surprisingly, less than one-third of the companies surveyed have attempted to identify key customers, or analyze their profitability. This is problematic, since a "best customer" based solely on sales volume or strategic importance may be relatively expensive to serve and provide a smaller profit margin compared to other customers.

TABLE 3
PERCENTAGE OF COMPANIES SURVEYED IN 2001 THAT PERFORMED ANALYSIS IN THE PAST TWO YEARS

Analysis	*%*
Product rationalization	29.5
Customer profitability analysis	29.5
Supplier rationalization	25.9

As few as one-fourth of all respondents have implemented key (or strategic) supplier programs. These numbers are unexpectedly low, possibly because many firms are using cumbersome lower-level tools, such as spreadsheets or manual methods, to analyze supplier performance and profitability. Firms may also be struggling with the accuracy of their data, or finding it difficult to make this data readily available across the enterprise.

Whatever the reason, customer, supplier, and product rationalization is not being conducted to the extent needed. Previous studies have shown that "instinct" or "feelings" are no match for formal analysis in understanding the importance of both suppliers and customers. For instance, Kraus and Ellram (1997) found that firms who reported satisfactory supplier development were more likely to put effort and resources into supplier development, and were more willing to share information with their suppliers. Since collaborating with less-than-optimal partners may result in substandard performance and weak relationships in the long term, companies would be well advised to perform more analysis in this area.

Implications for transportation providers. The drive for supplier rationalization and other analyses should not come as a surprise for transportation providers, as they have already experienced firms employing core carrier programs. Given the new environment, the key question for transportation providers is how these changes may impact them.

In part, the ability of a transportation provider to be more collaborative may not be direct, and may depend upon the visibility of transportation costs as well as the level of sophistication of the customer. If the transportation costs are bundled as part of the product cost, and the level of sophistication on the part of the customer (as it relates to understanding transportation costs) is low, transportation providers may be handicapped. Obviously, there are significant differences between FOB origin and FOB destination, and the customer needs to know them prior to making a decision.

When a customer suggests that they are considering a supplier rationalization strategy, it may be beneficial for the transportation provider to work with the supplier to provide an analysis of transportation costs—especially given that these changes will greatly impact their operating costs. Such a lane analysis would be beneficial to the provider—to identify the most profitable lanes—and would be seen as a "value added" service by the customer. These savings—due to overall supply chain efficiencies—could be shared by all of the participants. In fact, such partnerships might allow suppliers to compete for or retain business they might otherwise have lost.

Optimization

Optimization refers to the tools and processes that lead to fulfilling a supply chain strategy in the most efficient manner. While there are many tools and processes currently being utilized, this study focuses on ERP, order fulfillment, transportation management systems (TMS), and distribution o r warehouse management systems (WMS).

Overall, companies are showing a continued healthy trend of moving away from older approaches to newer, high-end software tools. These findings correspond to the increasing number of firms making a transformation to adaptive networks that can handle the speed and complexity necessary to respond to more sophisticated customer needs.

Over the last year, respondents who purchased or used commercial TMS software to manage transportation rose to 36.5%—a significant increase from 29.8% in 2000. Conversely, those using spreadsheets or manual methods fell to 11% in 2002, down from 27% in 2000.

However, TMS still lags behind the implementation of WMS packages. While over 75% of firms surveyed are using either commercial or internally developed WMS software solutions, only 69% are using TMS systems. This may be due to the maturity of WMS packages compared to TMS solutions, the variety of options available, and the relative volatility in this market space.

Although one might expect that many firms are using application service providers (ASP's) instead of commercially available software for shipping their products, this does not appear to be the case. A separate survey question indicated that while 18% of respondents are using ASP's, these firms ship on average fewer than twenty loads per week. Clearly, the ASP and software markets are not fully mature, and companies may still benefit from integrating and utilizing these solutions.

Implications for transportation providers. Technology is transforming transportation. The ability to track shipments in real time across the globe is becoming a reality. Information technology is becoming a requirement for providers as shippers are asking for more and more information about shipments both in motion and at rest. In addition to providing visibility of material flows, currently available technologies have also enabled providers to reduce several operating costs (Kent, Manrodt, and Parker, 2000). Overall, there are several implications for providers as it relates to this driver.

First, the ability to track and trace shipments in real time is fast becoming the expectation of all shippers. These expectations will only increase with time. Carriers will be required to document when a shipment was picked up, where it is (GPS preferred), if it will be delivered on time and, if not, when it will be delivered. These data will then have to be provided to the customer for calculation and verification of overall carrier performance.

As a result of these expectations, carriers will need to be both transportation and information experts. They will have to develop tools or interfaces that will enable customers to seamlessly manage their supply chain. This is an investment that smaller carriers may find hard to bear; they will have to either serve less demanding customers or seek ways to partner with larger carriers that can provide the needed information infrastructure.

TABLE 4
PERCENT OF RESPONDENTS USING OPTIMIZATION TOOLS, 2000-2001

Tools Used	*TMS*			*WMS*		
	2000	*2001*	*2002*	*2000*	*2001*	*2002*
Commercially purchased software package	29.8	36.5	35	40.2	40.7	40
Software package developed in-house	25.2	32.1	44	31.9	35	28
Manual/spreadsheets	27.1	18.6	11	19.5	14.3	15
Third party provider(s)	15.2	11.5	7	7.2	8.6	13
Other	2.65	1.3	2	1.2	1.4	3

Third, it is anticipated that carriers will have to utilize multiple technologies in the near future as customers adopt a wide range of technologies. For instance, one customer could be using Nistevo to tender loads, another Elogex and a third Red Prairie. For larger carriers that have a dedicated employee to service a single customer, this is cumbersome. For smaller carriers, this may require an employee to learn three different software packages. It is inefficient not only for the time and effort of learning three different interfaces, but also in having to check three different web sites for status on tendered loads. Some providers are attempting to develop interfaces making this redundancy obsolete, but no true market leader has emerged.

As the actual integration between the shipper and carrier becomes more automated, there will be less personal interaction between them. This could have a tendency to accentuate service failures as more attention is paid to the numbers, or actual performance. Carriers will have to be creative in finding ways to maintain a personal relationship that goes beyond the automated process. In the short run at least, there is a side effect to increased automation between customers and carriers—increased switching costs. Shippers will not have the same level of flexibility to replace carriers quickly and easily. It is expected that shippers will become increasingly particular as to who will move their goods, and expect that these relationships will have a longer life cycle than in prior years.

Finally, it is expected that profit margins earned by carriers from larger, more sophisticated shippers will decline. Much like the Wal-Mart business model, the margin will more than adequately be replaced by a larger volume of business for the carrier. In many cases, the business interaction elevates to a partnership whereby both parties identify and implement procedures and processes that are mutually beneficial. This will not be the case, however, for some smaller, less sophisticated shippers. Their rates will most likely result in increased margins for the carrier. This will reflect the inability of the carrier to gain the needed efficiencies due to the shipper's lack of technology.

Connectivity

Connectivity describes the level of integration that enables individuals, organizations and external parties to exchange information in a timely manner. A prerequisite of any adaptive network, connectivity relies on technology formats and protocols shared by all parties.

In 2001, most survey respondents characterized themselves as "somewhat" or "less than integrated" from front-end to back-end operations. The results for 2002 have shown no significant increase in the way respondents describe their level of connectivity.

Over the past few years, little progress has been made integrating transportation management systems (TMS) with warehouse management systems (WMS). TMS and WMS are still largely disconnected from order fulfillment, although some progress has been made to integrate order fulfillment into WMS, as reflected this year by a majority of respondents who indicated this key exchange to be "integrated," as opposed to "somewhat integrated" last year (see Table 5).

Companies are still relying on alternative means of communication, such as personal communication and other manual methods, to coordinate and integrate their activities. Alternatively, firms may have scaled back their investments for integrating ERP, TMS, and WMS systems as a reaction to economic uncertainty. Unfortunately, the value proposition that moved the organization towards these applications may not be fully realized until these solutions are more fully integrated. Disconnected technology has minimal value.

TABLE 5
INTEGRATION OF SOFTWARE PACKAGES

Software packages	*Mean*	*Mode*
Order fulfillment–ERP	3	1
Order fulfillment–TMS	3	1
Order fulfillment–WMS	6	7
ERP–TMS	3	1
ERP–WMS	3	2
TMS–WMS	5	7

1 = Very integrated; 7 = Not integrated

Implications for transportation providers. Clearly, this lack of integration impacts everyone. The lack of internal connectivity can lead to increased costs as expedited freight is used to meet service requirements or agreed upon service levels.

While it may be that carriers cannot change the internal connectivity of their clients, they should at the minimum be aware of the consequences of it. How can the carrier provide services to minimize the impact of this consequence? What information can the carrier provide that could be helpful? And, how will the carrier's business be impacted when the customer becomes more integrated over time?

Execution

Execution refers to the logistics activities that ensure availability of the right product, in the right quantity and condition, at the right place and time, to the right customer—all at the right cost. It encompasses all aspects

of performance in an adaptive supply chain.

The survey results indicate that there are still many firms who neglect to routinely measure their distribution and order fulfillment performance. From the number of survey respondents who answered each question, the percentage of firms measuring themselves using each indicator was determined (see Table 6). The three most frequently used measures for performance were: 1) lines filled out of lines ordered, 2) available on promised delivery date, and 3) cases shipped to cases ordered. Slightly more than 60% of respondents indicated they measured "lines filled out of lines ordered." Fifty-six percent of respondents measure whether their products/ services were "available on promised delivery date." However, very few are measuring order performance; only 16.3% responded to the category "in-voices shipped complete/total invoices."

For those firms who measured themselves on each criterion, survey respondents gave them-selves high marks in logistics execution. The following are 2001 survey results indicating self-reported execution of logistics performance on a number of widely used measurement criteria.

Survey results also show that most companies have achieved the ability to differentiate "best" and "average" customers. This is a positive development. Since the late 1980's, research findings have suggested that a "one-size-fits-all" approach to customer service is not effective. Langley and Holcomb (1992) provide one of the pioneering articles in this area. Firms are still trying to develop and implement processes and systems that can support differentiated service from an execution standpoint. Table 7 provides the most notable findings.

The differences between best and average customers can also be seen when it comes to calculating the perfect order percentage. To do so, each of the metrics are multiplied by each other (on time delivery x over/short/ damage x correct invoice x complete). A firm operating at 90% in all four areas will have a perfect order percentage of only 65.6%. Best customers experience a perfect order (lines filled/ lines ordered, on time, damage free and correct invoice) 85.7% of the time, compared to 80.5% for an average customer.

TABLE 6
REPORTED LOGISTICS PERFORMANCE, 2001

Available on promised delivery date	92.6%	Invoices shipped complete/total invoices	90.5%
Lines filled/lines ordered	93.4%	Dollars shipped/dollars ordered	89.5%
Cases shipped/cases ordered	92.4%	Orders that result in a backorder	6.2%

TABLE 7
LOGISTICS EXECUTION FOR BEST AND AVERAGE CUSTOMERS, 2001

Measure	*Best Customer*	*Average Customer*
On time delivery	96.39%	93.58%
Over/short/damage	2.03%	3.23%
Correct invoice	98.24%	96.34%
Complete (everything that the customer ordered)	2.29%	2.58%

Implications for transportation providers. The perfect order is fast becoming the preferred performance metric. It captures the totality of the interaction between the supplier and the customer, from the time the order is placed until it is delivered.

Clearly, transportation professionals have a profound impact on the perfect order. They must deliver goods on time and damage free. In addition, carriers will be expected to provide the data necessary to calculate the metric in a timely manner.

Regarding actual performance, the delivery of goods will always have some variability, resulting in a less than perfect experience. While most rational executives understand this, carriers will have to demonstrate that these are due to random acts, and not systemic, or process related errors. This will require carriers to become more involved in process mapping and perhaps seek ISO certification as assurance to customers of a reliable process.

The data will also have to be transferred between the carrier and the shipper on a customer by customer basis. The perfect order can be calculated as "the average of the averages" or individually, and then averaged. The later calculation will enable firms to complete a Pareto chart of the number of perfect orders by categories, as well as an aggregate number. In addition, the granular set of data can be used to calculate the perfect order for its most important customers.

Speed

Speed to market remains the ultimate factor determining whether a firm survives, regardless of changes in the economic landscape. It relies on the ideal connectivity, collaboration and execution elements of the adaptive supply chain.

Survey participants reported in 2002 that the minimum expected time it takes to acquire raw materials into their process—which represents the time an order is placed until it is received—is approximately 18 days. The replenishment cycle is even longer, taking on average up to 30 days. In general, if an order takes longer than 45 days, the customer will order elsewhere.

The demand for speed is evidenced in the frequency of customer orders. Among the respondents, almost 40% report that their "best" customers order on a daily basis, while an additional 22% order two to four times a week. This is almost double the level of activity reported by the majority of "average" customers who placed orders.

The results suggest a dilemma. As firms invest in tools and processes to enable cus-

tomers to place orders on a daily basis, there is still a tremendous lag time of 18 to 30 days before orders are received and the fulfillment process is completed. Based on findings presented earlier in this report, firms are delivering 92.6% of orders on the promised date. A significant gap exists between the frequency of order placement and the time window specified for meeting the customer's requirement. Somewhere in the fulfillment process, speed is lost.

The ability to respond quickly to market conditions and customer demand is crucial. The goal of logistics has often been described as getting the right product to the right place at the right time. The logistics perspective meant that this goal involved only two parties in the supply chain. The goal today is to achieve the right product at the right place at the right time for all members in the supply chain with increasing effectiveness and efficiency. Real-time adaptability provides firms with a tangible advantage by enabling them to get to market faster than their competitors.

Implications for transportation providers. No one has felt the changing pressure of speed more than carriers. Speed is a key component of being able to respond to uncertainty in a manner that is both cost efficient and customer effective. Without capabilities such as connectivity, optimization, or visibility in place, asset utilization will become an even bigger challenge. Furthermore, responsiveness (or speed) will not be the only negatively impacted element. Lack of speed in adapting to rapidly changing market conditions will ultimately affect execution.

Visibility

Visibility is the ability to see and manage the flow of products, services and information in real time. It includes access to inventory in transit, product availability and order status.

Visibility of the supply chain can no longer stop at the shoreline or at our domestic borders; it must circle the globe to manage the flow of products, services and information. Real-time inventory visibility, product availability and order-status information provides opportunities to drive down costs and improve customer service.

Unfortunately, many firms report having little visibility over many critical supply chain activities, including those most impacting customer service—shipment and order tracking. Responses to visibility issues are shown in Table 8.

TABLE 8
VISIBILITY OF EVENTS IN THE SUPPLY CHAIN (PERCENT OF RESPONDENTS)

Attribute	%	*Attribute*	%
Tracking inbound shipments	61.0	Divergence of shipments	20.3
Alerts to late or delayed shipments	58.1	Routing and scheduling optimization	41.9
Appointment scheduling	57.0	Electronic tendering of shipments	32.0
Domestic visibility of orders	57.0	In-transit merges	10.8
Continuous moves	2.1	Rating/contract management	7.1
Consolidation of orders	51.5	Tracking outbound shipments	65.2
Carrier selection	79.3	Vendor compliance	55.2

The results indicate that visibility still remains a major challenge for most firms. Some industry insiders insist that it is the next major frontier to be conquered. However, because visibility involves people, processes, technology and information flow parameters, it is an inherently complex issue.

Implications for transportation providers. For carriers, the issue of visibility is compounded by their customers' difficulty in integrating internal functions. This can create an "over the wall" execution scenario for the carriers, where they may be the last to know of a change in requirements, and are expected to "make up" for speed that has been lost at an earlier phase in the order fulfillment cycle.

How important is visibility? Shortly after the events of September 11, 2001, two global pharmaceutical companies responded to requests from a government agency about diverting to New York a very large supply of antibiotics and other goods they produced. The first firm impressed the government—as well as their own top management—by determining the feasibility of this request in about twenty minutes. The second company did not fare as well, and as a result of this one request, is overhauling its supply chain management processes and systems. Clearly, transportation firms have a unique opportunity to provide visibility between the dock doors.

This is not to say that all of the companies will require this level of visibility. Carriers will have to determine the needs of their individual customers. It is not then a matter of whether or not the shipper wants visibility as to the location of their shipment, but rather how much visibility they want, and their willingness to pay for it.

CONCLUSIONS

The pressures faced by today's carriers will only increase. The need to compete effectively, while remaining profitable, will not abate. Hence, successful carriers will have to become more effective in meeting the needs of the customer, and to provide the value added services that will profitably take inefficiency out of the supply chain.

It is the authors' conclusion that this can be done by focusing on the six drivers noted above. Clearly, transportation providers hold the key to successfully implementing many of these technologies. A few final thoughts for carriers may be in order.

First, carriers should know their strategy. How do they plan to compete? What is the key value proposition that they will be offering their customers today, as well as the future? How is this value proposition communicated internally? Will this change in the future?

Second, identify your customer base, both current and future. Some industries may benefit from your specialized equipment or expertise, while others may be more "commodity-based" in nature. Knowing your strategy and customer base is critical before progressing to the next step.

The third step is identifying the biggest needs in the industry. What challenges face them? Do not just focus on transportation, but in other areas as well, such as government regulation, imports, substitute products, new technologies or demographics. A good industry today may not be as attractive a few years from now.

Fourth, because visibility is the most critical capability for shippers, the implication is that

this will be the same for carriers that desire to have a strategic partnership.

Finally, is the carrier able to meet the needs of the customer by providing the services requested? For instance, if the biggest driver for a firm is visibility, does the carrier have the needed finances and expertise to implement a solution that will be beneficial? If it does, can these solutions be leveraged elsewhere in the marketplace? Leveraging a driver across multiple industries should provide the greatest return on the investment.

REFERENCES

Cooke, James, (2003, July), "Deflation Strikes Logistics," *Logistics Management*, Vol. 42, No. 7, pp. 27-32.

Delaney, Robert V. and Wilson, Rosalyn (2003, June 2), "14th Annual State of Logistics Report," presentation to the National Press Club. Study was funded by Cass Logistics and ProLogis.

Holcomb, Mary Collins and Karl B. Manrodt, (2000), "The Shippers' Perspective: Transportation and Logistics Trends and Issues," *Transportation Journal*, Vol. 40, No. 1, Fall, pp. 15-25.

Krause, Daniel R. and Lisa M. Ellram, (1997), "Success Factors In Supplier Development," *International Journal of Physical Distribution and Logistics Management*, Vol. 17, No. 1, pp. 39-52.

Langley, Jr., C. John and Mary Collins Holcomb, (1992), "Creating Logistics Customer Value," *Journal of Business Logistics*, Vol. 12, No. 2, pp. 1-28.

Manrodt, Karl B., John L. Kent, and Stephen R. Parker, (2003), "Operational Implications of Mobile Communications in the Motor Carrier Industry," *Transportation Journal*, Vol. 42, No. 3, Spring, pp. 50-58.

Manrodt, Karl B., Mary Collins Holcomb, and Alan Montgomery, (2002, September), "Visibility: Tactical Solutions, Strategic Implications," Printed and distributed by Cap Gemini Ernst & Young.

Manrodt, Karl B., Mary Collins Holcomb, and Richard Thompson, (2001, September), "Transforming Logistics: A Roadmap to Fulfillment Excellence," Printed and distributed by Cap Gemini Ernst & Young.

Manrodt, Karl B., Mary Collins Holcomb, and Richard Thompson, (2000, September), "Logistics @ Internet Speed," Printed and distributed by Ernst & Young.

Manrodt, Karl B., Mary Collins Holcomb, and Richard Thompson, (1999, September), "Striving for Excellence: New Measures for Logistics," Printed and distributed by Ernst & Young.

Morash, Edward A., (2001), "Supply Chain Strategies, Capabilities and Performance," *Transportation Journal*, Vol. 41, No. 1, Fall, pp. 37-54.

Pinkerton, Richard L. and Edward J. Marien, (1997, April), "Fourteen Steps to an Effective Transportation Program," *NAPM InfoEdge*, Vol. 2 No. 8.

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PRICE NEGOTIATION STRATEGIES ADOPTED BY SHIPPERS OF INTERNATIONAL AIR AND OCEAN TRANSPORTATION

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ABSTRACT

Government regulations in the international air and ocean shipping industry have undergone a wide range of new developments geared towards deregulation. These changes, coupled with the emergence of new technologies, have facilitated foreign trade operations leading to a substantial increase in international air and ocean cargo traffic in recent years.

This study investigates the regulation reforms that have affected pricing techniques in both industries and their implications on the negotiation strategies adopted by shippers and carriers. The survey results identified that each shipping firm negotiated on a variety of issues and employed more than one strategy for negotiating price.

INTRODUCTION

Globalization and international transportation have gained prominence more than ever before in the later half of the twentieth century. The relaxation of U.S. government regulations through the deregulation of both the air and ocean industries contributed to an increase in international air and ocean cargo traffic. Coupled with emerging advancements in technology in the 1990's, there has been a significant decrease in the complexities associated with the movement, storage, and tracking of international consignments, thereby facilitating foreign trade operations. Together, both of these factors have played a vital role in the facilitation of global trade. As a result, many firms now pursue global sourcing to utilize worldwide resources and worldwide technology more efficiently to

create a competitive advantage for themselves in the marketplace (Thomchick 2000).

This study provides a turn-of-the-century view of the regulations that have governed rate-making so far in both the international air and ocean shipping industries. The changes that occurred in the rate making process in the post-deregulated era in both industries are identified. In the case of the air transport industry, the most recent development in regulation was that of the 'open skies' bilateral air service agreements that began in the United States in 1992 (Doganis 2001). In the case of the ocean transport industry, the Ocean Shipping Reform Act (OSRA) of 1998 was the most significant development, completely altering the way shippers and carriers conducted business with each other.

These changes laid the foundation for this study. Although much research has been conducted on the impact of deregulation reforms on the air freight and ocean cargo industry, no study to date has performed an analysis of the price negotiation strategies employed by international shippers in the post-deregulated era. Thus, the objective of this study is to perform an analysis of price negotiation strategies adopted by shippers of international air and ocean transportation in the post-deregulated era. From a more micro view, the research examines the price negotiation strategies adopted by a selected sample of shippers of international air and ocean cargo. The study provides valuable information on the negotiation strategies and carrier selection practices employed by a selected sample of international shippers of diverse goods. All international shippers should benefit from this knowledge since these strategies represent current industry practices.

The research began with a review of the literature on the deregulation reforms that impacted the different approaches adopted in rate making in the air freight and ocean cargo industries. A survey of international shipping firms was then conducted by sending out a structured questionnaire via e-mail. The survey provided information on the factors that influence the carrier selection process and the price negotiation strategies adopted by the respondents. Conclusions were drawn regarding the negotiation strategies and carrier selection practices adopted by the sample.

LITERATURE REVIEW

International Air Transport Regulation and Cargo Pricing

Until the early 1930's, air was employed primarily for the transport of passengers. The usage of air for transporting cargo began in the early 1930's when airlines started transporting airmail (Williams, 1994). National Air Transport, organized in 1926, was the pioneer that employed airlines for the transport of all property other than mail and passengers' baggage (Williams 1994). However, after the establishment of the Civil Aeronautics Board (CAB), through the passage of the Civil Aeronautics Act in 1938, many carriers began to show interest in the air freight business (Williams 1994; Taneja 1980).

United Airlines initiated all-cargo service by offering the first domestic service between New York and Chicago in December 1940. American, United, and TWA followed suit by offering regular transcontinental cargo service from 1945 onwards (Williams 1994). At the same time in 1944, an agreement was reached in an intergovernmental conference in Chicago establishing a global association

for overseeing the rate making process. In April 1945, the International Air Transport Association (IATA) was formed for the purpose of rate making.

The final structure of the IATA resulted from the signing of the Air Services agreement in Bermuda in 1946 (Williams 1994). IATA's rate making process included the following steps. The rate fixing machinery initially arrived at a comprehensive pattern of specified fares on the basis of certain basic currencies, including the U.S. Dollar and the Pound Sterling. The specified fares were approved by the members of the IATA. The fares of individual carriers were based on their specific needs and calculated after considering various factors that influenced the tariff rates both directly and indirectly (Williams 1994). These factors included distance, cost of service, price elasticity of demand, specific needs of carriers serving particular trade lanes, government needs, anticipated demand patterns, availability and nature of competition in specific routes (Williams 1994).

The CAB approved the IATA traffic conference machinery on February 19, 1946, for a period of one year (Doganis 2001; Williams 1994) and later made it permanent in 1955 (Doganis 2001). Thus, IATA traffic conferences began to provide a multilateral link in the bilateral system to coordinate rate proposals between carriers, prior to government review, until deregulation occurred in 1977-78. During the period from 1946 to 1978, IATA had been under constant criticism for being a cartel with monopoly power to set rates and fares for international air transport (Taneja 1979). As a result, the CAB issued a show cause order proposing to disapprove IATA traffic conference provisions and related resolutions in June 1978 (Taneja 1979).

In 1977, the Carter administration initiated a chain of events that transformed the international air transport industry from a closed and protected industry to an open and competitive one (Doganis 2001). Although the Air Passenger Deregulation Act was passed in 1978, the air cargo industry was deregulated separately in the second half of 1977.

On August 21, 1978, President Jimmy Carter issued a comprehensive statement on "international air transport negotiations," setting forth the U.S. policy for the conduct of international air transport negotiations (Doganis 2001). This agreement effectively deregulated air cargo services between countries by introducing a double disapproval regime for fares, which suggested that the filed tariffs became operative unless both governments disapproved it. In the pre-deregulated era, double approval of fares by both governments was required.

By early 1990's, it became clear to many countries that the "open market" bilaterals had not gone far enough and needed further liberalization (Doganis 2001). An "open skies" agreement was inaugurated to enable a new phase of international deregulation (Doganis 2001). The key element of this bilateral, with regard to cargo pricing policy, was that there would be no tariff controls except in instances where the tariff was leaning more towards one of the two extremes. In such instances, government intervention was advocated to protect consumers from unreasonably high prices or to protect airlines from artificially low fares due to government subsidies (Doganis 2001). With the above-mentioned objective and others favoring true liberalization, the Clinton administration, in April 1995, issued the first formal statement of international air transportation policy in 17 years.

Following this statement, the United States prepared for a phased removal of restrictions and liberalization of the air service market. As a result, on tariffs, double disapproval or the country of origin rule was replaced by the decision that government should not interfere in tariff setting, except in extreme instances to prevent discriminatory practices. However, published international fares still continue to be established through the rate setting machinery of IATA.

Air freight services are now sold and marketed in a variety of ways by line haul operators, integrators, and freight forwarders (Williams 1994). The line haul operators sell only a small proportion of their cargo space directly to customers. The greater proportion of their cargo space is sold through freight forwarders and agents who negotiate a fixed amount of space with the airlines. The freight forwarders and agents then sell the freight space to customers. The line haul carriers publish their cargo rates at IATA tariff conferences. On the other hand, integrated operators offer a variety of products and services, depending upon the weight of the consignment and delivery speed required by shippers.

Air cargo rates, irrespective of the operator (line-haul, integrated operators, or freight forwarders) providing the service, are determined on the basis of a number of characteristics and circumstances, including the nature of the commodity, cargo volume, density, weight, routing season, regularity of shipments, nature of transport (imports or exports), priority and speed of delivery (Williams 1994; Frankel 1982). Discounts on cargo rates are widely applied and are based on the volume of cargo transported and the regularity of the customer. However, air cargo rates tend to vary a great deal based upon the nature of the commodity and its destination (Williams 1994). This rate variation can be attributed to three main factors that differentiate the airline industry from other industries. These factors include total dependence of an airline's productivity on its fleet, the large percentage of operating costs not in control of the airline, and the inability of an airline's output (cargo space) to be inventoried (Williams 1994).

International Ocean Transport Regulation and Cargo Pricing

U.S. international ocean shipping is carried out in U.S. owned flag vessels, U.S. owned foreign flag vessels, and in foreign owned, foreign flag vessels. U.S. flag shipping is usually conducted in ships built and owned by U.S. citizens and is comprised of tramp, liner, proprietary, and independent shipping (Federal Maritime Commission 2000).

Tramp shipping involves transporting mostly one general, dry, or liquid bulk commodity per voyage. Liner shipping, on the other hand, involves carrying a wide range of cargo from a number of shippers per voyage. Proprietary shipping is usually employed in the transport of a particular commodity and is operated on behalf of a single economic interest (Federal Maritime Commission 2000). Independent shipping generally consists of dry or liquid bulk carriers chartered by independent owners for a specific voyage or time period on behalf of a particular firm (Thomchick 2000; Federal Maritime Commission 2000).

The ocean shipping industry has undergone many changes from the early 1900's until today. In the early 1910's in the United States, the ocean shipping industry was largely self-regulated through organizations of carriers in each trade route called conferences that dominated liner trading

(Thomchick 2000; Federal Maritime Commission 2000). These conferences set rates and influenced indirectly the number of sailings in a particular route.

Congress passed the Shipping Act of 1916 to define the provisions for the operation of ocean shipping conferences (Thomchick 2000). This act extended immunity to those agreements that were filed with and approved by an independent regulatory agency that eventually became the Federal Maritime Commission (FMC) by executive order in 1961. However, the practices of carriers that were considered to be anti-competitive were curbed.

In the first half of the 1900's, carriers forced shippers to be loyal for a certain period of time in order to get a reduced rate on shipments called deferred rebates. The Shipping Act outlawed deferred rebates to shippers (Federal Maritime Commission 2000). Carriers were also prohibited from making unfair contracts with shippers based on the volume of cargo offered. Every carrier and conference of carriers in international commerce were required to file a schedule of rates and charges with the FMC, which ruled that the rates actually charged must be in compliance with the schedule filed (Brooks 2000). Dual rate contracts, contracts in which a shipper gets a lower rate if he/she promises all or a fixed percentage of cargo to a carrier or conference of carriers, were permitted (Thomchick 2000; Federal Maritime Commission 2000). However, they were subject to the approval of the FMC.

In 1978, Congress passed the Ocean Shipping Act as an amendment to the Shipping Act of 1916 (Federal Maritime Commission 2000). This act prohibited carriers from maintaining rates and tariffs below the level filed with the FMC. The Shipping Act of 1916, though amended numerous times, continued to be the major U.S. maritime legislation governing ocean shipping conference operations until 1984. The Shipping Act of 1984 retained anti-trust immunity for ocean conferences, but still required carriers to file rates and charges with the FMC (Thomchick 2000). Carriers were finally allowed to enter into independent agreements with shippers outside conferences, but were still required to obtain approval from the conferences for such an agreement. This act prohibited the adoption of dual rates.

The next noteworthy legislation in the area was the Ocean Shipping Reform Act of 1995 that attempted to eliminate tariff and contract filing with the FMC, as well as government tariff enforcement and regulation (Thomchick 2000; Lewis 2000). This act was replaced by the Ocean Shipping Reform Act (OSRA) of 1998.

In May 1999, OSRA took effect (Thomchick 2000; Lewis 2000), representing a logical continuation of the trend toward deregulation established by the Shipping Act of 1984 (Kendall 1986). OSRA introduced a new era of one-to-one confidential service contracts with creative provisions aimed to weaken the dominance of conferences. Contracts must still be filed with the FMC, but the terms of the contract are not revealed to the public as before (Brooks 2000). Shippers are no longer able to use publicly filed terms of a competitor for negotiating a better deal with carriers. OSRA does not require carriers to file tariffs with the FMC, but requires carriers to publish tariff rates. The discussion of the above laws and regulations pertain to the liner sector of the ocean shipping industry.

Ocean cargo rates are now determined on the basis of a number of factors, including the cost of owning and operating the vessel, cost of providing the service, value of the service to the owner of goods, an appropriate profit margin, ability of the cargo to sustain its transport expenditure, degree of competition, and prevailing economic conditions (Thomchick 2000; Button and Stough 2000). Although these factors provide a general basis for arriving at a rate for transporting cargo, different approaches to pricing are evident in the tramp and liner shipping sectors.

Tramp shipping transports a single commodity like coal, grain, ore, or phosphate rock per voyage. Since tramp shipping deals mostly with one shipper and one commodity per voyage, all the costs of operating the ship, cargo handling, port fees and harbor dues are added to the capital charges of vessel ownership, overheads and administration expenses (Thomchick 2000; Button and Stough 2000). The total of these costs is calculated in proportion to the number of tons to be hauled. Thus, cargo rates in tramp shipping are mainly dictated by demand/supply conditions existing in the market (Thomchick 2000; Button and Stough 2000).

The liner sector, on the other hand, carries a wide range of cargo from a number of shippers per voyage. Therefore, rate structures in the liner sector are more complex than in the tramp sector. Liner rates are usually based on the stowage factor and the amount of vessel space occupied by the cargo. If a cargo has a stowage factor less than 40, then it does not utilize the space in the vessel efficiently (Thomchick 2000). The liner operator has the right to charge the shipper either on the basis of weight or measure, whichever yields the highest revenue. Also, since liner shipping involves carrying a wide variety of cargo, rates can be quoted per linear foot, per head, per thousand feet, per barrel, and so on (Thomchick 2000; Button and Stough 2000).

Surcharges are often applied to liner cargo rates on certain occasions to help cover short-term economic conditions, including the adverse effects of fuel price increases, insurance rate increases, currency fluctuations, and trade imbalances (Button and Stough 2000). These surcharges are applied regardless of the method (tariffs or service contracts) employed for determining the price for transporting the cargo. When tariff pricing is adopted, shippers do not have the advantage of negoti ating a favorable price with the carriers, since published tariff rates must not be changed. If service contracts are employed, shippers reserve the right to negotiate a favorable rate with the carrier (Thomchick 2000).

METHODOLOGY

Samples

The design of the sampling methodology involved surveying firms that ship goods internationally via either air or ocean transport. The sampling technique employed for conducting this research was convenience sampling. The sample was chosen from a group of firms with which the faculty in the Smeal College of Business Administration has business relationships. A sample of 12 firms that are international shippers of goods was chosen.

Survey Instrument

The survey instrument was a structured questionnaire consisting of 17 questions. Most of the survey questions were left open-ended in an attempt to avoid restricting information

from the respondents. The main focus of each survey was to identify the price negotiation strategies adopted by the firm while negotiating with its air or ocean carriers.

Survey Technique

The survey technique involved initially contacting all the firms that comprised the sample via phone to briefly describe the purpose of the survey. This was then followed by sending out questionnaires via e-mail. From the twelve firms in the sample, only seven firms responded to the email survey. No follow-up contacts were made. Though only seven firms responded to the survey, the authors believe the quality of the data and the integrity of the questionnaire are high. By using this approach, it was possible to identify the most appropriate individuals in the firms who could provide the requested information.

Demographics of the Sample

All the respondents were manufacturing firms that are international shippers of goods using either air, ocean, or both for transporting goods. All the firms in the sample spend an average of at least $7 million on transportation per year. The goods transported by the respondents included medical, consumer, electronic, paper, glass, chemical, and computer products.

STUDY RESULTS

Strategies Adopted by Shippers in International Air Transport Negotiations

The process of international air cargo distribution has undergone noteworthy changes in the past couple of decades due to the deregulation of the air industry and the ubiquitous emphasis placed on lean production methods and supply chain management techniques. Transporting cargo by air has gained importance in this changing environment since air offers a faster and more reliable mode of transport than that offered by ocean.

The study data indicate that air was used for transporting finished goods that had high intrinsic value per ton/kilo/pound. Air was also used for transporting goods that were originally shipped by ocean, when shipments were to be expedited. Many firms indicated that, for cargo that could move either by air or ocean, the mode was selected based on the value of the product, type of product, service level, critical nature of the freight, transit time, time available to reach the marketplace, and cost of the material in the supply chain. In certain firms, the mode of transport was determined by affiliates in foreign countries. The decision process in those firms was influenced by product availability, weight/volume of the product determining the freight cost, transit time, and expected time of arrival of the product at the destination.

The carrier for transporting the product was selected from a variety of sources across firms. These sources include trade journals, solicitations, networking through the international trade industry, on-line auction process, recommendations from other firms, and carriers already in use. The air cargo carriers identified through various sources were then short listed based on their ability to satisfy certain service requirements. The strategies adopted for selecting the carriers varied from one firm to another with the process being influenced by numerous factors. Some firms identified their service requirements and weighed these requirements against the cargo carrying capacity of the

carriers. All the carriers with adequate cargo carrying capacity to meet the shipping requirements of the firm were short listed. These short listed carriers were then weighed against various secondary factors and the carrier that best met all of the service requirements of the shipper was finally selected.

Other firms identified and short listed those carriers that were willing to enter into long term partnerships or global alliances. These carriers were then weighed against several other secondary factors and the carrier with the ability to provide the best service in terms of all the factors required by the shipper was selected. A limited number of respondents placed primary emphasis on the experience of the carrier in the industry and the overall service provided.

The secondary factors that influenced the carrier selection process include frequency of service, price, transit time, infrastructure, financial stability, size, delivery capabilities, ability to consolidate volumes over various trade lanes, and quality of the overall service provided. Service provided by the carrier was considered the most important factor in the carrier selection process by most respondents. Many firms are now focusing more on customer service and inventory management techniques, and this may be the cause for the additional emphasis placed on service by the shipping firms. Price of the service provided was considered the second most important factor by some firms while transit time was regarded as the next important factor after service by most firms.

In addition to the above-mentioned factors, technology played an important role in the carrier selection process in a number of firms. The carriers are now selected based upon their ability to provide on-line bookings, on-line cargo tracking, and the ability to create shipper issued commercial invoices via Electronic Data Interchange.

Thus, each shipping firm has a primary criterion for short listing the air cargo carriers that operated in the market. All the carriers that satisfied the primary criterion were then evaluated on their ability to satisfy other requirements of the firm. The carrier that satisfied both the primary and secondary criteria to the maximum possible extent was selected. The carrier selection process in each firm was very detailed and based upon the performance of carriers on a variety of aspects.

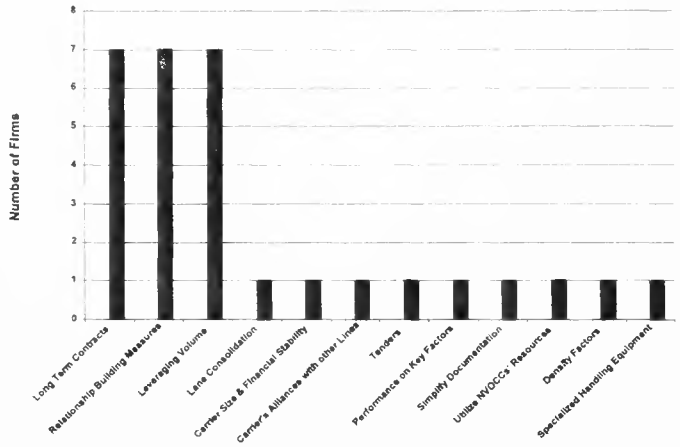
Following the carrier selection process, the shippers negotiated with the selected carrier on a number of issues. These negotiations were conducted on a centralized basis in all the firms that responded to the survey. Although negotiations were conducted on a centralized basis, many firms regionalized the negotiations based on the diverse requirements of subsidiaries in each region.

The negotiations were handled by different departments in each firm. In certain firms, the negotiations were handled by a common department called either, "World Wide Distribution Procurement," "Corporate Logistics," or "International Transportation Department." Other firms had separate departments handling negotiations for each of the modes. Some of the firms that responded had different departments that conducted negotiations for inbound and outbound shipments. The departments that handled inbound negotiations in some firms are either called "Global Sourcing" or "Inbound Team," and the departments that handled outbound negotiations are either called "Logistics" or "Customer Focus Group."

Although price was considered to be the only factor in the negotiations between shippers and carriers, negotiations were conducted on several other factors as well. While, for certain shippers, service was the most important negotiating factor, for others, a variety of factors were on equal par when negotiations were conducted. However, all the firms negotiated on a variety of issues with their carriers, including overall service provided, frequency of service, price, transit times, liability, reporting capabilities, accessorial fees and surcharges, trade lanes, and length of contract. In some firms, the length of the contract with the carrier was determined based upon a number of factors, such as the number of trade lanes served, terms of renegotiation, and value added services provided. A limited number of respondents also placed emphasis on guaranteed cargo space, type of equipment used, equipment availability, cargo tracking capabilities, and performance metrics during the negotiating process. The negotiations were also conducted on the ability of the carrier to establish electronic links with freight forwarders to obtain cargo status, to ensure a proactive approach in identifying cargo delays, to provide automated pre-alert information to the customer, to identify opportunities to allow for pre-clearance of cargo, and to provide multiple service options for each lane.

The shipping firms adopted different strategies to arrive at an affordable price while negotiating with the carriers, as depicted in Figure 1. Every firm that responded to the survey employed more than one negotiation strategy. These price negotiation strategies included entering into long term agreements, concentrating on relationship building measures, leveraging volume to reduce price, floating bids to get a competitive price from the existing base of carriers, consolidation of various lanes, density factors, size of the carrier, financial stability, and alliances the carriers had with other lines.

FIGURE 1
PRICE NEGOTIATION STRATEGIES ADOPTED BY SHIPPERS



Some shipping firms also opted to employ overseas resources of the carriers to satisfy the needs and requirements of their customers. This, in turn, provided the carrier with potential opportunities in foreign countries, which resulted in a reduction in the service price for the shipper. During the negotiation process, certain firms identified opportunities to simplify the documentation process in an attempt to reduce handling fees. Thus, several potential opportunities to reduce the price without hurting overall service are explored during the negotiation process. Shippers and carriers also use the negotiating table to explore opportunities that would benefit both the parties from the relationship.

Strategies Adopted by Shippers in International Ocean Transport Negotiations

The ocean shipping industry has undergone many changes as well due to maritime deregulation culminating in OSRA, which took effect in May 1999. OSRA has replaced conferences that once dominated the liner shipping industry with confidential contracts between shippers and carriers. This change has enabled carriers to collaborate on a variety of issues while maintaining their freedom and flexibility to conduct business with shippers on a one-to-one basis.

A major portion of the physical distribution of international freight is still carried by ocean with air being used only for the transport of high value, low-bulk items and when shipments need to be expedited. Although all of the respondents in the study used both air and ocean for transporting goods globally, around 75 to 95 percent of the overall volume of cargo they transported was carried by the ocean mode.

There was no difference whatsoever in the strategies adopted by the respondents in the carrier selection process between the two different modes. As in the air mode of transport, the respondents required the ocean carrier also to possess technological capabilities to provide on-line ocean bills of lading and on-line cargo tracking, in addition to other general abilities required. Technology is fast emerging as a vital factor in the carrier selection process, regardless of the mode employed for transporting the products.

Shippers conducted negotiations with the selected carrier on a variety of aspects, including price, overall service, frequency of service, length of contract, and trade lanes. The strategies adopted by shipping firms while negotiating price with the carriers was similar to those adopted while negotiating price with air cargo carriers. Thus, all the firms that responded to the survey adopted the same approach while selecting their carriers, regardless of the mode they operated in, and employed similar strategies while negotiating with them on various aspects.

These negotiations were conducted on a centralized basis, and the department that handled these negotiations varied from one firm to another. OSRA had completely altered the manner in which shipping firms negotiated with their carriers. Shippers are now placing additional emphasis on overall service provided, rather than on price alone, as was done in the period prior to OSRA.

All the respondents that ship goods by ocean after the inception of OSRA move them under service contracts. Many shipping firms share the opinion that the contracts to/from the U.S. after OSRA are more similar to contracts outside the U.S. There is also mention about

the increase in the number of contracts with multiple trade lanes after the passage of OSRA.

The negotiation process after OSRA became effective is purely confidential, thereby making the process highly competitive. Shippers are now entering into long term agreements with carriers to obtain leverage on the price based on the volume of cargo transported. Some of the respondents have reduced their carrier base by approximately 50 percent after the passage of OSRA, and are focusing their efforts in building relationships with a limited base of carriers. Conferences and conference contracts have become less meaningful in the post-OSRA environment, paving the way for individual agreements with strong emphasis on relationship building.

MANAGERIAL IMPLICATIONS OF THE RESEARCH FINDINGS

There is no doubt that both the air and ocean industry have witnessed significant changes after the 'open skies' bilateral and OSRA, respectively, became effective. These changes have in turn brought about changes in the way shippers and carriers in each of the modes conduct business with each other. This research has attempted to identify the influence of these and prior regulatory changes in the operations of both the industries, especially in pricing, and the strategies adopted by shippers and carriers in the wake of these recent developments.

The "open skies" bilateral completely eliminated tariff controls in the air industry and attempted to increase the variety of price and service options for shippers. Government intervention in pricing was virtually eliminated, paving the way for free pricing. On the other hand, in the ocean shipping industry, OSRA brought about a new approach of one-to-one confidential contracts between shippers and carriers, thereby attempting to weaken the dominance of conferences in rate fixing. These deregulation reforms have ensured a significant transformation in the operations of both the industries which are outlined below.

After the "open skies" bilateral came into effect in the air industry, firms are now shipping most of their air cargo under contracts. In a similar fashion, the once traditional liner shipping industry has now moved closer to embracing confidential agreements with shippers since the inception of OSRA. Many of the conferences have dissolved in the wake of OSRA. Now, more than 80 percent (Brooks 2000) of ocean cargo moves under service contracts with tariffs being employed only on a very limited basis for small or one time shipments.

Shippers in both modes now have the freedom to select carriers based upon their ability to provide the required service. New developments in technology have forced many shippers to conduct their operations in an e-business environment in an attempt to adapt to the changes in the marketplace. This has resulted in the evolution of an interesting trend in the carrier selection process that requires carriers to use electronic purchasing tools such as Request-For-Information (RFI) and Request-For-Pricing (RFP), to make them eligible for selection. In addition, shippers are now selecting carriers based upon their ability to provide on-line bookings, on-line tracking of shipments, and on-line ocean bills of lading. Although each business has different needs, priorities, and buying strategies, shippers that employ these cutting edge technological tools select carriers that have the ability to conduct business electronically.

At present, negotiations are conducted on a variety of issues including service, price, and

trade lanes. In certain firms, negotiations are conducted on a centralized basis while in others they are conducted on a decentralized basis. Each firm employs a different strategy for getting an affordable price from carriers. Many large multinational corporations leverage their collective tonnage to receive the lowest possible freight rates and the best service in terms of transit times and cargo space. An emerging trend now is that of measuring the performance of carriers on certain Key Performance Indicators (KPI's), such as cargo tracking capabilities, transit time, and frequency of service that were agreed during the negotiation process. These KPI's are used to evaluate the performance of a carrier and to either award or terminate business.

The negotiation strategies adopted by firms continue to evolve based upon the service requirements of the shipper and the ability of the carrier to meet those needs. In these circumstances, a further liberalization in both the air and ocean industry would mean more changes in the operation of both the industries.

The airline industry at present is moving toward "clear skies" bilaterals, aimed at removing the existing constraints on airline ownership by foreign nationals, and certain other provisions that pertain mostly to air passenger transport. Within the first decade of this millennium, the ownership and investment rules are most likely going to be liberalized (Thomchick 2000). It would be valuable to identify the changes that these provisions of "clear skies" bilaterals will have on the way operations and negotiations are conducted in the air cargo industry.

The ocean shipping industry has witnessed big changes since OSRA became effective. Some conferences have disbanded, paving the way for individual discussion agreements between shipper and carrier. In the future, it is expected that the remaining conferences will also disappear due to the fact that they cannot satisfy the demands of multinational shippers for global service contracts encompassing multiple trade lanes. In addition, more than 80 percent (Brooks 2000) of ocean cargo moves under service contracts and tariffs are adopted only on a very limited basis. This has also contributed to the decline of conferences. In future, OSRA may eventually eliminate tariffs, giving prominence only to confidential one-to-one contracts between shippers and carriers. In these circumstances, it would be highly intriguing to find out the changes in strategies adopted by shippers and carriers in ocean transport while negotiating with each other.

FUTURE RESEARCH

A small sample was selected based on convenience, keeping the time frame short for the completion of the study. A more detailed study with a larger sample, stratified on the basis of the amount spent for international transportation of goods per year, might have yielded more information. This might also have provided information on any differences, if any, in the carrier selection process and price negotiation strategies employed by small, medium, and large international shipping firms.

The e-mail survey method was chosen for its efficiency and convenience in contacting respondents within a short time frame. However, this method might have limited the volume and detail of information provided by the respondents. Personal interviews may have resulted in more detailed replies.

Future research on this topic could use a stratified sample based upon the amount

spent for international shipping of goods per year and employ personal interviews. This would provide more information that may not have been revealed by this study.

ACKNOWLEDGEMENT

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REFERENCES

Brooks, M. R. (2000), *Sea Change in Liner Shipping: Regulation and Managerial Decision-Making in a Global Industry*, Elsevier Science Limited.

Button, K. and Stough, R. (2000), *Air Transport Networks*, Edward Elgar Publishing Inc.

Doganis, R. (2001), *The Airline Business in the Twenty-first Century*, Routledge. In Taneja N. K. (1981), *Airlines in Transition,* D.C. Heath and Company.

Federal Maritime Commission. (2000, June). *The Ocean Shipping Reform Act: An Interim Status Report.* [On-line]. Available: www.fmc.gov.

Frankel E.G. (1982), *Regulation and Policies of American Shipping,* Auburn House Publishing Company.

Kendall, L. C. (1986), *International Trade in Ocean Shipping Services*, Ballinger Publishing Company.

Lewis, Ira. (2000), "The Ocean Shipping Reform Act of 1998," *Transportation Journal*, 39, 4 (Summer), 27-34.

Taneja, N. K. (1979), *The U.S. Airfreight Industry*, D. C. Heath and Company.

Taneja, N. K. (1980), *U.S. International Aviation Policy*, D. C. Heath and Company.

Thomchick, E. (2000), *International Logistics*, Kendall/Hunt Publishing Company.

Williams, G. (1994), *The Airline Industry and the Impact of Deregulation*, Avebury Aviation Ashgate Publishing Limited.

General References

Brewer, S. H. (1967), *The Complexities of Air Cargo Pricing*, University of Washington Publication.

Carron, A. S. (1981), ed. *Transition to a Free Market: Deregulation of the Air Cargo Industry*, The Brookings Institution.

Forsyth, P., Button, K., and Nijkamp, P. (ed). (2002). *Air Transport*, Edward Elgar Publishing Inc.

Gaudry, M. and Mayes, R. R. (ed.). (1999). *Taking Stock of Air Liberalization*, Kluwer Academic Publishers.

Juda, L. (ed.) (1983). *Shipping Nationalism and the Future of the United States Liner Industry: The UNCTAD Code and Bilateralism*, Times Press.

Meyer, Oster, Morgan, Berman, and Strassmann (1981). *Airline Deregulation*, Auburn House Publishing Company.

Schneider, L. M. (1973). *The Future of the U.S. Domestic Air Freight Industry*, Harvard University Publication.

White, L. J. (ed.). (1988). *International Trade in Ocean Shipping Services*, Ballinger Publishing Company.

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Journal of Transportation Management

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Book:

Coyle, John J., Bardi, Edward J., and Novack, Robert A. (2004), *Transportation*, 6th ed., Cincinnati, OH: South-Western College Publishing.

Wilson, J. W. (2003), "Adapting to the Threat of Global Terrorism: Reinventing Your Supply Chain," [On-line]. Available: http//:georgiasouthern.edu/coba/centers/lit/threat.doc. Accessed: 11/12/03.

MANUSCRIPT SAMPLE

A FRAMEWORK FOR EVALUATING SUPPLY CHAIN PERFORMANCE

Terrance L. Pohlen, University of North Texas

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.

INTRODUCTION

The ability to measure supply chain perfor-mance 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 perfor-mance within a single firm.

Table 1 about here

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.

$$y = a^2 - 2ax + x^2 \quad (1)$$

REFERENCES

Manrodt, Karl (2003), "Drivers of Logistics Excellence: Implications for Carriers," In J. W. Wilson (Ed.), *Logistics and Transportation Yearbook 2003* (pp. 126-154) Englewood Cliffs, NJ: Prentice-Hall, Inc.

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