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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)**

Mode	Exports		Imports		Total Trade	
	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 truck-load 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.

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