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TERRORISM AND THE GLOBAL SUPPLY CHAIN: WHERE ARE YOUR WEAK LINKS?

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ABSTRACT

For many years, managers have chosen to ignore the risks associated with acts of terrorism that can potentially and catastrophically affect the global supply chain. As producers and suppliers become more tightly tied through long term relationships, common communications and information technology, events affecting one member of the supply chain can have a profound impact on the ability of the rest of the network to operate. The purpose of this discourse is to highlight the linkages which leave a supply chain vulnerable in the case of direct or indirect disruption caused by unexpected terrorist activity.

Headlines proclaim **“Despite Demonstrations and Terrorism Fears, Commerce Continues”** (Pope 2000). For how long? What now? Is **your** supply chain vulnerable to disruptions due to terrorist activity? What kinds of terrorist activities are likely to disrupt supply chain operations?

Many in the United States have long considered terrorism as something that happens somewhere else to someone else. To a great extent that belief has been supported. Recent terrorist activity in the U.S. has been confined to a few high profile cases such as the Atlanta, Oklahoma City, and World Trade Center bombings. Many

have chosen to forget the events that occurred domestically and world-wide during the Viet Nam War. However, Stephen W. Brooks of the Treasury Department, a leading expert on anti-terrorist training and planning, has commented that he expects the number of terrorist attacks in the U.S. to increase (Fabey 1998). Even more frightening is the observation that terrorists can take as much time as necessary to determine the appropriate target and make plans for the attack. Weapons, whether some form of firearm or the more difficult to detect biological variety, are easily obtained on the street or through the Internet.

According to Brooks, businesses, especially big companies doing business with the government, have become a primary target. Raids on some terrorist groups have revealed plans for attacks on ports, rails, and other transportation facilities and networks. Such attacks would provide high visibility and extensive disruption, furthering the objectives of the terrorist group. The reality of such threats prompted President Clinton to declare war on terrorism. The maritime community, with a long history of dealing with terrorist activity in the form of pirates, hijackers, and smugglers, has expressed a growing concern that it is only a matter of time before a port, ship, or related facility becomes a target of a terrorist attack.

In view of the mounting level of concern regarding the potential for disruption of private and business activity by terrorist activity, the question that may be asked is whether reality supports that concern (Patterns of Global Terrorism 1999). During the years 1994 through

1999, statistics substantiate the concerns expressed regarding terrorist activity (Table 1).

A review of these statistics reveals that businesses, targeted 1,589 times during this five-year period, are subject to terrorist attacks in far greater numbers than any other category.

While there are undoubtedly many explanations for the targeting of any given business, the question for transportation and logistics professionals is, "What effect will this have on my company as we seek to meet strategic and customer service objectives," followed closely by, "What can be done to reduce the potential vulnerability in the supply chain?"

PREVIOUS RESEARCH

In an attempt to develop an understanding of the potential points of vulnerability in the supply chain it is necessary to examine both the logistical functions within the firm and

TABLE 1
TOTAL FACILITIES STRUCK BY INTERNATIONAL TERRORIST ATTACKS:
1994-1999

Year	Business	Diplomatic	Government	Military	Other
1994	130	24	27	5	126
1995	338	22	20	4	126
1996	236	24	12	6	90
1997	327	30	11	4	80
1998	282	35	10	4	67
1999	276	59	27	17	95
Total	1,589	194	107	40	584

Adapted from: _____, "Patterns of Global Terrorism 1999," Department of State Publication 10678, Office of the Secretary of State, Office of the Coordinator for Counterterrorism, April 2000, Appendix C Statistical Review, p. 104.

throughout the supply chain. Previous studies have investigated various aspects of the supply chain related to the most efficient operational considerations when moving revenue traffic (cargo and passengers). In one such study (Cavinato 1992), a model of twenty basic cost and value elements is developed which are used to define ten key strategic and management areas. Yet, not a single element in the list of twenty cost and value elements or the list of ten key strategic and management areas refers to the enormous costs, financial and human, that could result from terrorist activities directed toward the firm or the environment in which it operates.

A study conducted by Hsu and El-Najdawi (1991) examined the safety stock/lot sizing relationship. Results indicated that total production costs were determined by the number of set-ups, inventories carried, and the frequency of shortages that were the result of the lot size/safety stock relationship. Though it represents a fairly definitive study of four safety stock policies, it provides no reference to the implications of terrorism on safety stock policy decision making.

Modal selection and carrier choice criteria were the objectives of a study by Foster and Strasser (1990). Variables such as costs, transit time, negotiable rates, negotiable service, reliability, frequency of service, claims settlement, equipment availability, electronic data processing, quality of sales personnel, and warehousing capabilities were elements of importance to both carriers and shippers. However, elements such as vulnerability to terrorist activity were not mentioned by either carriers or shippers as being a consideration in the selection of carrier or mode. In a related study, the selection of mode and port for international logistics was investigated. Neither vulnerability to terrorist activity nor contingency alternatives to continue port activities were mentioned as selection criteria (Min and Galle 1996).

The examination of routing and scheduling by Ronald Ballou (1990) did not take into consideration the effects of extraneous elements

such as the probability of terrorist disruption. Instead the emphasis was restricted to the minimization of miles traveled and vehicles used when developing a methodology for routing and scheduling.

Kathleen Allen (1991) examined the role of logistics in the overseas plant selection process. This study examined the importance of corporate and/or environmental characteristics in executive's perceptions of the importance of logistics as overseas production facility acquisition was considered. While factors such as product type, revenue size, number of overseas production facilities, technological production sophistication, foreign market growth objectives, and the relative costs of distribution were considered, the probability of terrorist activity was not a factor for consideration.

The impact of inventory centralization was examined in an effort to determine the need to change the number of stocking locations based on the nature and magnitude of the uncertainty with which a firm is faced (Tallon 1993). Uncertainty in this research is restricted to demand uncertainty. No consideration is given to the need to reduce the uncertainty resulting from the probability of terrorist activity.

The importance of developing close vendor ties for the successful implementation of integrated logistics management and just-in-time inventory systems was the subject of a study by Thomas Harrington, et. al. (1991). In this study, a methodology for the evaluation of vendor performance was developed. This tool would be used by managers to formally evaluate vendors for the purpose of determining the most desirable vendors with which to develop long term relationships, identifying problems needing corrective action, and gaining productivity improvements. None of the criteria identified related to the impact of terrorist targeting of the supplier and/or its operating environment.

In addition to studies of the individual elements of logistics activity, studies of international logistics management such as that by Morgan

and Arnold (1991) have been conducted. Terrorism is not a topic of consideration in overall studies just as it has not been considered in studies focusing on individual elements of the logistics activity.

IMPACT ON SUPPLY CHAIN DESIGN AND COMPOSITION

No matter the product category, size, country of origin, or any number of other factors, firms of all descriptions are reaching out to markets in all parts of the world. As they reach into these arenas, the strength and reliability of the supply chain becomes of exponential importance. From Alexander the Great to Amazon.com, history is replete with examples of the impact of supply chain operations on the ability to accomplish planned strategic objectives.

Location

Location is a major element of supply chain design. From the determination of production facility and warehouse/distribution center location for maximum market coverage by shippers, to the determination of the most efficient location of terminal facilities and most direct route by carriers, location has always been one of the most important factors in the decision. Location is also an identifiable indicator of the probability of terrorist activity (Table 2).

From this table it can be seen that terrorist attacks are a fact of life in most parts of the world. It is important to remember that, like a stone tossed into a quiet lake, each attack creates a pattern of disruption that continues to be an issue even after the initial event. These

**TABLE 2
INTERNATIONAL TERRORIST ATTACKS BY REGION
1994 - 1999**

Year	Africa	Asia	Eurasia	Latin America	Middle East	North America	Western Europe
1994	25	24	11	58	116	0	88
1995	10	16	29	5	45	0	272
1996	11	11	24	84	45	0	121
1997	11	21	42	128	37	13	52
1998	21	49	14	111	31	0	48
1999	52	72	35	121	25	2	85
Total	130	193	131	594	299	15	666

Adapted from:____, "Patterns of Global Terrorism 1999," Department of State Publication 10678, Office of the Secretary of State, Office of the Coordinator for Counterterrorism, April 2000, Appendix C Statistical Review, p. 102.

disruptions are related to the actual destruction of facilities and infrastructure as well as the continued fear of further attack which affects the behavior of those involved.

When taking an integrated supply chain perspective, location becomes even more of an issue. No longer is the element of risk restricted to the facilities and personnel under the direct control of the company. From the shipper's perspective, locational risk considerations include the location of suppliers (first, second, and even third tier), inventory storage and distribution center placement, carriers and carrier routes selection, and customer location.

Contingency Planning

Managers at all levels of the supply chain must face the reality of terrorist activity and its potential impact on supply chain operations. Partner selection must include an evaluation of the ability of that partner to perform, even in the event of terrorist generated disruption, just as they are expected to perform in the event of natural disasters and other unplanned events. However, unlike a natural disaster in which those affected are simply a matter of chance, terrorist activity is often specifically targeted (Table 3). This means that several links in the supply chain may be affected simultaneously, either directly as a result of the actual event, or indirectly as a result of facility/infrastructure destruction, or human casualties (Table 4).

The development of contingency plans is the responsibility of all members of the supply chain. Because of the need for integration, these plans must not only cover all aspects of firm operations communication links between the individual members. Just as the growth of ERP programs purports to more tightly tie supply chain members into an integrated information network, the vulnerability of all members of that network to IT sabotage is increased.

TABLE 3
ANTI-U.S. TERRORIST
ATTACKS BY REGION
1999

Region	Number of Anti-US Attacks
Latin America	96
North America	1
Asia	6
Eurasia	9
Middle East	11
Africa	16
Western Europe	30
Total	169

Adapted from:____, "Patterns of Global Terrorism 1999," Department of State Publication 10678, Office of the Secretary of State, Office of the Coordinator for Counterterrorism, April 2000, Appendix C Statistical Review, p. 106.

Note: Includes attacks against U.S. facilities and attacks in which U.S. citizens suffered casualties.

Impact of the Internet

The increased use of the Internet for commerce, whether consumer or business oriented, has had a tremendous impact on affected firms. Just as firms developed the logistics techniques necessary to implement JIT strategies, they must

TABLE 4
U.S. CASUALTIES INCURRED IN
ANTI-U.S. TERRORIST ATTACKS
1999

Organization	Number of Casualties
Government	7
Military	9
Diplomat	9
Business	133
Other	26
Total	184

Adapted from:____, "Patterns of Global Terrorism 1999," Department of State Publication 10678, Office of the Secretary of State, Office of the Coordinator for Counterterrorism, April 2000, Appendix C Statistical Review, p. 106.

Note: Includes attacks against U.S. facilities and attacks in which U.S. citizens suffered casualties.

now further refine those techniques to respond to an Internet-based operating environment. To be specific, JIT requirements of smaller, more frequent deliveries and shipments, have now become requirements for faster deliveries and shipments at the single-item level on a world-wide basis. This has entailed the development of multiple channels using carriers capable of handling smaller sized shipments with a global reach.

To accomplish this herculean task, carriers have formed international alliances, made increased investments in information technology, increased

their use of the communication potential of the Web, and made greater use of faster transportation modes—specifically air. As shipments get smaller, and increased use is made of small package carriers, security becomes more of an issue. At this time, small package carriers are caught between the need to maintain shipper privacy and the need to provide security for individual shipments and for their facilities and personnel in the aggregate. In fact, most small package carriers, particularly the USPS, require a search warrant before packages can be opened by law enforcement officials (Brooks 2000).

Another factor to be considered is that, if security is a responsibility of the shipper, many of the small "dot com's" and other firms using the Internet as a mechanism to reach a global market are unaware of the scope of such an undertaking and/or do not have the financial resources to accomplish the task. If security, of both the package and the contents is the responsibility of the carrier, then the carrier's personnel are converted into some type of unofficial enforcement army which would be an unacceptable situation. Couple this with the incredible number of small packages handled on an hourly basis, and the potential for terrorist penetration is greatly increased.

IMPLICATIONS FOR MANAGERS

The need for supply chains having the greatest potential to operate even in the event of unexpected terrorist activity directed toward the shipper, carrier, customer, or the operating environment is the responsibility of all parties involved. While the specific methods chosen by any individual entity may differ, the objectives must remain the same—to deliver the quality of product and performance that meets customer needs and company objectives. In order to accomplish these objectives, managers must take the initiative and scrutinize existing plans and processes in an effort to identify and strengthen those linkages that are especially vulnerable to terrorist disruption.

Shippers

Over the years, as firms have designed supply chains for competitive advantage and increased efficiencies, the emphasis has been on decreased numbers of suppliers, increased cooperation with suppliers on everything from forecasting to product development, and decreased inventory levels with increased inventory flow at all levels of the supply chain. The ultimate objective is to deliver the greatest level of customer satisfaction in the most efficient and cost effective manner possible. The greatest effort has been focused on the internal processes and procedures needed to facilitate the accomplishment of these goals.

The end result has been supply chains which encircle the globe. Suppliers, customers and manufacturing and storage/distribution facilities have been located to take advantage of reduced costs in manufacturing, transportation, and inventory carrying costs. Increased use of joint purchasing has resulted in reduced costs. All of these individual entities are connected with information technology links from bar coding to track inventory, to Internet ordering, payment, tracking and tracing, to ERP systems intended to coordinate inventory levels and production rates to meet but not exceed customer needs. In order to produce this new "lean, mean" supply chain, in many cases, redundancy has been rooted out of the system.

With the greater global reach and lack of redundancy in the system, new criteria must be included when making supply chain design decisions. New criteria for **vendor selection** must include the ability to operate in the event of terrorist activity, location, and the identity of the carriers and routes used to transport products. Location and safety stock levels are a second area of concern. **Location decisions** must include a consideration of the risk factor involved when locating facilities, serving customers, and/or using vendors who are located in areas subject to a higher probability of terrorist disruption. When making **safety stock decisions**, the likelihood of supply interruption based on vendor

location and carrier selection and routes must be considered. The level of interdependency between vendors must be scrutinized. There is an increased vulnerability in the event that supply is disrupted to all the dependent vendors. Therefore, the vulnerability of the common supplier to disruptive activity must be assessed. All of these factors affect the level of safety stock that must be carried.

IT decisions must be made with recognition that an intentional corruption of the system can affect all elements of the supply chain. A criterion for IT system selection, then, should be the ability of the system to resist corruption attempts as well as the ease with which the results of system sabotage can be identified and corrected. As the supply chain becomes more IT dependent, the question becomes whether it is able to operate through an alternative system if necessary.

Carriers

Carriers are faced with their own need to protect their ability to operate in the event of terrorist disruption. Internal considerations might range from supplier selection for items such as tires and fuel to the vulnerability of information and GPS systems. The location and security of terminal facilities is an important consideration for personnel, equipment, and cargo in transit.

The decision as to shipper selection is an important one. Factors which should come under consideration include location of shipper facilities, location of the shipper's customers, and the routes that must be taken to serve these customers. Just as important is the choice of partners in alliances designed to extend geographic coverage and service offerings.

Route decisions involve the choice of port, terminal, and air facilities in addition to the actual road or trackage that might be used. Terrorist activity can and has affected the ability of carriers to make use of such facilities, thus disrupting more than one level in a supply chain and/or multiple supply chains.

CONCLUSIONS

There will always be a question of cost vs. benefit when reassessing and redesigning a supply chain. The primary emphasis during this process is most commonly on cost reduction. However, reducing the immediate and long term effects that can result from terrorist disruptions does not come without costs. Companies pay high insurance costs to protect their executives who are targets of terrorist kidnapping. There are additional costs for body guards, drivers, and bullet proof automobiles. The objective is to protect that managerial expertise and prevent the disruption of operating and strategic activities. Insurance costs for facilities and for inventory stored in more politically unstable locations are substantially higher. How do these costs compare to the costs of "bullet proofing" systems and facilities? How does the cost of the judicious use of built-in redundancy compare to the cost of operational disruption and the

inability to deliver the requisite level of customer service?

It is essential that carriers and shippers examine their practice of establishing and/or servicing a global supply chain. The location and operations of suppliers, transportation modes, individual carriers and routes, and storage/distribution facilities must be reexamined with an eye to their vulnerability to terrorist activity. Carriers must examine the coverage, service, and route requirements of their customers. All members of the supply chain must assess their levels of security and their ability to function in the event of terrorist disruption not only at their own level but at any other level of the supply chain.

As a result of increased technology, advanced modes of transportation, instant communication and the development of global enterprises, there is every possibility that the next "business" to suffer a loss of lives and/or economic loss will be yours.

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