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ABSTRACT

Computer to computer data exchange by companies in a supply chain have been well-recognized as an effective means of reducing cost and decreasing paperwork errors. In many cases, manufacturers, wholesalers, and retailers have become electronically linked to better manage inventory, ordering, and billing information. However, supply chains, by definition, also include common carriers that move goods between supply chain partners but may not have a long-term relationship with either the shipper or his customers. This could be the missing or weak link in an otherwise effective supply chain. The purpose of this paper is to examine the state-of-the-art of EDI in the motor carrier industry to identify possible trends.

Electronic Data Interchange (EDI) systems have been used by shippers and carriers since the late 1970s. This article reports on findings of a recent survey of large domestic motor carriers regarding their use of EDI and emerging Internet technologies to provide vital information links with their supply chain partners.

INTRODUCTION

Various forms of computer-based information technology (IT) have been used to facilitate business-to-business transactions for at least three decades. During the 1970's, suppliers and customers began linking mainframe computers to facilitate direct data exchange. Suppliers could receive and complete orders without a manual purchase request from the customer. Data from the inventory tracking and production systems could be transmitted to the supplier through Electronic Data Interchange (EDI) communication links. A purchase order could automatically be submitted. Invoices could be sent and payments made through Electronic Funds Transfers (EFT). In the freight transportation industry, freight forwarders and shippers gained access to airline, rail, ship, and truck schedules permitting them to book cargo directly utilizing EDI. These pockets of technology development redefined logistics processes and, by the late 1980's, became mandatory for companies seeking to maintain their competitiveness.

To engage in traditional EDI, business partners must add three components to their existing computer systems: EDI standards, EDI

translation software, and some sort of transmission capacity. To illustrate the underlying concept, Emmelhainz provides the analogy of an American dealing by mail with a trading partner in Germany (1993). To successfully communicate, the parties would require a letter written in "generally accepted business format", translation capacity from English to German, and a mail service or other method of transmission. With an electronic transfer, EDI standards furnish the format, EDI software provides the translation, and either direct links or value added networks (VANs) are utilized.

The key to EDI has been the development and implementation of standards—standard business procedures, standard definition of business terms and standard documents. After considerable effort the Transportation Data Coordinating Committee (TDCC) adopted data interchange standards in the mid-seventies for domestic shipments. This action greatly enhanced the transportation use of EDI in the United States. In the early eighties, the American National Standards Institute's (ANSI) standards committee X12 took over the task of expanding U.S. industry standards in transportation. And by the mid-eighties, the United Nations had created EDI for Administration, Commerce, and Transportation (EDIFACT). In 1992 the U.S. voted to adopt the structure and syntax of EDIFACT. However, since the official adoption of EDIFACT as the worldwide standard, few U.S. transportation carriers have implemented new traditional EDI systems. Reasons cited include EDI complexity and cost, growth of customized systems (lack of true standard systems) and the superiority of Internet based information systems.

Since the mid-1980's, supply chain managers at progressive companies in competitive industries have increasingly turned to Internet based information technologies to facilitate business-to-business logistics transactions like purchasing, order processing, inventory management and transportation tracking. For example, in 1995 Michelin N.A. began building a customized extranet system so their small to midsize customers could shop and buy on-line as well as track their shipments from origin to destination. At the same time, Michelin N.A.continued to operate a traditional EDI system for their large volume customers. Soon after their extranet system was implemented, Michelin's EDI customers wanted to be on the extranet because they found it to be superior to EDI (Smith, 1999).

While the literature contains many publications dealing with information technology and SCM there is little published research on the current use of IT (EDI and Internet systems) by the U.S. motor carrier industry. Truck transportation in the U.S. very often provides the vital physical link between suppliers and their customers. In fact, trucks carry approximately 80% of the U.S. domestic freight by revenue according to a Cass Logistics 1999 study (Barber, 1997). Unfortunately, the physical movement of goods today is often still impeded by ineffective information flows that have not kept pace with developments in information technology. The American Trucking Association estimates that required paperwork still can reach as much as $900 per truckload in the worst case scenario ("Information…", 1999). The clear implication is improvements in both EDI and web-based IT may not yet have been realized in the trucking business. The purpose of this paper is to present the results of a recent study undertaken to evaluate the current level of EDI and Internet based technology utilization among the largest carriers in the U.S. motor carrier industry. First, a brief literature review will be presented, followed by an explanation of the research methodology employed. The results will then be discussed and conclusions drawn concerning the future of EDI and Internet based information technology in the motor carrier industry.

LITERATURE REVIEW

A review of the recent literature on EDI usage in transportation indicates that most applications are shipper, customer, or carrier specific. Miller reported that over 50 percent cent of EDI systems used by motor carriers were proprietary

and included unique message formats (1995). Johnson, Allen and Crum found that while the number of motor carriers using EDI increased over 100 percent form 1987 to 1990, EDI usage was mostly limited to individual carrier-shipper transactions (1992). In a more recent survey, Seideman found that large shippers typically require industry-specific transaction data and will only utilize motor carriers able to provide that unique information (1992). It also appears that customer size makes a difference when it comes to establishing EDI links with carriers. According to a 1993 logistics technology and benchmarking survey conducted by KPMG Peat Marwick and Company, 61 percent of shippers with annual revenues exceeding $500 million have established EDI links with carriers. Only 35 percent of companies with annual revenues under $500 million had done so by 1993 (Information, 1999). This same survey also confirmed earlier reports that most EDI systems used by motor carriers were not compatible even within the trucking industry.

More recently, the literature has reported a number of successful implementations of Internet based systems by large motor carriers. Wood found that in 1999, 78 percent of LTL carriers and 62 percent of TL carriers based in Arkansas were using some form of e-commerce to conduct business with their supply chain partners (1999). These carriers include J.B. Hunt Transport Services Inc., American Freight Ways Corp. and USA Truck. Dryden found that many large TL carriers like the $2.5 billion Schneider National have invested heavily in Internet based systems as a better IT alternative to EDI. Schneider's scope of Internet based services is large and includes not only the usual shipment tracking by customers but, also provides links to all of Schneider's business software. Their web-based system unifies data about all modes of transportation in a base of over 1000 rail and motor carriers (Dryden, 1999). Crum, Johnson and Allen studied EDI between U.S. motor carriers and shippers in 1990 and again in 1996. Their longitudinal assessment found the growth of EDI transactions declined in the early nineties. On the other hand, 100

percent of the responding shippers reported using Internet technology for business transactions with their supply chain partners (1998).

In summary, a review of the relevant literature published since 1990 shows that important strides were made by large U.S. motor carriers in the application of EDI technology through about 1995. Since then, it appears there has been a shift away from developing new traditional EDI systems to the use of Internet based formation systems in business-to-business information exchanges involving large motor carriers. Many of the reported Internet applications include the use of standard EDI transportation formats developed in the seventies and eighties suggesting an evolutionary progression of transportation data interchange.

METHODOLOGY

In order to evaluate the use of and prospects for EDI and web-based systems in the U.S. trucking industry, an open-ended questionnaire was developed. This questionnaire contained 15 questions and was patterned after the one used successfully in a 1994 study by Gourdin and Clarke (1994). The questionnaire is shown below in Table 1. To identity the largest U.S. trucking companies, reference was made to a 1997 survey by *Inbound Logistics* that ranked the top 75 U.S. motor carriers in terms of revenues earned from trucking operations (Top 25 motor Carriers, 1998). While over 400,000 for-hire trucking firms are registered with the U.S. Department of Transportation, fewer than 800 had annual revenues exceeding $20 million in 1998 (Coyle, 2000). The largest trucking companies in the U.S. tend to be in the LTL segment which is even more concentrated. The top 10 LTL carriers account for more than 60% of the total less-than truckload business (Coyle, 2000).

The 75 largest trucking companies were targeted for this study because of the likelihood they had experience with both EDI and Internet technologies. The disadvantage of focusing on a small number of very large firms is that the

TABLE 1
SURVEY QUESTIONNAIRE

1. Using EDI?
2. For what?
3. Where was EDI system developed?
4. Is EDI system accessible by outside parties?
5. Whom do you exchange data with via EDI? (type of company or organization)
6. Have you encountered problems with your EDI system(s)? If so, what types of problems?
7. Are your EDI lacking capabilities? If so, what?
8. Using web-based systems?
9. For what?
10. Where was the web-based system developed?
11. Is web-based system accessible by outside parties?
12. Whom do you exchange data with via web-based systems? (type of company or organization)
13. Have you encountered problems with web-based systems? If so, what types of problems?
14. Are your web-based systems lacking capabilities? If so, what?
15. Future trends in Information Transfer?

results may not be generalizable to the trucking industry as a whole. However, the primary goal of the present study was to investigate the current level of EDI among the subset of the trucking industry most likely to have implemented EDI to link their supply chain partners. So, this limitation was considered acceptable.

This list of 75 trucking companies was then cross-referenced to the list of companies with one or more attendees at the 1999 International Council of Logistics Management (CLM) Conference in Toronto, Canada. This was done so that the survey could be e-mailed directly to a senior executive in each trucking company. Fifty-four of the largest 75 U.S motor carriers (72%) were represented at the 1999 international CLM conference. Finally, the most senior attendee was identified by job title (e.g., Presi-dent, VP-operations, VP-Information Systems, etc.) from the published list of conference attendees.

The survey was then sent via e-mail to named executives at 54 of the largest 75 motor carriers in the U.S. Due to the nature of this study, participants were not randomly selected in the strict sense. Rather, large motor carriers most likely to be engaged in both EDI and Internet systems were surveyed. A complete list of the companies surveyed is included in Table 2. The results of the survey are presented and discussed in the next section.

TABLE 2
MOTOR CARRIERS CONTACTED

United Parcel Service	Vitran
Roadway Express, Inc.	Southeastern Freight Line
Schneider National, Inc.	Atlas Van Lines
Consolidated Freightways	FFE Transportation
Penske Truck Leasing	Trimac Specialized Carriers
Ryder Integrated	CRST Logistics, Inc.
Logistics	Crete Carrier Corporation
RPS, Inc.	Covenant Transport
Con-Way Transportation	Dart Transit
J. B. Hunt Logistics, Inc.	Contract Freighters, Inc.
ABF Freight System	Heartland Express
United Van Lines	KLLM Transport Service,
Overnight Transportation	Inc.
North American Van	Burlington Motor Carriers
Lines	Matlack, Inc.
American Freightways	New Penn Motor Express
Werner Enterprise, Inc.	Roberts Express
Swift Transportation	USF Red Star, Inc.
USF Holland, Inc.	Celadon Trucking
Allied Holdings	APA Transport
Watkins Motor Lines	Merchants Home Delivery
M. S. Carriers	Mercer Transportation
Trimac Transportation	New England Motor
U. S. Xpress	Freight
Estes Express Lines	Morgan Drive Away
Mayflower Transit	Stevens Transport, Inc.
CTI	Pitt Ohio Express, Inc.
Landstar Logistics, Inc.	Daylight Transport
Averit Express	Allied Van Lines
Viking Freight Systems	

DISCUSSION OF RESULTS

Nine of the 54 e-mailed surveys could not be delivered because of unknown or unrecognized addresses reducing the effective sample size to 43 of the largest 75 U.S. motor carriers. Twenty-one of the 43 trucking executives completed and returned the questionnaire for a response rate of 49 percent. This was somewhat higher that typical response rates for this type of survey probably because of the ease and convenience of e-mail replies. In fact, 17 of the 21 responses were made within 24 hours of the questionnaire's receipt. The use of e-mail surveys in the logistics area seems promising for the future. Table 3 summarizes the respondents' answers to the 15 posed questions.

TABLE 3
SURVEY OF RESPONSES

1. **Using EDI?**
   Yes 100%   No 0%

2. **For what?**
   Shipment tracking, tracking billing, electronic payment, load tendering, and ordering

3. **Where was EDI system developed?**
   In house   73%   Outside Vendor 9%
   Both   18%

4. **Is EDI system accessible by outside parties?**
   Yes 27%   No 55%   No Response   18%

5. **Whom do you exchange data with via EDI? (type of company or organization)**
   Shippers, consignees, other trucking companies, railroads, banks, auditors, paying agents, and freight brokers

6. **Have you encountered problems with your EDI system(s)? If so, what types of problems?**
   No Problems   36%   Some Problems 55%
   No Response   9%
   start-up problems, excessive cost, lack of true standards

7. **Are your EDI lacking capabilities? If so, what?**
   Yes 55%   No 45%
   Lack of true standards

8. **Using web-based systems?**
   Yes 82%   No 18%

9. **For what?**
   As alternative to EDI, for partners with limited or no EDI, trade EDI documents, signed purchase orders, shipment customer tracing, tendering orders.

10. **Where was web-based system developed?**
    In House   91%   Outside Vendor 9%

11. **Is web-based system accessible by outside parties?**
    Yes 80%   No 20%

12. **Whom do you exchange data with via web-based systems? (type of company, organization)**
    Shippers, interline carriers, entire customers base, any customer not using EDI

13. **Have you encountered problems with web-based systems? If so, what type of problems?**
    Yes 12%   No 88%
    Start-up bugs, some small customers don't have access

14. **Are your web-based systems lacking capabilities? If so, what?**
    Yes 14%   No 60%
    No Response   26%

15. **Future trends in Information Transfer?**
    Standards (similar to ANSI X12) for Internet communication, more use of scanned (documents) info sharing, tracing EDI documents via Internet, faster dial-up process and faster data transmission

EDI use by large U.S. motor carriers is widespread with customer service still the major function supported. All the respondents indicated they used EDI to support one or more business functions. The only EDI transaction all respondents were using for customer service was shipment tracking. A majority of the largest U.S. motor carriers also reported using EDI to transmit freight bills and to generate internal shipment tacking documents.

Surprisingly, only 27 percent of the trucking companies said their EDI system was accessible to outside parties. There may be several possible explanations for this result. Two of the respondents noted they were unsure what was meant by the term "outside parties" and elected not to answer this question. It appears this question was not sufficiently clear to preclude different interpretations. It is also likely that

several of the respondents use EDI with shippers contract carriage (versus common carriage). In this case the trucking companies may not consider the shipper to be an "outside" party.

Respondents who said their EDI systems were accessible to outside parties reported using EDI with a variety of supply chain partners. These included shippers, consignees, freight brokers, and interline trucking companies. Only a few of the respondents indicated they exchanged EDI documents with intermodal carriers (like railroads or airlines) or with financial institutions. More than half of the largest motor carriers included in the sample indicated they had experienced problems with their EDI systems. Problems reported included startup malfunctions, excessive cost and lack of true standards.

Regarding the use of the Internet for business-to-business transactions, slightly over 80 percent of the respondents are currently using web-based technologies to support several functions. Uses include completing and transmitting signed purchase orders, shipment tracking and tracing by customers, exchanging EDI documents and shipment tendering orders. Interestingly, several of the respondents said they use the Internet as an alternative to their EDI system and to communicate electronically with supply chain partners who have limited or no EDI capability. While the types of outside parties with Internet links to the motor carriers is very similar to the EDI links reported in the survey, significantly fewer respondents report having encountered problems with their web-based systems (12 percent versus 36 percent with EDI problems). The results also indicate much greater satisfaction with the capabilities provided by the Internet versus EDI. Only 14 percent of the respondents reported their web-based systems lacked capabilities while 55 percent said their EDI system lacked capabilities.

MANAGERIAL IMPLICATIONS

Internet use is rapidly becoming a basic requirement for U.S. motor carriers as an effi-

cient means of conducting business with their supply chain partners. After 20 years of development, the sole use of traditional EDI by the largest U.S. motor carriers seems to have peaked. The current focus on information technology, at least in this sample of the largest U.S. motor carriers, has shifted away from EDI technology to web-based information technology. There are many solid reasons for this shift.

Customers in supply chains are demanding high quality, timely information as well as on-line billing and payment throughout complex, often international distribution linkages. Customers of the large U.S. motor carriers also want flexible information systems that can very quickly change as information requirements change. This demand, expressed in this survey, clearly favors Internet systems and discourages the growth of new traditional EDI systems that are not flexible or nimble enough to keep pace with changes in business practices. Globalization is also a factor in the shift to the business use of the Internet by large trucking companies. Globalization is increasing competition and adding new supply chain partners who lack EDI capability. The lower cost and speed of implementing new information links via the Internet relative to EDI is a third factor which seems to be influencing motor carriers.

The present survey showed that approximately 90 percent of the largest U.S. motor carriers who responded were able to develop web-based systems in house, avoiding the high development costs often associated with the use of outside venders. Most large trucking companies appear to feel the costs of new EDI development and implementations outweigh potential benefits. Internet systems offer lower cost, more flexibility, and much faster implementation. Even proponents of EDI are saying EDI is too expensive, too complex and too inflexible and offers too few benefits for smaller motor freight shippers.

Apart from the development and implementation cost advantages the Internet offers over EDI, Internet solutions also appear to offer substan-

tial monthly savings in communications cost. EDI network costs are generally based on a charge per character which discourages more volume. On the other hand, Internet access charges from an Internet service provider (ISP) are based on connectivity time or a flat monthly charge. Therefore, transmitting more data actually reduces the cost per character and encourages more volume.

Yet, survey results indicate that EDI is still very common among the largest motor carriers and will likely be used to exchange standard documents with large shippers for the foreseeable future. While motor carriers in the U.S. are not developing new X12 transactions using EDIFACT design rules, existing X12 transactions will likely be maintained and used in conjunction with Internet transmission.

Investments made in EDI appear safe for now, but new investments in EDI by the largest motor carriers seem unlikely. Rather, smaller investments in Internet technologies appear to be more likely. Aside from the cost and time advantages, there may also be an important service reason for the shift to new supply chain information systems. When EDI systems were being designed and developed, the business climate emphasized the efficient handling of large-scale business-to-business transactions. The current business climate emphasizes the end-user. Web-based technologies can link everyone in a supply chain with the ultimate customer.

CONCLUSIONS

This research found that the largest U. S. trucking companies are using both EDI and the Internet to facilitate a variety of transactions with their supply chain partners. Information technology has changed significantly since EDI systems were first introduced. Motor carriers tend to use information technologies in response to customer demand as a matter of customer service rather than for internal information needs. The widespread appeal of the Internet combined with other contemporary factors, including the relative cost of new EDI systems versus Internet systems and the increasing complexity of supply chains, have led large U.S. motor carriers to develop new web-based systems for business-to-business transportation transactions. The growth of EDI by the largest motor carriers has leveled off. While new EDI growth is unlikely for the U.S. motor carrier industry, current EDI systems are being used, especially with large shippers, and will likely be maintained for the foreseeable future.

Over the longer term, however, the lack of standard business practices and procedures among supply chain partners (often even within the same company) will tend to push trucking managers away from costly EDI solutions to cheaper, simpler and faster Internet solutions. In the seventies and eighties, EDI offered motor carriers and their customers the opportunity to eliminate much of the delay associated with the flow of goods. Most large motor carriers developed EDI systems and used them in a proprietary way to support the information demands of their larger customers. In the nineties, the Internet offered a cheaper, more flexible way to transmit important logistics data throughout an entire supply chain. This research has shown that the largest U.S. motor carriers are increasing their use of the Internet for both EDI and non-EDI transmissions. As long as the Internet can support the increasing volume and speed demands, large motor carriers will get closer and closer to paperless transport movements with all their customers.

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