

## **SHIPPER PERFORMANCE BENEFITS ON AN ELECTRONIC LOGISTICS MARKETPLACE**

Rahul Kale, University of North Florida

Paul Fadil, University of North Florida

Dag Naslund, University of North Florida

### **ABSTRACT**

Electronic Logistics Marketplaces (ELMs) are exotic, technological innovations that have not taken off as much as electronic marketplaces (EMs) have. It has been argued that ELMs have a great potential to improve the transportation performance of the participants, but the literature on ELMs is very scarce at best. This article, using a simulation model based on real world shipment data, demonstrates the benefits that may be obtained by a shipper participating in such an ELM. Results clearly show that the benefits obtained by a shipper participating in such an ELM may be quite substantial. This is true even for those ELMs that have been configured with the primary intent of improving transportation carrier performance, without any regard to the performance of the participating shippers. Although much research needs to be done on ELMs, the mutual benefits these systems to shippers and carriers alike, should provide tangible incentives for further conceptual and empirical exploration.

*Keywords:* Electronic logistics marketplaces, electronic marketplaces, simulation, transportation performance

### **INTRODUCTION**

One of the most promising outcomes of the internet revolution has been Electronic Marketplaces (EMs). Obviously, this business model which would not have been possible without the advent of the internet. Although the best known of these marketplaces, ebay, amazon, etc. cater mainly to consumers, other electronic marketplaces operate primarily in the business-to-business setting. An electronic marketplace is defined as an inter-organizational information system where buyers and sellers can meet to conduct business. Thus, an electronic marketplace is a form of intermediary that establishes electronic links between buyers and sellers interested in conducting transactions (Choudhury, Hartzel & Konsynski, 1998; Movahedi, Lavassani & Kumar, 2012). Travelocity in the airline industry and The Seam in the cotton industry are examples of a couple of EMs that exist today. Several electronic markets operate in the logistics field, bringing together buyers and sellers in areas such as transportation, warehousing, and manufacturing (e.g., Descartes Systems Group, Manhattan Associates, NTE (formerly National Transportation Exchange), and Transplace etc.). The purpose of this article is to model an electronic logistics marketplace (ELM) and demonstrate its potential benefits to participating shippers.

The next section presents literature relevant to EMs in general and then research that focuses on ELMs in particular. From these reviews we derive a research framework and develop a model while illustrating its experimental design. Finally, the results are presented and the paper concludes with managerial implications and directions for future research.

## LITERATURE REVIEW

As EMs have proliferated, so have their definitions. Bakos (1991, p. 296) provides one of the earliest and broadest definitions of an EM as “an inter-organizational information system that allows the participating buyers and sellers to exchange information about prices and product offerings”. EMs are very well researched and is a field of continuing scholarly inquiry in the functional discipline of Information Systems in particular and in other management disciplines as well. Interested readers are referred to seminal works on EMs such as Anandalingam, Day and Raghavan (2005); Grieger (2003); Wang, Zheng, Xu, Li, and Meng (2008) for a detailed summary of definitions and classifications of the EM landscape. It is argued that EMs provide various benefits to participants such as reduction in search and transaction costs, reduced prices, accessibility to a larger base of buyers and/or suppliers and business process automation etc. (e.g. Bakos, 1997; Grieger, 2003; Howard, Vidgen & Powell, 2006). EMs in the transportation or logistics domain have been termed as Electronic Transportation Marketplaces (ETMs; for example by Goldsby & Eckert, 2003), or Electronic Logistics Marketplaces (ELMs; for example by Wang, Potter & Naim, 2007). ELMs are internet services that bring together buyers (shippers) and sellers (transportation carriers) of transportation services in order to increase the efficiency of both shipper and carrier operations. One way these exchanges benefit shippers is that they allow a larger number of carriers to bid for shipments, thereby increasing supply competition and reducing prices. Carriers, too, may benefit from transportation exchanges by gaining access to a large pool of shippers, allowing for increased capacity utilization and reducing “dead-hauls” (Nair, 2005; Wang, Potter, Naim, & Bevor, 2011; Yilmaz & Savasaneril, 2012).

### Open ELMs

ELM can be used for either spot sourcing of transport services or long-term collaboration. Spot sourcing refers to the ad-hoc procurement of transport service to fulfill an urgent, short term need and is a price driven, arm’s length transaction between a shipper and carrier (Caplice, 2007). These types of ELMs typically are the so called “open” ELMs, with open platforms and hence had the same characteristics as generic open EMs in the sense that they adopted many-to-many transactions and utilized fixed and/or dynamic pricing (Gosain & Palmer, 2004). “Open” ELMs mean that any shipper/carrier may participate on the ELM and benefit from the services offered by the ELM (Wang et al., 2007). As with many other dot-com businesses, open ELMs have not been universally successful. Among the reasons most often cited for their failure is that shippers and carriers used ELMs to transact only a small percentage of shipments, and, shippers preferred to send loads via their trusted contract carriers rather than rely on ELM spot markets (Caplice, 2007; Cooke, 2001; Pinkham, 2001). As well, carriers were reluctant to participate in transportation exchanges in order to avoid reducing their businesses to “commodity” status, thereby eroding profit margins. The operational scope of open ELMs is usually limited to basic load posting and matching services with the benefits of lower search and coordination costs. As discussed above, this type of ELMs met with mixed success.

## Closed ELMs

Long-term collaboration, on the other hand, implies a more partnership approach between shipper and transportation carrier. To increase their viability, some ELMs have focused on facilitating existing relationships between shippers and carriers, using the market to supplement rather than replace, existing relationships. This resulted in the development of closed ELMs, aiming not for a large volume of transactions, but to facilitate the existing, long-term collaborative relationships between shippers and their carriers. “Closed” ELMs are closed in the sense that the ELM is “owned” by a specific shipper and/or transportation carrier and the owner decides who participates and benefits from the closed ELM (Wang et al., 2007). The operational scope provided by closed ELMs goes beyond the basic services offered by the open ELMs, with complex offerings sometimes even encompassing complete order fulfillment services. The potential benefits of closed ELMs are enormous. Using the software provided by the ELM, shippers and carriers may form their own, closed ELMs on these web-sites to better manage their transportation needs and resources. Depending on the rules of the ELM, shippers may share shipment information with their core carriers and/or participating shippers, in order to increase capacity utilization and reduce short shipments. Participating shippers can also identify backhaul opportunities for their contract carriers and, in turn, get a price break from the carriers. Participating shippers may also collaborate to consolidate shipments to get price reductions from carriers (Cooke, 2001; Cullen, 2001; Ergun, Kuyzu & Savelsbergh, 2007a; Ergun, Kuyzu & Savelsbergh, 2007b; Nair, 2005). During our discussions with industry officials regarding closed ELMs, it was noted that no general rules govern all ELMs. In certain instances, the owner of the ELM sets the rules, whereas in others cases the rules are set through open discussions between the participating shippers and/or carriers. However, based on these same discussions, it was concluded that ELMs can generally be classified into three categories as shown in Figure 1. It is important to note that, from now on, ELM, unless otherwise specified, would mean a “closed” ELM.

The first is a “shippers’ ELM”. Typically, a shippers’ ELM is geared towards improving the transportation performance of shippers. Shippers may share information on shipping requirements. If one shipper has extra needs, it can negotiate with a second shipper that has excess contracted capacity, thus creating cost savings for both shippers. The first shipper may receive below-market prices for carrier capacity, while the second shipper may avoid defaulting with its contract carrier for renegeing on contracted capacity. With neutral ELM, shippers and carriers may participate together in sharing information on shipping requirements and capacity availability (e.g. Cooke, 2001). Though these communities may be owned by shippers, neutral communities typically strive to benefit all of the participating parties. Therefore, carriers may achieve higher capacity utilization and shippers fewer short shipments through the sharing of information on neutral exchanges. Finally, it is conceivable that carriers could create carriers’ ELM to manage their relationships with shippers. Although no such arrangements (of which the authors are aware) currently exist, these communities would involve carriers sharing capacity and shipment information for their own benefit. Berman (2010) describes an ELM along these lines that started as a carriers’ ELM; however, it seemingly does not claim to be such anymore.

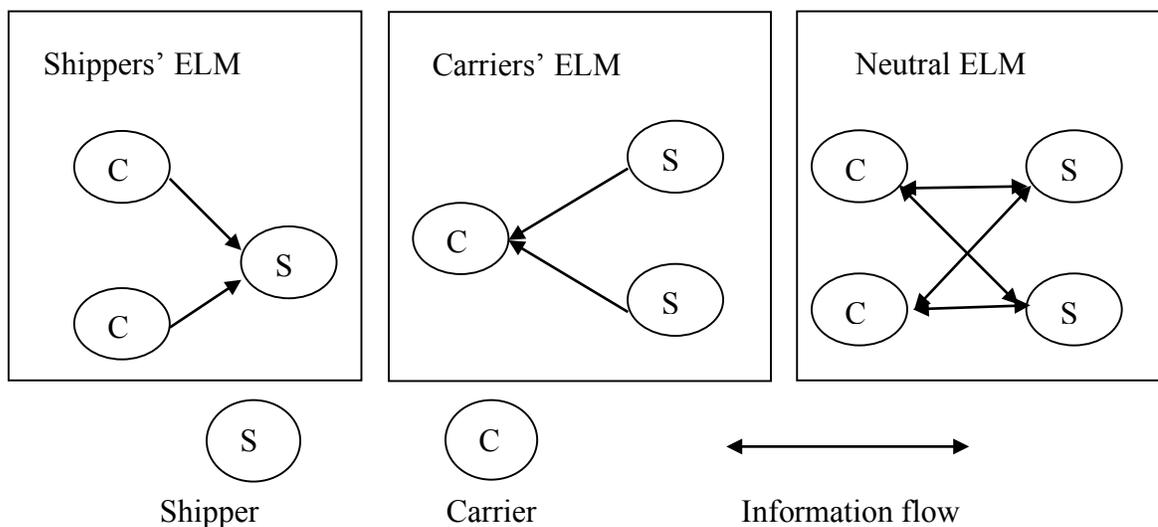
## Research Question

A relatively recent article (Wang et al., 2011) concluded that research on closed ELMs is very scarce. Though there are several articles in the practitioner literature espousing the values and potential benefits of ELMs based on anecdotal evidence, there is very little rigorous research in the logistics and transportation literature. Especially, to the best of our knowledge, there is no large scale, archival data-driven empirical study in the academic literature that tries to investigate the impacts of these ELMs on the performance of the participating shippers and carriers. Given the scarcity of literature on ELMs and their great promise in substantially improving the performance of its participants, it is important to investigate the significance of benefits that may be obtained by its participants. With this background, this article would use real world data from a shipper and subject this data to the business rules of closed ELMs. Thus, this article presents valuable insights by answering the question: “what potential improvement may be expected if a given, real world shipper may have utilized an ELM to manage its transportation”. Given that there are very few studies in the logistics and transportation academic literature related to the actual benefits of ELM accruing to its participants, this article makes valuable contribution by presenting such evidence of potential benefits of ELMs.

## RESEARCH FRAMEWORK

The following discussion takes a shipper’s point of view. Before we get into the simulation model, it is important to first describe how transportation is usually/conventionally managed, and then describe how they may be managed differently on ELMs. Consider a shipper-carrier dyad where the shipper has fairly stable transportation requirements between a pair of locations. One of the most common methods by which a shipper handles such requirements is to enter into a contract with a carrier. Both the shipper and carrier commit to a particular volume (q units), perhaps based on the average requirements of the shipper (S units) and transportation rate (T per unit).

Figure 1. Types of ELMs



### Transportation Management through Conventional Transaction

Once the contract is set, day-to-day transactions ensue. A carrier sends a vehicle to the shipper with carrying capacity of  $q$  units. The shipper then tenders the shipment quantity of  $q$  units. However, occurrences are seldom deterministic. On a given day, either the shipper's requirements ( $S$ ) or the carrier's availability ( $C$ ) may deviate from  $q$ . If either  $C$  or  $S$  is greater than  $q$ , the excess may be handled via the spot transportation market. However, if  $C$  is less than  $q$ , then the shipper suffers in the form of either delayed shipments or lost sales. If  $S$  is less than  $q$ , then the shippers may end up either paying for unused capacity or paying for default penalties. With a conventional contractual relationship, the carrier becomes aware of the actual shipper requirements only when the carrier arrives at the shipper's dock. Similarly, the shipper becomes aware of the carrier's actual capacity only when the carrier arrives at the shipper's dock. By the time a party is aware of a contract default, it may be too late to take remedial actions. Therefore, the shipper suffers in terms of either delayed delivery or lost sales, whereas the transportation carrier may suffer in the form of reduced capacity utilization.

To illustrate how a conventional transaction works, let's consider an example from Table 1. In the first scenario,  $S = 100$  and  $C$  is only 50. Thus, the shipper cannot sell all its shipments, it may only ship 50 and the remaining 50 shipments may result in lost sales. The same happens in scenario 2. Though the carrier has enough quantity as promised, the shipper happens to have a greater demand which would again result in lost sale. In scenario 3, the shipper actually has only 50 shipments, fewer than the contract amount of 100 units. Thus, it's now the carrier that has to go with 50 empty units in the truck and thus suffers reduced capacity utilization. In scenario 4, though the shipper has enough shipments per the contract, the carrier happens to have extra space which would now go unutilized. These scenarios should illustrate the problems faced by both, the shipper and the carrier, owing to uncertainties in shipper requirements and carrier's capacity availability.

Table 1. Sample Scenarios

SN	Shipper	Carrier	Collaborating Shipper	Collaborating Carrier
1	100	50	50	150
2	150	100	50	150
3	50	100	150	150
4	100	150	50	150
5	50	150	150	50

(In the above table, the contract size between shipper-carrier is 100 units. The contract size between the collaborating shipper (and its contract carrier) and the collaborating carrier (and its contract carrier) is also 100 units. Thus, in scenario 3 for example, the collaborating shipper has 50 units less than promised with its contract carrier. On the other hand, the collaborating carrier has 50 units more than what it committed to its contract shipper).

## **Transportation Management on an ELM**

On an ELM, the participants are connected with each other electronically to facilitate visibility of operations and share the relevant information based on who owns the ELM. For example, on a shippers' ELM, the shipper owns the ELM and there is one-way information sharing; the participants, the shipper's contract carrier and other collaborating shippers and carriers share their information with the shipper that owns the ELM. In scenario 1, as the shipper has access to information about the participants' operations, the shipper knows *beforehand* that the contract carrier does not have enough capacity (a deficit of 50 units). At the same time, the shipper also knows that its collaborating partners have excess capacity available with them (50 with shipper and 50 with carrier). Thus, the shipper, instead of losing sale, may ship the remaining 50 units through either one of the two collaborating partners. Interestingly, though the shipper ELMs do not aspire to benefit carriers, the participating carriers may still get some benefit. For example, in scenario 5, the shipper only has 50 units, 50 units less than the contract amount. Thus, the shipper is in a risk of defaulting with its carrier. However, the shipper knows that its collaborating shipper has 50 additional units that it may want to ship. The shipper may combine its load with its collaborating shipper and present the contracted quantity of shipments to the carrier to avoid defaulting with the carrier. Thus, the carrier too is benefited by participating on a shippers' ELM. On a neutral ELM, all the participants share information with each other; that is, there is a two way sharing of information. As a result, the carrier too may benefit from information visibility and collaboration. For instance, in scenario 3, the shipper is 50 units short of the promised quantity and the carrier would be left with 50 units of unused capacity. However, the carrier may pool the 50 units of additional shipments available with the collaborating shipper and avoid underutilizing its capacity. Finally, a carrier ELM would be owned and operated by a transportation carrier to maximize its own capacity utilization. Though such ELMs are geared to maximize capacity utilization of the concerned carriers, shippers too, would get some benefit. For example, in scenario 1, the carrier has less capacity than the promised amount (only 50 units). The shipper is in a position to potentially lose sale. However, since the carrier knows that there is extra capacity available with its collaborating carrier, the carrier would then pass on these shipments to the collaborating carrier. As a result, the shipper's needs are taken care of and the carrier avoids defaulting on the contract with the shipper, a win-win scenario for both of them.

### **RESEARCH METHODOLOGY: SIMULATION**

To investigate the performance benefits of ELMs, a large-scale empirical study using archival data from ELMs may be the preferred choice for this empirical research. However, the use of ELMs, as discussed in literature review, is still in its infancy. Further, companies tend to be very secretive when adopting new technology or business processes. This makes obtaining archival data a very difficult task. As well, since the use of such ELMs is not widespread, there will be serious concerns regarding any data that may be collected through questionnaires. Given the difficulties in obtaining archival data and/or survey data, and concerns in using such data in research, we propose using simulation modeling to investigate empirically the benefits of such ELMs to the participating parties. Simulation has often been used in logistics research literature to answer important questions and do meaningful research, especially where there is limited data availability.

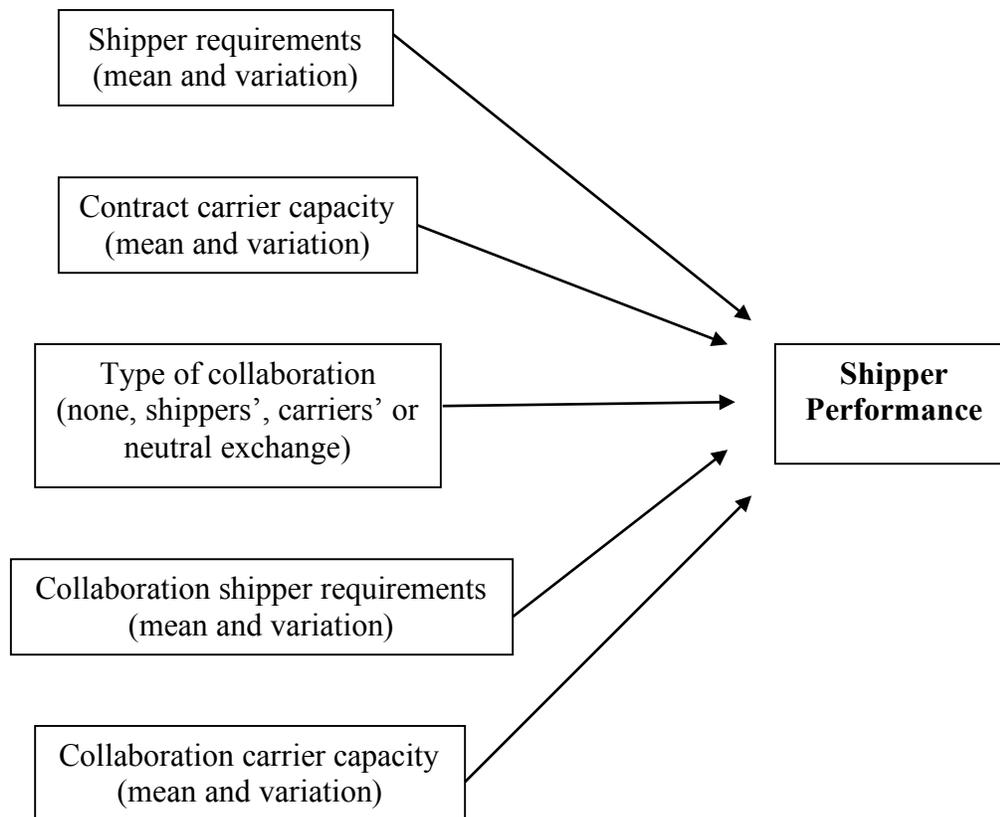
## Simulation Model

The simulation model is shown in Figure 2. Following are the independent and the dependent variables in our model.

**Dependent variable: Order fulfillment.** Order fulfillment measures the ratio of shipments that are shipped on time. Shipments that are not shipped on time either result in delayed delivery or lost sales, both of them being very detrimental to the shipper. For any shipper, order fulfillment drives sales revenues. That is, every time quantity shipped and hence order fulfillment increases, sales revenue also goes up. We propose to use “order fulfillment” as the performance measure for shipper performance. We prefer order fulfillment over quantity shipped because order fulfillment is a more commonly used performance measure in logistics (e.g. Kritchanchai & MacCarthy, 1999; McAfee, 2002). We define order fulfillment as

$$\text{Order fulfillment} = (\text{quantity shipped}) / (\text{shipper requirements})$$

Figure 2. Model of Shipper Performance



### *Independent variables*

- Primary shipper’s requirements: This construct measures the level or magnitude of the shipper’s requirements and the variability of such requirements.

- Primary carrier's capacity: This construct measures the level or magnitude of the carrier's carrying capacity and the variability of this capacity.
- Collaborating partner's characteristics: A shipper may collaborate with either a shipper or another carrier, or with both. This construct measures the level or magnitude of the shipper's requirements or the carrier's capacity and the variability of these requirements and/or capacity.
- Type of collaboration: Shippers have four alternatives to manage their transportation. They may manage their transportation using the conventional method, or they may manage their transportation using one of the three alternatives: a shippers' ELM, a carriers' ELM or a neutral ELM.

### **Input Data Analysis**

We collected shipping records for truckload shipments of a major manufacturer of hardware and home improvement products. Every record pertains to a truckload shipment for an origin-destination city pair (lane). We collected data for an entire calendar year. We were provided in excess of 25,000 shipment records over 1,365 unique origin-destination city pairs or lanes. The number of records within a given lane varies from a maximum of 2,445 to a minimum of 1. The weights of the truckload shipments vary from a maximum of 45,390 pounds to a minimum of 2,740. Product diversity accounts for the wide variability of the weight of truckload shipments. To narrow down the number of lanes, and to obtain a better fit of the data with theoretical distributions, only those lanes that had 100 or more records over the course of the year were considered. Using this criterion reduced the number of lanes to 41.

We use the data we have collected for our empirical analysis. Standard theoretical probability distributions are fitted to the data, and the parameters of these fitted distributions are used to model the shipping requirements of the primary shipper and of the collaborating shipper. The data for these 41 lanes were fitted with a normal distribution. The normal distribution is widely used in business simulation studies. However, the normal distribution may generate negative values, and negative shipping requirements do not make practical sense. Hence any negative values were truncated to zero. Further, normal distribution will generate fractional values for the number of truckload shipments; we rounded fractional values to their nearest integers. The fit of the theoretical normal distributions to the data on shipping records on the 41 lanes was obtained using the input analyzer of Arena software. The data on shipping records of the 41 lanes were aggregated on a weekly basis. Thus, there were 52 data points for each lane, corresponding to 52 weeks of the year. Out of 41 lanes available a satisfactory fit was obtained on 10 lanes. The "chi-square test" was used to test for the goodness of fit. Of the 10 lanes, six were selected to model three different levels of shipping requirements for the primary shipper and the collaborating shipper. The maximum mean was 17.7 (corresponding to shipping requirements of approximately 17.7 truckload shipments per week) and the minimum was 2.4 (corresponding to a shipping requirements of approximately 2.4 truckload shipments per week). We present the six lanes that were selected in Table 2.

Table 2. Goodness of fit statistics of theoretical normal distribution for the selected lanes

Lane Number	Lane Miles	Number of truckloads per week			Fitted theoretical distribution			Chi-square value	
		Minimum	Maximum	Total	Mean	Standard deviation	Coefficient of variation	Sample	Critical
1	2324	0	6	125	2.4	1.33	0.55	1.3	6.25
2	2424	1	13	336	6.46	3	0.46	4.26	9.24
3	502	1	30	740	14.2	6.46	0.45	1.5	12.02
4	177	0	9	166	3.13	1.94	0.62	3.96	9.24
5	400	1	12	261	5.22	1.95	0.37	3.1	9.24
6	1404	2	38	937	17.7	6.89	0.39	7.18	12.02

The chi-square values for the lanes are well below the 90% confidence level, with critical chi-square values shown in the table (the input analyzer used different numbers of intervals in fitting the theoretical distributions for the different lanes. Hence the different lanes had different degrees of freedom and hence different critical chi-square values). Thus, at the 90% confidence level, there is not sufficient evidence to reject the hypothesis that the fitted distributions shown in the table do not adequately represent the data.

### Experimental design

#### *Simulation parameters and parameter values.*

1. Mean and variation of the distribution of the primary shipper’s shipping requirements. The theoretical fitted distributions are used to model the shipping requirements of the primary shipper. As mentioned earlier, the normal distribution is used to model these requirements. To capture the range of shipping requirements in our dataset, two extreme values reflecting “high” and “low” shipping requirements were chosen, as well as one value approximately in the middle showing “medium” shipping requirements were chosen from the ten distributions we obtained. Table 2 shows six of these fitted theoretical normal distributions. The first three lanes are used to model the shipping requirements of the primary shipper. The means of these lanes are 2.4, 6.46, and 14.2. As explained below, the means of the theoretical distribution form the basis for the contract size between the primary shipper and its contract carrier. Since the mean truckload shipping requirements has to be integers, we round these requirements to 2, 6 and 14 truckload shipments per week. Further, the coefficient of variation of truckload shipping requirements of these lanes vary from 0.45 to 0.55. To represent this variation, we chose 0.5 for the coefficient of variation.
2. Mean and variation of the distribution of the primary carrier’s available capacity. Given the practical difficulties in obtaining data from multiple organizations, we assumed that the contract carrier’s carrying capacity has the same means and coefficient of variation as that of the primary shipper. Assuming the same means as that of primary shipper makes sense, as the contract carrier will commit the same amount of capacity asked by the primary shipper.
3. Mean and variation of the distribution of the collaborating shipper’s requirements. We decided to model the shipping requirements of the collaborating shipper by using the same dataset we used to arrive at the shipping requirements of the primary shipper. Using the primary shipper’s

shipping records to simulate the collaborating shipper's requirements should not create undue problems. On high traffic lanes, it is possible to have a large number of shippers with various levels of shipping requirements. Some of the shippers on these high traffic lanes may well match with the shipping requirements (means and coefficients of variations) of the primary shipper. The last three distributions in Table 2 will be used to model the shipping requirements of the collaborating shipper. The means of these lanes are 3.13, 5.22 and 17.7. Similar to the primary shipper-carrier pair, the means of these theoretical distributions will form the basis for the contract size between the collaborating shipper and its contract carrier. Hence, the mean truckload shipping requirements has to be integers. We round these requirements to 3, 5 and 18 truckload shipments per week. Further, the coefficient of variation of truckload shipping requirements of these lanes vary from 0.37 to 0.62. To represent this variation, and to keep the difference between these levels consistent at 0.2 (the corresponding coefficient for the primary shipper is 0.5), we chose 0.7 for the coefficient of variation. We decided to include 0.5, the primary shipper's coefficient of variation. In order to present a diverse set of examples, we also used one more value of 0.3. Thus, in all, we have three levels of variation for collaborating shipper's shipping requirements, 0.3, 0.5 and 0.7. In order to be consistent, the same set of coefficients of variation is used for the primary shipper as well. Further, we assume that the collaborating shipper profiles are available on every lane of the primary shipper. That is, every profile of the primary shipper had all these profiles for collaborating shipper as well.

4. Mean and variation of collaborating carrier's available capacity. Similar to primary carrier's carrying capacity, we assume that the means of the carrying capacity of the collaborating carrier are equal to the shipping requirements of its contract shipper. As well, the same levels of coefficients of variation for carrying are used for the collaborating carrier.
5. The contract quantity between the primary shipper-carrier. This is assumed to be equal to the primary shipper's requirements. This should make sense, as the contract carrier will gear its operations to satisfy the shipper's requirements.
6. The contract quantity between the collaborating shipper-carrier. Similar to above, this is assumed to be equal to collaborating shipper's requirements.

Table 3 shows the experimental design with the dependent and independent variables and their values. The contract size between the primary shipper-carrier pair takes three values, as shown in Table 3, and are treated as three different variables. Two dummies are used to represent the high and medium contract size. The low contract size serves as the base case. Dummy variables are used for the other independent variables as well, with the lower value for each independent variable serving as the base case.

As per the experimental design shown in Table 3, we have six variables at three levels. That gives us ( $3^6 = 729$ ) 729 parameter combinations in the simulation model. Fifty trial replications for the first combination of primary shipper's requirements and primary carrier's capacity (mean 14 units, coefficient of variation 0.7), and collaborating shipper's requirements and collaborating carrier's capacity (mean 18 units, coefficient of variation 0.7) were conducted. The results were used to find the required number of replications for obtaining 10% precision on shipper performance. The number of required observations was found to be 140. In order to be conservative, each parameter

combination is replicated 300 times. The methodology followed to arrive at the required number of observations to achieve a pre-determined level of precision in simulation results is outlined in Law and Kelton (2000, pp. 511-515). Finally, the simulation model was validated by manually computing the results for more than 1600 observations on the dependent variable and comparing these results to the ones obtained through the simulation program. No discrepancies were found and hence it was concluded that the model was valid.

Table 3. Simulation model parameters and parameter values

<b>Simulation Parameters</b>	<b>Parameter Levels</b>
Primary shipper’s shipping requirements, primary carrier’s carrying capacity and the contract size between primary shipper-carrier pair	2, 6 , 14
Coefficient of variation for primary shipper’s shipping requirements	0.3, 0.5, 0.7
Coefficient of variation for primary carrier’s carrying capacity	0.3, 0.5, 0.7
Collaborating shipper’s shipping requirements, collaborating carrier’s carrying capacity and the contract size between collaborating shipper-carrier pair	3, 5, 18
Coefficient of variation for collaborating shipper’s shipping requirements	0.3, 0.5, 0.7
Coefficient of variation for collaborating carrier’s carrying capacity	0.3, 0.5, 0.7

### **SIMULATION RESULTS AND DISCUSSION**

Ordinary least squares regression is used for data analysis. Various available options for managing transportation form one set of the independent variables. As explained earlier, a shipper or a carrier has four options to manage its transportation: the conventional method, shippers’ ELM, carriers’ ELM and the neutral ELM. Further, each ELM provides three more options to manage transportation, collaboration with a shipper, collaboration with a carrier, and collaboration with both a shipper and a carrier. Thus, shippers and carriers have ten options to manage their transportation. These options are represented by nine dummy variables. The conventional method is used as the base case for the regressions.

Order fulfillment forms the dependent variable and the 21 dummy variables form the independent variables for the regression analysis (please refer to Table 4 for regression results). The model is highly significant (it is significant at 0.001% level) and the model  $R^2$  statistic is 86.7%. Further, the coefficients on all of our independent variables are significant at 0.001% level.

There are several aspects worth noting about the results. First, a shipper receiving greater benefits in terms of increased order fulfillment on shippers’ and neutral ELM than on a carriers’ ELM. Shipper benefits on shippers’ and neutral ELMs are almost twice as much as on a carriers’ ELM. On a shippers’ or a neutral ELM, a shipper takes a proactive role to improve its order fulfillment. Whereas, on a carriers’ ELM, the improvement in shipper’s order fulfillment is limited to the extent the primary carrier tries to avoid defaulting on the contract with its contract shipper. Second,

there is value in collaborating with more than one partner. On all the three ELMs, the benefits of collaborating increase as the number of collaborating partners increases from one to two. However, the added benefits from the second collaborating partner seem to be less than the benefits obtained from the first partner.

Table 4. Shipper performance model results: Dependent variable-Order fulfillment

Variable	Unstandardized Coefficients		Standardized Coefficients	t	Sig.	
	B	Std. Error	Beta			
(Constant)	.820	.001		663.120	.000	
Shippers' ELM, collaborating with	Shipper	.074	.001	.362	63.142	.000
	Carrier	.075	.001	.363	63.279	.000
	Both	.123	.001	.599	104.358	.000
Neutral ELM, collaborating with	Shipper	.074	.001	.362	63.142	.000
	Carrier	.075	.001	.363	63.279	.000
	Both	.123	.001	.599	104.358	.000
Carriers' ELM, collaborating with	Shipper	.042	.001	.203	35.428	.000
	Carrier	.042	.001	.204	35.546	.000
	Both	.068	.001	.332	57.807	.000
Primary shipper-carrier contract size	Medium	-.031	.001	-.237	-47.990	.000
	High	-.053	.001	-.407	-82.417	.000
Primary carrier coefficient of variation	Medium	-.043	.001	-.328	-66.496	.000
	High	-.081	.001	-.616	-124.812	.000
Primary shipper coefficient of variation	Medium	-.021	.001	-.160	-32.391	.000
	High	-.039	.001	-.295	-59.679	.000
Collaborating partner's contract size	Medium	.012	.001	.094	19.080	.000
	High	.037	.001	.286	57.834	.000
Collaborating carrier coefficient of variation	Medium	.005	.001	.040	8.010	.000
	High	.008	.001	.062	12.594	.000
Collaborating shipper coefficient of variation	Medium	.005	.001	.042	8.462	.000
	High	.009	.001	.071	14.371	.000

To verify this, we created Table 5 showing the impact of various collaboration options on all the shipper performance measures. The first set of variables is dummies for the independent variables. The first row is the base case in our regression, which is the constant of the regression equation for order fulfillment (82.0%). The second row shows the impact of the shipper collaborating with other shipper on a shippers' ELM (as indicated by value 1 for the dummy S\_FS). The column after

the dummy variables is our dependent variable, order fulfillment or shipper performance. Thus, the value in the second row of the “order fulfillment” column gives the order fulfillment when the shipper moves to a shippers’ ELM and collaborates with other shipper (represented by the dummy S\_FS). The value is the sum of the regression constant (0.820, please refer to Table 4) and the coefficient for the dummy S\_FS in the regression equation (0.074 in Table 4). All the other values in Table 5 are obtained in similar fashion. From Table 5, on a shippers’ ELM, when the number of collaborating partner increases from 0 to 1, order fulfillment increases from 82.0% to 89.4 %. When the number of collaborating partners goes up from 1 to 2, the order fulfillment increases from 89.4% to 94.3%. Thus, though order fulfillment increases with an increase in the number of collaborating partners, there seems to be decreasing marginal returns to collaboration, in terms of order fulfillment.

Table 5. Collaboration effects comparison table

Summary of the impact of various collaboration options for the primary shipper available in Internet logistics exchange on various shipper performance measures (collaboration comparison table)

Collaboration options for the shipper									Shipper performance measure
S_FS	S_FC	S_FSB	N_FS	N_FC	N_FSB	C_FS	C_FC	C_FSB	Order Fulfillment
0	0	0	0	0	0	0	0	0	0.820
1	0	0	0	0	0	0	0	0	0.894
0	1	0	0	0	0	0	0	0	0.895
0	0	1	0	0	0	0	0	0	0.943
0	0	0	1	0	0	0	0	0	0.894
0	0	0	0	1	0	0	0	0	0.895
0	0	0	0	0	1	0	0	0	0.943
0	0	0	0	0	0	1	0	0	0.862
0	0	0	0	0	0	0	1	0	0.862
0	0	0	0	0	0	0	0	1	0.888

S\_FS/ S\_FC/ S\_FSB = Shippers ELM, collaborating with a shipper/carrier/both  
 C\_FS/ C\_FC/ C\_FSB = Carriers ELM, collaborating with a shipper/carrier/both  
 N\_FS/ N\_FC/ N\_FSB = Neutral ELM, collaborating with a shipper/carrier/both  
 OF = Order fulfillment

As for the desirable characteristics of the collaborating partners, referring to the results table (Table 4), the benefits in terms of order fulfillment are greater for higher contract sizes. Thus, the greater the volume of shipments of the collaborating shipper (S2) and the carrying capacity of its contract carrier (C2), the more the primary shipper will benefit by managing its transportation on ELM. Thus, it seems that bigger shippers and/or carriers may have more available slack to accommodate the primary shipper’s shipping requirements.

Table 6 gives the impact of collaborating partner characteristics on shipper performance. This table is created in a similar way as Table 5. The collaborating partner characteristics form one set of variables. The last column pertains to order fulfillment or shipper performance. As seen earlier,

the base order fulfillment is 82.0%. From (collaborating partner table) Table 6, as the contract size between the collaborating shipper-carrier pair goes up from the base level to medium level, the order fulfillment increases to 83.2% (from the base level of 82.0%). On the other hand, when the collaborating partner’s level of operations (or contract size) goes up to high level from the base level, the order fulfillment increases to 85.7%. Thus, in terms of order fulfillment, it is more beneficial to collaborate with a bigger partner.

Table 6. Collaborating partner characteristics effects table

Effect of collaborating partner characteristics on shipper performance.

Contract Size		CV Carrier		CV Shipper		Shipper performance measure
Medium	High	Medium	High	Medium	High	Order Fulfillment
0	0	0	0	0	0	0.820
1	0	0	0	0	0	0.832
0	1	0	0	0	0	0.857
0	0	1	0	0	0	0.825
0	0	0	1	0	0	0.828
0	0	0	0	1	0	0.825
0	0	0	0	0	1	0.829

CV = Coefficient of Variation

Referring to the results table (Table 4), the variability of the shipping patterns of both, the collaborating shipper and its contract carrier (coefficients on all dummies of coefficient of variation) positively affect primary shipper’s order fulfillment. From the base level of 82.0%, the order fulfillment increases to 82.5%, and 82.9% (please refer to Table 6) as the variability (coefficient of variation) of either the collaborating shipper or the collaborating carrier increases to 0.5 or 0.7 respectively, from the base case of 0.3 Thus, having a collaborating partner with erratic or unpredictable shipping patterns or carrier capacity increases the shipper’s order fulfillment. With a high degree of variability in the shipping requirements of the collaborating shipper (S2) and the carrying capacity of its contract carrier (C2), there will likely be more mismatches between the collaborating shipper-carrier pair. This in turn creates more slack with the collaborating shipper and/or carrier, and will improve the order fulfillment of the primary shipper.

On the other hand, all other things being equal, higher contract sizes between the primary shipper-carrier pair are associated with lower order fulfillment for the primary shipper (please refer to the results table, Table 4). Thus, all other things being equal, higher shipping volumes will typically result in lower order fulfillment. This may be because problems get magnified with increases in shipping volumes. For example, at higher contract sizes, for any given coefficient of variation, there will be greater mismatch between primary shipper requirements and contract carrier capacity than at lower contract sizes. Since the collaborating partner’s support remains the same, at higher contract sizes, this will result in lower order fulfillment.

However, it is important to note that the above interpretation depends upon the assumption that all variables other than the contract size remain the same. This assumption may not always be valid, as bigger shippers may have well established and stable shipping patterns and hence have lower coefficient of variation in their shipping requirements.

Table 7 (for convenience, also referred to as primary pair table) shows the quantitative impacts of primary shipper-carrier characteristics on various shipper performance measures. As the primary shipper-carrier contract size increases from the base case to medium and high level, the order fulfillment drops to 78.9% and 76.7% respectively, from the base level of 82.0%.

Table 7. Primary shipper-carrier characteristics effects table

Effects of primary shipper-carrier characteristics on shipper performance (primary pair table)

Contract Size		CV Carrier		CV Shipper		Shipper performance measure
Medium	High	Medium	High	Medium	High	Order Fulfillment
0	0	0	0	0	0	0.820
1	0	0	0	0	0	0.789
0	1	0	0	0	0	0.767
0	0	1	0	0	0	0.777
0	0	0	1	0	0	0.739
0	0	0	0	1	0	0.799
0	0	0	0	0	1	0.781

CV = Coefficient of Variation

Further, the variability of the shipping patterns of the primary shipper and the carrying capacity of its contract carrier (coefficient on all dummies of related to coefficients of variation of primary shipper’s requirements and its contract carrier capacity) negatively affect shipper’s order fulfillment (please refer Table 4). For the quantitative values of these impacts, please refer to the primary pair table (Table 7). With the increase in the variability (coefficient of variation) of the primary shipper’s requirements from a base case of 0.3 to 0.5, and 0.7, the order fulfillment drops to 79.9% and 78.1% respectively, from the base level of 82.0%. In case of the variability of carrier capacity, order fulfillment drops to 77.7% and 73.9% for the respective increase in variability. Thus, having erratic or unpredictable shipping patterns or carrier capacity availability harms the shipper’s order fulfillment. In terms of order fulfillment, variability in contract carrier capacity seems to be much more harmful than variability in shipper requirements.

### LIMITATIONS

These findings increase our understanding about the impacts of ELMs on the performance of the participating shippers and thus make valuable contributions to the logistics literature. However, in the case of our simulation model, we did not have information on spot market. Inclusion of spot market may enrich the model. Shipping requirements and carrier capacities of all the shippers and carriers in the simulation model are independent of each other. In the real world, if there is monopoly on certain shipping lanes, this assumption may be unrealistic. Further, the data used

related only to truckload shipments. This could be expanded to include less-than truckload shipments where other factors such as weight and volume of cargo might become important considerations in selecting collaborating partners. A shipper or a carrier also needs to consider the nature of shipments of its collaborating partners as in the case of hazardous cargo, for instance. That may change the extent of benefits derived by participating on such ELMs. Finally, we assumed certain probability distributions for all the other participants other than the primary shipper. Though this may be suitable for this exploratory research, this limits the generalizability of the results. As the logistics exchanges continue their operations and accumulate data over time, it may be very insightful to conduct empirical study using the actual transaction/archival data from few of these ELMs.

## CONCLUSIONS

Shipper benefits are greater when the shipper collaborates with multiple partners rather than with a single partner. Though there is evidence of decreasing marginal returns to collaboration, the incremental benefits from additional partners are still substantial. Interestingly, even though a carriers' ELM is biased against shippers, participating on a carriers' ELM may provide substantial benefits to the shipper in terms of increased order fulfillment. As previously noted, shippers receive indirect benefits on a carriers' ELM as a consequence of their contract carrier's actions to improve performance. There are instances reported in the practitioner press about carriers persuading their contract shippers' to join carrier ELMs and even offering to pay their shippers their participation fees as an incentive to have them join (Cooke, 2001). Vice-versa may also be true. Our results indicate that participation on a carriers' ELM by shippers brings substantial benefits to the shipper, despite the bias of the ELMs in favor of the carriers. Thus, a shipper is likely to benefit directly or indirectly by participating on an ELM, no matter the configuration of the ELM. Further, bigger shippers with high shipment volumes would benefit more than smaller shippers by moving to ELMs. Finally, increases in the contract carrier's variability decreases shipper's order fulfillment, demonstrating that it is important to have a dependable carrier.

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