Electronic commerce techniques for process change in an integrated supply chain

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Use of an economic metaphor for a usage of the computer aided logistic organization leads to motivating self-interested parties to achieve mutual satisfactory and efficient outcomes. Efficiency, in this sense, is maximized when redistributing the trade surplus leaves everyone at least as well as before. Simulation of economic aspects of transport logistic chain is currently under the way at Rijeka College of Maritime Studies. The system consisted of 24 different types of organizations and 103 different documents interchanged in the supply chain.

The primary aspects were transaction costs and vertical integration using electronic aided logistics and electronic documents. The paper introduces results of the research showing savings up to 1,2 % of GDP for any country. The savings have been calculated for each organisation type, showing it's structural position in the supply chain.

Fundamental Change In Supplier Base Management

In business today, change is fundamental. Over the past decade operations managers have faced many models for change, including just-in-time (JIT), total quality management (TQM) and business process reengineering (BPR). A continuum of the magnitude of change required to achieve success has emerged from these operations-oriented models for change, anchored by JIT's philosophy of continual, incremental change at one end and BPR's requirement of radical, discontinuous change at the other.

A fundamental change in supplier base management has been under way in the industry in recent years. Since 1991, the supplier base has been reduced significantly (by 50% or more) across all sectors of the industry. Many firms have taken proactive steps to consolidate and restructure their supplier networks in order to reduce cost, improve quality, and strengthen their competitiveness. A major change has been the delegation of greater responsibilities to key suppliers, such as the production of major parts and components, laboratory and inspection functions, and management of lower tier suppliers. The reduction in the supplier base, rather than being confined to the upper-tiers, appears to have permeated all layers of the industry.

Firms have re-organised, streamlined and integrated across business units their internal operations pertaining to supply chain management. Different forms of organisational structures for supply chain management have emerged. Many of the firms have achieved greater internal efficiency in procurement and material management. A key effort has been to reduce subcontracting cycle time. Some have adopted electronic data interchange (EDI) methods to expedite purchasing operations. Others have started to place greater emphasis on "best-value" subcontracting, within the constraints of existing acquisition regulations. The widening of procurement operations into a more strategic level encompassing an integrated view of supply chain management practices is evidenced. The industry is moving toward lean practices, although it is still at a relatively early stage and much can be gained from appropriate transfer of best lean commercial practices.

Many firms have been engaged in a serious re-evaluation of what they "make" or "buy," as they have attempted to redefine their core competencies as part of their longer-term strategic thrust. Although a majority of firms have started to outsource parts and components that they had earlier designed and built in-house, others appear to have brought back work from their suppliers. A combination of these developments may help explain why there appears to be a lack of a consistent trend or pattern in the proportion of end-product value that is outsourced. A strong move toward lean practices would have suggested a definite increase in the outsourcing ratio. Lower cost and strategic realignment of production are given as the most important reasons for increased outsourcing.

Two-way communication between primes and their most important suppliers has increased substantially since 1989, serving as a platform for wider collaborative relationships. Information now regularly provided by major suppliers to their customers include data on production costs, statistical process control, actions taken to improve production processes, longer-term business plans, proprietary financial information, and feedback to customer companies on how they can improve their purchasing and material management functions. On their part, customer companies regularly provide to their most important suppliers information on their planned production schedules and requirements, cost targets, plans for supplier base restructuring, long-term business strategies, and quality of incoming parts. Closer interactions also include: technical assistance to suppliers to improve their quality; joint diagnosis and resolution of manufacturing problems; joint

diagnosis and reduction of inventory and scheduling problems; and joint new product design, development and demonstration.
Regardless of which philosophy of change a company chooses to embrace, it must consider the impact of information technologies (ITs) as an agent of change. Particularly in this time of increased focus on supply chains and supply chain management, ITs which span traditional organizational boundaries to automate and integrate supply chain functions are critical.

Electronic commerce

Electronic commerce is a means of enabling and supporting previously mentioned changes on a global scale. It enables companies to be more efficient and flexible in their internal operations, to work more closely with their suppliers, and to be more responsive to the needs and expectations of their customers. It allows companies to select the best suppliers regardless of their geographical location and to sell to a global market.
One possible definition of electronic commerce used by European Union is: "any form of business transaction in which the parties interact electronically rather than by physical exchanges or direct physical contact"(EC, 2000; Timmers Paul, 1999).
Electronic Commerce encompasses a broad range of activities. The core component is addressing the commercial transaction cycle. Electronic Commerce includes electronic trading of physical goods and services and of electronic material. Upstream and downstream of the transactions it also includes the advertising and promotion of products and services, the facilitation of contacts between traders, the provision of market intelligence, pre- and post-sales support, electronic procurement and support for shared business processes.
Electronic commerce can be sub-divided into four distinct categories (European Commission - DG XIII; EC 2000):

- business-business
- business-consumer
- business-administration
- consumer-administration

An example in the business-business category would be a company that uses a network for ordering from its suppliers, receiving invoices and making payments. This category of electronic commerce has been well established for several years, particularly using Electronic Data Interchange (EDI) over private or value-added networks.
The business-consumer category largely equates to electronic retailing. This category has expanded greatly with the advent of the World Wide Web. There are now shopping malls all over the Internet offering all manner of consumer goods, from cakes and wine to computers and motor cars.
The business-administration category covers all transactions between companies and government organisations. For example, in the USA the details of forthcoming government procurements are publicised over the Internet and companies can respond electronically. Currently this category is in its infancy, but it could expand quite rapidly as governments use their own operations to promote awareness and growth of electronic commerce. In addition to public procurement, administrations may also offer the option of electronic interchange for such transactions as VAT returns and the payment of corporate taxes.
The consumer-administration category has not yet emerged. However, in the wake of a growth of both the business-consumer and business-administration categories, governments may extend electronic interaction to such areas as welfare payments and self-assessed tax returns.
There is no single theoretical perspective that explains the impact of electronic commerce on interorganizational relationships; existing approaches tend to be too narrow to address the complexity of the observable phenomena. Therefore, this study develops a multidisciplinary framework for a more comprehensive understanding of the role of electronic commerce (EC) and related technologies. The framework is being applied in the context of a comparative case analysis of supply relationships in the transport industry. The framework acts as a foundation to examine the production network of supply relationships for international transport. Taking network perspective, rather than individual dyadic relationships, offers significant insight at the cost of considerable complexity. To cope with the complexity, we defined our organization-set as a series of focal networks comprising the document, material and cash flow.
Transport logistics cannot in authors view be solved with Internet paradigms already in use. Interactive shopping will introduce big changes in transport sector. Shopping would be done all over the world, and usually every thing would be bought from separate merchant possibly in different countries. This will conduct to smaller packages; smaller quantities of the same goods, but increasingly bigger amount of transported goods. Every package has to be accompanied by the same amount of documentation. The emerging growth of documentation mass will ask for new models of transport logistics. Quantity of the documentation, and need for efficiency will demand strategic alliances, between involved parties. This will be very difficult task to achieve. Nowadays, there are more than 30 different parties involved in international transport. They are interchanging between 200 different types of document among them. Interactive communications using WWW are obsolete in this domain, because of the amount of documents and often lack of time.

The Research Model

The structure of a very complex system cannot be represented in one diagram, as such a diagram would be far too large and convoluted. The structure can only be represented by a hierarchy of diagrams with the top-level diagrams representing the gross structure of the system and the bottom level ones representing its detailed structure. Different hierarchies are needed to represent different views of the purpose and structure of

the system. The research model represented in figure 1 consists from 24 different generic companies with 103 generic documents interchanged. The research model has been created as a sublimation of the models created and reviewed by:

- UN ECE (Nations 1987, Jan; Nations 1988; Nations 1989; Nations 1990a; Nations 1990b; Nations 1990c; Nations 1990d; Nations 1990e; Nations 1990f; Nations 1990g; Nations 1990h; Nations 1990i; Nations 1990j; Nations 1990k; Nations 1990l; Nations 1990m; Nations 1990n; Nations 1990o; Nations 1990p; Nations 1990q)
- European Union (ECC 1990)
- SITPRO (SITPRO 1989)
- OECD (Research)
- Australian National University(Clarke 1994)
- EURIDIS.

In order to keep the model relatively small a number of the companies and documents have been excluded.
There was also the problem of recognizing generic companies involved in the process, because of the differences in various countries. The customs broker or customs agent, for example, exists in some countries and it is a part of freight forwarder in other countries. The implication of the above is that the project needs to develop and manipulate many different representations of the structure of its systems. However one also observes the projects having great difficulty correlating their many different representations.

Second problem in model creation is commonly known as wire syndrome, and it has its origins in electronic schema design. If one examines the diagrams used by hardware engineers one observes a curious feature. Each rectangle in the higher level diagrams expands into a network of thousands of chips and their interconnections in the lower level diagrams, but each line in the higher level diagrams corresponds to just a single interconnection or at best a set of such interconnections in the lower level diagrams. This introduces the problem of selecting interconnections (documents) for the model, and while generic companies as entities are relatively easily recognized, identification of the generic documents is very difficult. There is big probability that from the multitude of the documents (interconnections) chosen by two different teams will exist a difference.
Simulation has been used to define economic behavior of the model and its entities for two generic case studies – usage of the electronic and paper documents. The only difference in the model is different time to perform the activity. For obvious reasons the time has been generated using the continuous distribution bounded on the lower side. Bounding of the distribution has been introduced because there has to be a minimum time for processing (retrieving, reading, processing, printing and sending) the document.

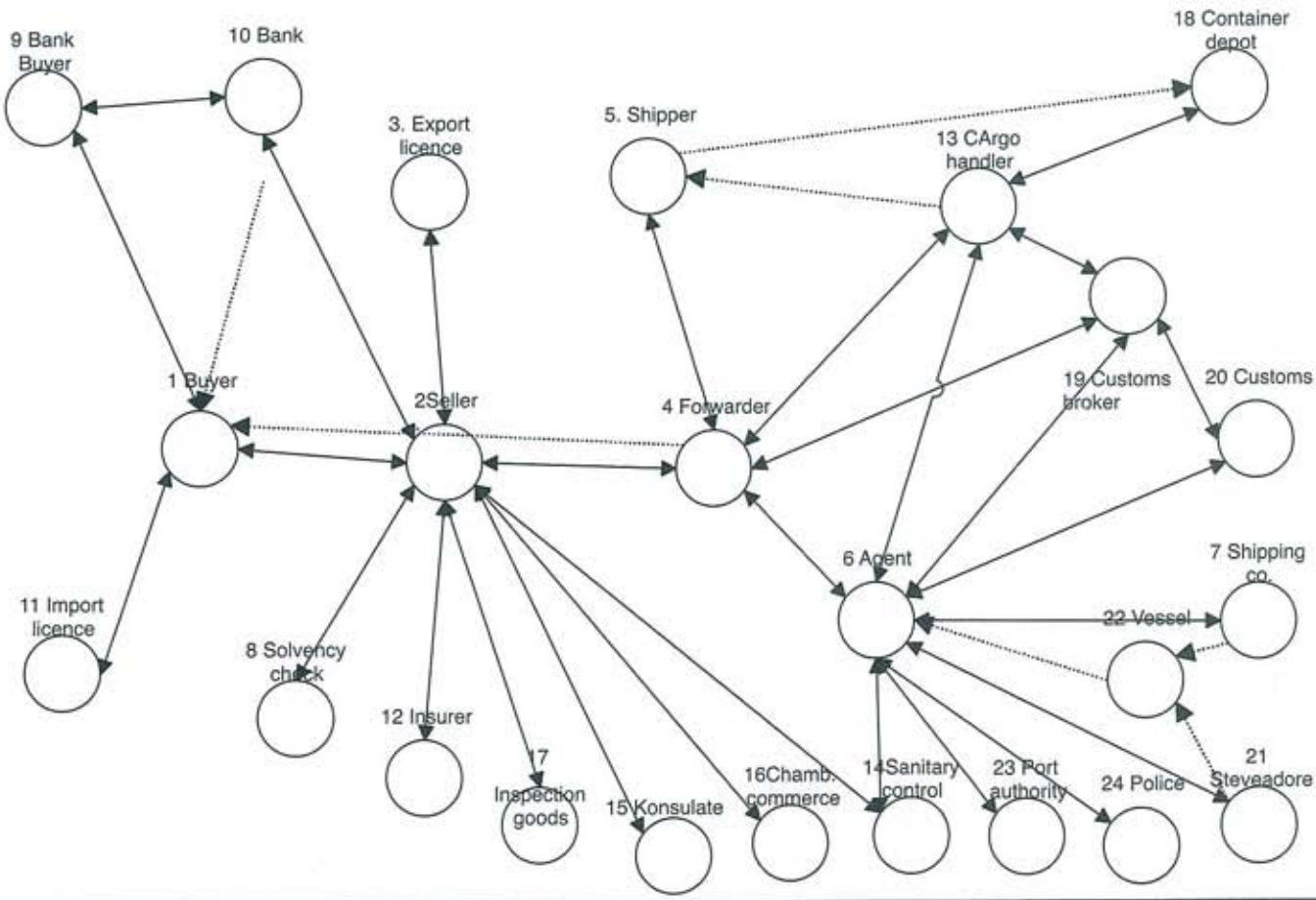

Fig. 1. Network representation of the model

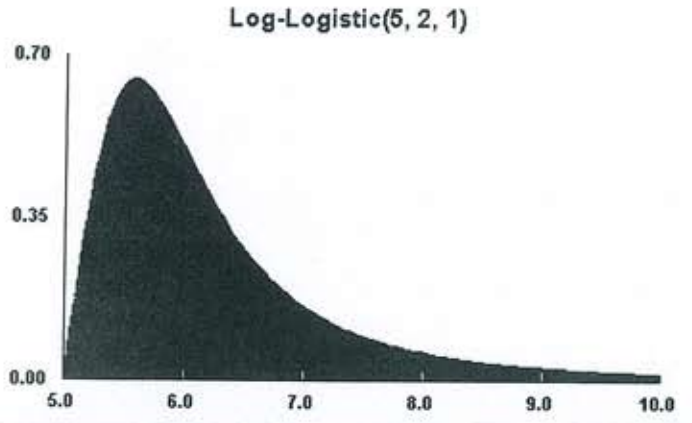

Fig. 2. Log-logistic distribution

From a multitude of the distributions a log-logistic distribution (figure 2) was chosen, because it is a continuous distribution bounded on the lower side, and it is used to model the output of complex processes such as business failure, product cycle time, etc. (Johnson, 1995).

A bound time of 5 minutes for electronic documents was chosen, and 30 minutes for classic documents. The costs of each document processing in model has constant value of 0.5$, and variable cost of 10$ per hour. Variable cost is dependent on the processing time and indicates, in accordance with a US freight transport statistics, a yearly income of 24 000 $.

The results

The results show that electronic documents can decrease the transaction costs, as shown on the figures 3 and 4 and tables 1 and 2. Electronic documents diminish the time used to obtain, create the documents, and thus the costs are decreased. For one shipment (total of 103 documents) electronic documents are 39% cheaper, then paper documents.

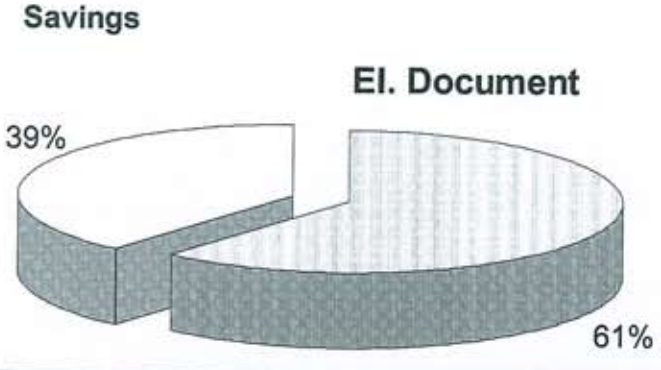

Fig. 3. Decrease of the document costs. (100% signifies the cost of the classic document)

Observe that the results are grouped, and that the standard deviation is small. The difference between the electronic and paper documents is 295.44$ for one set of 103 documents in one shipment. The difference in time is equal to 2001 minutes or 33 hours and 22 minutes.

	Total time [min]	Total cost [$]
Average	3048.47	8360
St. Dev.	36.79	17370
99% confidence lower bound	3010.66	23130
99% confidence upper bound	3086.28	33400

Table 1. Results for electronic documents

	Total time [min]	Total cost [$]
Average	5050.25	761.68
St. Dev.	12.22	2.78
99% confidence lower bound	5034.61	758.82
99% confidence upper bound	5065.89	764.19

Table 2. Results for paper documents

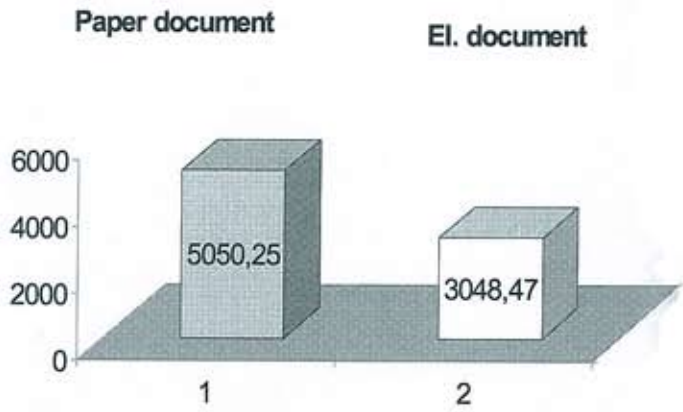

Fig. 4. Cecrease of the document processing time

Using this research findings one can very easily calculate the data for the cost- benefit analysis. Following assumptions have been utilised:

- Total number of shipments 50 000 / per year
- Annual wages for persons involved 20 000$ / per year
- Daily work time 6 hours
- Working days 260 days/year
- Classic documents fault rate 10 %
- Computer and programs cost 3000 $ per computer
- Additional integration cost 100.000$ per company

Final savings are 21 799 573$ per year.

For the complete supply chain the result from simulation experiment has shown that the time for one shipment documents processing is 5050 minutes for classical documents

(Cdocuments), and 3048 minutes for electronic (Edocuments) ones.

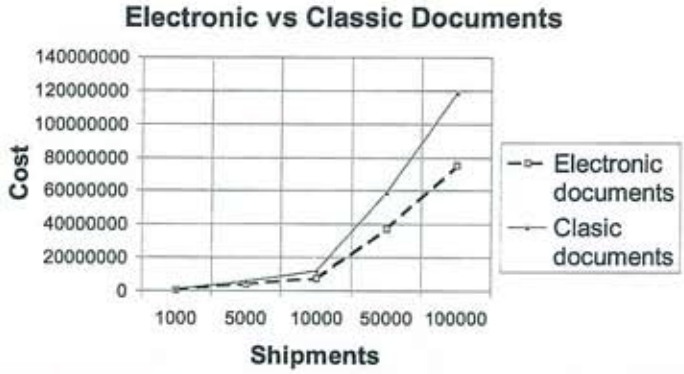

Fig. 5. Costs and benefits vs shipments

It is easy to calculate that for 50000 shipments per year the one needs 1628 persons to process all Edocuments and 2698 persons to deal with paper documents. The classic documents need 65,66% more workers. The personnel cost is 32 564 203 $ for Edocuments and 53 952 991 $ for Cdocuments, adding additional 10% for the faults in the classic document operations, the final saving are 26 784 188$.

The hardware / software costs for Edocuments are the integration costs of 100 000$ and 1628 computers making total system cost of 4 984 615$, leading to total cost of 37 548 7814$ for Edocuments.

No of shipments	1,000	5,000	10,000	50,000	100,000
Electronic documents	$ 848.974	$ 3.844.872	$ 7.589.744	$ 37.548.718	$ 74.997.436
Clasic documents	$ 1.186.966	$ 5.934.829	$ 11.869.658	$ 59.358.291	$ 118.696.581
Difference	$ 337.991	$ 2.089.957	$ 4.279.915	$ 21.799.573	$ 43.699.145

Table 3. Cost benefit analysis for different number of shipments

It is interesting that the payback period of the hardware / software for the total chain is 61,5 days. For different number of shipments integration costs for electronic documents and paper documents are shown in the picture 6, and calculation is represented in table 3.

From this data it is easy to calculate the payback period as quotient between the savings due to electronic document usage and costs of investment in information technology. The results are represented in the picture 7.

Conclusion

The results have shown large savings with usage of the electronic documents. UNCID has estimated that the costs of the data flows associated with international trade to be between 4 to 7 % of the value of the goods, and that the complete distribution costs are up to 16% of the net value of the goods. This implies that the information data flow is from 25 to 47% of the transportation price. 39% of the decrease in the information cost flow leads to, as the transport consumes about 6 to 8 % of the GDP, the savings up to 1,46% of the GDP.

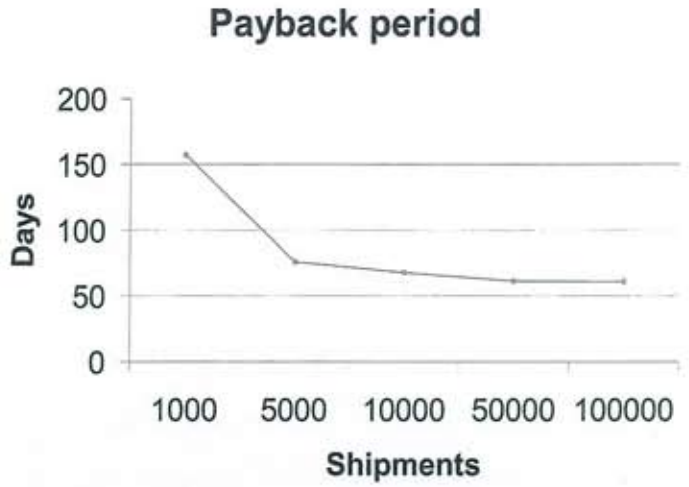

Figure 6. Payback period vs shipments

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