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.

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 the 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; Timmerman 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 type of documents 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:

- 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**
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.

Savings

<table>
<thead>
<tr>
<th>Electronic document</th>
<th>Paper document</th>
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<tbody>
<tr>
<td>39%</td>
<td>61%</td>
</tr>
</tbody>
</table>

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.

<table>
<thead>
<tr>
<th>Table 1. Results for electronic documents</th>
</tr>
</thead>
<tbody>
<tr>
<td>Average</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>St. Dev.</td>
</tr>
<tr>
<td>95% confidence lower bound</td>
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<tr>
<td>95% confidence upper bound</td>
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<table>
<thead>
<tr>
<th>Table 2. Results for paper documents</th>
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<td>Average</td>
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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.

![Electronic vs Classic Documents](image)

**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. It is essential to add the overhead costs to the classic document operations, the final saving is 26 784.188$. The hardware / software costs for Edocuments are the total costs of 100 0000 and 1628 computers making total system cost of 4 984.615$, leading to total cost of 37 548.78145$ for Edocuments.

<table>
<thead>
<tr>
<th>No of shipments</th>
<th>1,000</th>
<th>5,000</th>
<th>10,000</th>
<th>50,000</th>
<th>100,000</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Electronic</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>documents</td>
<td>$848.974</td>
<td>$3 844.872</td>
<td>$7 586.744</td>
<td>$37 548.719</td>
<td>$74 997.426</td>
</tr>
<tr>
<td>Classic</td>
<td>$1 886.986</td>
<td>$5 203.820</td>
<td>$11 869.658</td>
<td>$59 389.201</td>
<td>$118 606.581</td>
</tr>
<tr>
<td><strong>Difference</strong></td>
<td>$337.965</td>
<td>$1 359.848</td>
<td>$4 276.915</td>
<td>$21 739.272</td>
<td>$43 009.145</td>
</tr>
</tbody>
</table>

**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 presented 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 increase 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.

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