Information Technology Adoption and Use in Non-Integrated Air Cargo Operations

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ABSTRACT

This paper presents the key findings of a survey of 202 forwarder and 26 airline senior air cargo executives conducted in late 1999 and early 2000. The study was directed at understanding information technology adoption and use in the U.S. scheduled air cargo sector. Our key finding is a strategy of “one size fits all” information systems for this industry is unrealistic. Different companies and market segments appear to have very different information technology needs.
INTRODUCTION

This paper presents the key findings of a survey of 202 forwarder and 26 airline senior air cargo executives conducted in late 1999 and early 2000. The study was directed at understanding information technology adoption and use in the U.S. scheduled air cargo sector.

Information Technology Adoption

The study investigated the adoption of key information technologies used to coordinate operations of forwarders and airlines. In some technologies such as barcoding, radio, wireless, and automated vehicle location systems we find similar patterns of low adoption across both forwarders and airlines. For electronic data interchange (EDI), we find that adoption is much lower for forwarders than airlines. Other technologies, such as Internet web sites have a very high adoption level for both forwarders and airlines. Electronic commerce was used by about 25% of both forwarders and airlines with a large proportion indicating their intention to use.

Perceptions of Information Technology

How firms perceive information technologies influences how they use them. Both forwarders and airlines share the view that electronic communications between them will lead to improvement in quality of services, cooperation and competitive advantage. While large forwarders perceived greater cost benefits than smaller firms, cost was not seen as the primary benefit of electronic communications relative to other factors. An examination of perceptions of who benefits from EDI found some interesting differences. While “equal benefits” is the largest category of perceived beneficiaries amongst forwarders and airlines, almost half of firms see some other particular party benefiting before them. While this may not necessarily mean that these firms will not adopt EDI, their perceptions may influence the degree to which they enthusiastically reorganize their operations to use a technology that they believe will benefit another party more than themselves.

Non-Users

The majority of the forwarders in the survey do not use electronic communications to coordinate their activities with airlines. A review of the reasons for not adopting electronic communications finds problems of few partners and the absence of standards for information
exchange as the top reasons for both forwarder and airline non-adopters. The study finds that certain sectors of the forwarding sector may be behaving rationally in choosing not to adopt electronic communications. We find a significant proportion of forwarders characterizing their operations as limited to stable specialized markets where skills rather than information technology are a source of competitive advantage. While such sectors can probably benefit from information technology, they are unlikely to adopt an information technology that does not support their existing competitive strengths.

**On-Time Performance**

In an attempt to understand the relationship between IT use and operational performance we investigated measures of on-time performance. On-time performance is often discussed as the dependent variable for scheduled air cargo and the basis for comparison with the integrated sector. While a majority of forwarders and airlines indeed list improving on-time performance as a top priority we find that on-time performance is a complicated measure. While most firms want to improve their on-time performance, firms differ in what is satisfactory on time performance for them. Many firms express high satisfaction with what would seem to be relatively low levels of on-time performance as measured objectively. Rather than an uncharitable interpretation of low standards, this might suggest that there are many markets in which on-time performance is not the only critical measure of service quality.

Information technologies are often associated with improvements in operational performance across supply chains: higher on-time performance, fewer problems, fewer delays and less time spent waiting for transit. A major contribution of this study is that it attempts to “unpack” this simple association between IT and operational performance. While we do find some limited evidence that the use of technologies such as electronic documentation and barcoding are associated with higher levels of performance, the real story lies in understanding the factors that influence the effective use of IT in the logistics chain.

**The Role of Heterogeneity**

The air cargo industry is very heterogeneous. An overview of the forwarder and airline respondents and the business environment of air cargo highlights the diversity of the products and services offered, organizational characteristics, and modes of differentiation in the industry. For instance, airlines pursue dominance on geographic routes and deal with many hundreds of forwarders. Forwarders pursue different modes of differentiation depending on their size and deal with relatively few airlines. The majority of forwarders compete in other
modes of transportation as well as air cargo. And the nature of the demand for air cargo generates different types of shipments and procedures across different routes. These differences are important when we consider that operational performance results from the performance of a combination of heterogeneous firms into a single logistics supply chain for each shipment. Surely these factors influence how effectively IT is used within the logistics chain.

Forwarder-Airline Relationships

Trusting, competitive, mutually influential relationships would seem to be strongly associated with the effective use of information technologies across logistics supply chains. The study finds that airlines and forwarders view their relationships differently. We examined forwarder-airline relationships along the dimensions of trust, disagreement, cooperation and influence and found significant differences. In general, forwarders indicate they have much lower cooperation with airlines than airlines indicate they have with forwarders. As well, both forwarders and airlines indicate that they do not influence their partners as much as they think their partners influence them. While the direction of the differences is important, equally important are the implications of the presence of these differences. We conjecture that where differences in trust, cooperation, and mutual influence are great, these may place constraints on how IT can be used, and a limit to how effectively it can be used.

The Key Insight

The study suggests that a strategy of “one size fits all” information systems is problematic. The development of information systems that do not support firms to invoke their desired modes of differentiation does not engage the existing structure of the industry. Forwarders and airlines and larger and smaller firms have different goals and strategies. To the extent that larger firms have different trust and cooperative relations with their airline partners, they will integrate information systems differently into their supply chains. Smaller firms may not be able to integrate information systems in the same manner as larger firms. Across dimensions of size and other attributes, these firms require appropriate information technology solutions.
BACKGROUND

Three organizational configurations dominate the provision of air cargo services. Integrators, such as FedEx and UPS own all assets of production and provide door-to-door service, forwarders and combination carriers provide air cargo services through their coordinated efforts and generally use belly space on passenger flights for the airborne part of the journey and forwarders and all-cargo carriers fly only cargo. Our study is interested in the second of the three types of operations. These operations offer rates much lower than those of the integrators and they tend to handle much less regular freight. We were interested in exploring the extent to which these non-integrated services were attempting to, or successfully leveraging information technologies to improve the efficiency of their operations.

Airlines and forwarders in the U.S. scheduled air cargo industry face higher demands than ever before from the global supply chains they serve to provide higher levels of service and on-time reliability. Information technologies (IT) such as electronic data interchange (EDI), barcoding, tracking and tracing, Internet technologies, wireless communications, electronic commerce and Cargo Community Systems (CCS) are often associated with expectations of improved service levels, lower costs, fewer delays and increased on-time performance. The expectation is that information systems, by sharing information between forwarders, airlines and other firms in the logistics chain, will increase coordination, lower costs and raise operational performance. However, there is little evidence that demonstrates that this is in fact the case. There is even less research that provides insight into the conditions when IT can be used to best advantage in the context of air cargo.

Therefore, this study this paper describes was designed around two fundamental research questions:
1. What information systems are being used, by whom, and to what degree?
2. What conditions influence the effective use of information systems?

This paper addresses the first research question: what is being used, by whom, and to what degree. We provide key descriptive statistics from the forwarder and airline surveys and presents general findings on perceptions of technology, adoption and use, operational performance, and relationships between forwarders and airlines. The second question requires more complex models and methods and is addressed in Forster and Regan (1), Forster, King and Nault (2) and Forster (3).
RELATED STUDIES

Studies of the adoption of Information technology by freight transportation service providers have mainly been focused on the commercial trucking industry. We know of no other studies with air cargo as their focus. An early study reported results from a survey of a small group of carriers regarding their perceptions of the use of communications and positioning systems, while another documented a survey of trucking companies that had as its focus attitudes towards ITS technologies (4,5). Another early study focused on the acceptance of ATIS technologies, including route guidance, navigation, road and traffic information, roadside services and personal communication, based on two nationwide surveys of dispatchers and commercial vehicle operators (6), while (7) surveyed approximately 300 companies to determine carriers' propensity to use new technologies, particularly two-way communication and automatic vehicle location/identification technologies. Another study investigated the use of IT in port operations through interviews with port operators and a small survey of carriers (8). A more recent study presents a multivariate discrete model of trucking industry adoption of communication and information technologies (9).

SURVEY METHODOLOGY

Two similar surveys were administered to forwarders and airlines in the U.S. scheduled air cargo community. The forwarder survey (cover letter, questionnaire, return envelope) was mailed to the head office of 1,433 forwarders operating in the U.S. and U.S. territories in September, 1999. Cargo Network Services, a wholly owned non-profit subsidiary of the International Air Transport Association (IATA), provided support for the mailing list, survey mailing and for reminder facsimiles from the researchers. Surveys were directed to a single respondent, generally the CEO or senior executive in charge of air cargo. Forwarder surveys were returned from late September 1999 to February 2000. Airline surveys were returned in the period February 2000 to July 2000.

The questions in the survey drew upon a conceptual model of information technology impacts. Questions drew upon previously validated measures and where these were not available, were based on industry-specific knowledge gained through field research. Further information on the survey design is available in (1) and (3).
CHARACTERISTICS OF RESPONDENTS

Forwarder Respondents

The initial mailing went to 1,433 forwarders in the U.S. and U.S. territories in 1999 and early 2000. It was estimated that there were approximately 1,500 forwarders operating in the U.S. providing air cargo services at that time. Therefore, the population sampled closely approximates the entire population of U.S. forwarders. The survey received 203 responses from forwarders with one unusable survey for a response rate of 14.1%. The relatively low response rate was probably due to the fact that the survey was considerably long and detailed.

The profiles of the forwarder respondents and non-respondents were examined for response bias, to see if respondents systematically differ from non-respondents. Using 1998 sales figures we compared respondents and non-respondents and found no significant difference. In addition, we compared the first 40 and last 40 respondents on organization size, tonnage, and revenues and found no significant response bias. Therefore, we have some confidence in generalizing the findings of the study to the population of U.S. forwarders at the time of the survey.

Five states were responsible for 67% of responses (Figure 1). As New York (JFK), Los Angeles (LAX), Dallas/Fort Worth (DFW), Miami (MIA) and Chicago (ORD) are the five busiest air cargo ports in the U.S, indicating the sample is consistent with industry geography.

The typical forwarder organization has been in the air cargo business for 17.5 years (ranging from 1 to 60 years), and the individual completing the questionnaire had been with their company for an average of 13 years (ranging from less than 1 to 35 years). 93% of responding firms were privately held, while 7% were publicly held, with public firms larger and older than private firms.

The distribution of forwarders by firm size indicated in Figure 1, indicating that the sample is heavily skewed towards smaller firms. Descriptive statistics in Figure 2 confirms the diversity of firms in the forwarding industry. Forwarders range from small regional firms with a single office to large firms with hundreds of branch offices. There is a wide range of activity with specialized and time-definite products. On average, 10% of revenue came from specialized freight services, and 22% of revenue from time-definite services.
Almost all forwarder respondents provide other modes of transportation: 94% provided ocean cargo services, 73% expedited ground transport, 64% intermodal transport, and 37% rail services. Of firms that ship via modes other than air, on average 50% of their gross revenue was attributable to air cargo. In general, air cargo is only one of a portfolio of logistics offerings, competing within firms for resources with other modalities within logistics services providers. In many firms, air cargo is most likely provided as a necessary supplement for their ocean and surface customers.

For our discussion of information systems, the multi-modal nature of the forwarding business suggests that for many of these firms the structural reorganization necessary to use information systems effectively is very difficult to achieve. Information systems that integrate all modes of transportation might be one approach. However, this solution requires forwarders to adopt standards across transport modes, which in itself is problematic. Another point is that where air cargo is but a small part of the overall business of the forwarder, its use of information systems is subordinated to the larger business of the forwarder.
### Forwarder Descriptive Statistics

<table>
<thead>
<tr>
<th></th>
<th>N</th>
<th>Min</th>
<th>Max</th>
<th>Mean</th>
<th>Std. Dev.</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Air Cargo Business</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gross Revenue $USD thousands</td>
<td>165</td>
<td>1</td>
<td>1,382,850</td>
<td>26,665</td>
<td>153,170</td>
</tr>
<tr>
<td>Metric Tonnes</td>
<td>160</td>
<td>1</td>
<td>1,369,788</td>
<td>17,863</td>
<td>118,766</td>
</tr>
<tr>
<td>Years in air cargo</td>
<td>199</td>
<td>1</td>
<td>60</td>
<td>17</td>
<td>12</td>
</tr>
<tr>
<td>% Total revenue in air cargo</td>
<td>188</td>
<td>1</td>
<td>100</td>
<td>50</td>
<td>32</td>
</tr>
<tr>
<td><strong>Air Waybills</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>House AWBs</td>
<td>154</td>
<td>0</td>
<td>6,325,000</td>
<td>63,907</td>
<td>534,423</td>
</tr>
<tr>
<td>Master AWBs</td>
<td>154</td>
<td>0</td>
<td>675,000</td>
<td>8,155</td>
<td>56,820</td>
</tr>
<tr>
<td>Direct AWBs</td>
<td>154</td>
<td>0</td>
<td>75,000</td>
<td>1,976</td>
<td>8,236</td>
</tr>
<tr>
<td><strong>Organization Size</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>FTE Employees</td>
<td>194</td>
<td>1</td>
<td>60,000</td>
<td>433</td>
<td>4,358</td>
</tr>
<tr>
<td>Air cargo FTE</td>
<td>110</td>
<td>1</td>
<td>10,800</td>
<td>150</td>
<td>1,093</td>
</tr>
<tr>
<td>Information Systems empl.</td>
<td>165</td>
<td>0</td>
<td>250</td>
<td>7</td>
<td>31</td>
</tr>
<tr>
<td>Air cargo branches</td>
<td>172</td>
<td>0</td>
<td>390</td>
<td>8</td>
<td>39</td>
</tr>
<tr>
<td><strong>Products</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>% Gross revenue from specialized freight</td>
<td>192</td>
<td>0</td>
<td>100</td>
<td>10</td>
<td>22</td>
</tr>
<tr>
<td>% Gross revenue from time-definite services</td>
<td>190</td>
<td>0</td>
<td>100</td>
<td>22</td>
<td>33</td>
</tr>
</tbody>
</table>

In terms of the geographic distribution of shipments handled by these forwarders the Far East Asia, Western Europe, and U.S. domestic shipments account for 79.6% of shipments. 25 firms (13%) of respondents indicated they serviced a single region.

### Airline Respondents

The airline survey was sent to 82 scheduled airlines providing air cargo services with the U.S.. Approximately 100 airlines were offering air cargo services in 2000 so the survey population closely approximates the overall population of scheduled airlines.

26 airlines responded, yielding a response rate of 32%. Responses were received from eight states and two provinces. New York (34.6%) and California (15.4%) accounted for 50% of the responses. 38.5% of airlines were publicly owned, 34.6% were government owned, and 26.9% were privately held firms.
Descriptive statistics in Figure 3 indicate a diversity of firms on dimensions of size and the types of products and services offered.

**Figure 3 Airline descriptive statistics**

<table>
<thead>
<tr>
<th>Airline Descriptive Statistics</th>
<th>N</th>
<th>Min</th>
<th>Max</th>
<th>Mean</th>
<th>Std. Dev.</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Air Cargo Business</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gross revenue 1998</td>
<td>22</td>
<td>360</td>
<td>600,000</td>
<td>79,896</td>
<td>134,113</td>
</tr>
<tr>
<td>US export (USD thousands)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tonnes US export 1998</td>
<td>19</td>
<td>120</td>
<td>145,000</td>
<td>37,409</td>
<td>40,838</td>
</tr>
<tr>
<td>US origin AWBs 1998</td>
<td>19</td>
<td>250</td>
<td>1,335,000</td>
<td>155,301</td>
<td>312,069</td>
</tr>
<tr>
<td>Loose shipments as %AWB</td>
<td>22</td>
<td>1</td>
<td>98</td>
<td>41</td>
<td>31</td>
</tr>
<tr>
<td>Consolidated shipments as %AWB</td>
<td>22</td>
<td>2</td>
<td>99</td>
<td>58</td>
<td>31</td>
</tr>
<tr>
<td><strong>Air Cargo Employees</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>FTE employees</td>
<td>24</td>
<td>1</td>
<td>3,850</td>
<td>394</td>
<td>943</td>
</tr>
<tr>
<td>Managers/executives</td>
<td>23</td>
<td>1</td>
<td>200</td>
<td>25</td>
<td>42</td>
</tr>
<tr>
<td>Information systems</td>
<td>19</td>
<td>0</td>
<td>25</td>
<td>4</td>
<td>8</td>
</tr>
<tr>
<td><strong>Products</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Special cargo as % US export gross rev.</td>
<td>24</td>
<td>2</td>
<td>96</td>
<td>15</td>
<td>20</td>
</tr>
<tr>
<td>Time-definite services as % US export gross rev.</td>
<td>24</td>
<td>0</td>
<td>90</td>
<td>13</td>
<td>25</td>
</tr>
</tbody>
</table>

**PERCEPTIONS OF INFORMATION TECHNOLOGIES**

How IT is perceived by organizations influences decisions related to its adoption and use. In this section we review forwarder and airline respondents’ perceptions of the benefits of electronic communications and whom they perceive benefits most from EDI investments.

**Benefits of Electronic Communication**

Information technologies are often associated with competitive advantage, operational improvements, efficiency, and cost reduction. We asked forwarders to indicate how they think electronic communications with airlines have benefited or will benefit their company. We asked airlines how their communications with forwarders have benefited their U.S. operations. The results are summarized in Figure 4.
Both forwarders and airlines estimate the top three benefits of electronic communications are quality of services, cooperation between forwarders and airlines, and competitive advantage. Forwarders ranked control of costs at the bottom of their list of perceived benefits.

**Figure 4 Perceived benefits of electronic communications**

![Bar chart showing perceived benefits of electronic communications for forwarders and airlines.](chart)

Given that the size of firms can matter in terms of resources, influence, markets and strategy we compared the top and bottom quartile of forwarders in terms of air cargo revenues. A means comparison found significant differences in how they perceive the benefits of electronic communications with airlines. Larger forwarders reported higher on: competitive advantage and control of operations. That is, larger forwarders perceive that investments in electronic communications with airlines have, or will, provide greater benefits than smaller forwarders.

Larger forwarders perceive greater benefits from electronic communications with airlines and are higher adopters of IT. This creates an impression that larger forwarders are more aggressive in IT adoption leaving smaller forwarders at a disadvantage. However, an examination of the data suggests that not all smaller firms are "slow" or "missing the boat" with respect to electronic communications. Examining the business environment of forwarders we find that smaller firms perceive they compete in more stable environments and on the basis of the skills of their employees and cost performance. It suggests a picture of small privately held firms competing in niche markets where it is unprofitable for larger firms to enter. For these forwarders it might make good business sense not to engage in the adoption of costly information systems at this time.
A comparison of EDI users and non-users found that EDI users see marginally higher benefits in competitive advantage than non-adopters.

Benefits of EDI Investments

Perceptions of which party benefits from EDI investments may influence decisions to invest. We asked forwarders and airlines to indicate whom they believed would benefit the most from EDI investments. 45% of forwarders and 60% of airline respondents indicate they see all parties benefiting equally. Only 9% of forwarders and 4% of airlines indicated that they themselves would be the primary beneficiary of EDI investments. 46% of forwarders and 36% of airlines perceive that some particular party other than themselves will benefit before they will. That is, airlines perceive that forwarders will benefit more than them, and forwarders perceive that airlines will benefit more than them. Where firms do not perceive themselves as the primary beneficiary, we anticipate they may have little incentive to adopt EDI or to be reluctant adopters.

INFORMATION TECHNOLOGY ADOPTION

To assess the adoption level of information technologies, we asked respondents to indicate whether they are currently using, now experimenting, plan to use, or do not plan to use a particular technology. The technologies considered were: electronic data interchange, Internet web sites, electronic commerce, radio tracking, wireless communications, barcoding, and automated vehicle location systems. This section describes the findings for forwarders and airlines.

Electronic Data Interchange (EDI)

While both forwarder and airline respondents indicate that they either have adopted or intend to adopt EDI, they are at different stages of adoption. Airlines indicated that at the time of the survey they have significantly higher adoption of EDI than forwarders. 72% of airlines indicated they are using EDI, while 28% of forwarders indicated the same. 40% of forwarders and 15% of airlines indicate they are planning to use EDI.

Given that electronic coordination through EDI requires both parties to be EDI users, the responses indicate that a higher percentage of airlines than forwarders are capable of
establishing electronic linkages with their partners. Those forwarders that are EDI users will seek out airlines that are as well. However, given that more forwarders than airlines are planning to use EDI, this situation may not exist in the long term. In addition, not all forwarders require EDI links to provide their type of services. An independent means comparison of firm size (log) between forwarder EDI users and non-users indicates that EDI users are significantly larger firms.

**Barcoding and Tracking and Tracing**

Barcoding is necessary to track and trace shipments. While 66% of forwarders and 88% of airlines indicate they are using, experimenting or planning to use barcoding, only 19% of forwarders and 24% of airlines actually used barcoding at the time of the survey. This pattern resembles that of EDI, where, few are using, more plan to use, but few are experimenting.

A comparison of forwarder barcode users and non-users found that firms that use barcoding are significantly larger. This suggests that barcoding is used by a relatively small group of larger forwarders. Of the forwarders that barcode, 76% indicated they are using standards conforming to IATA resolution 606.

Tracking and tracing technologies enable firms to monitor the movement of shipments as they move through the logistics supply chain. In doing so, they provide information to decision-makers who can use this information to improve coordination between firms. The quality of this information is critical to how effective tracking and tracing is for their operations. We asked forwarders to indicate their satisfaction with tracking and tracing capabilities.

We find forwarders marginally satisfied (3.3 on a 5-point scale) with the accuracy and speed of electronic tracking and tracing information. They are least satisfied with the frequency of scanning. We asked the airlines to what extent their customers were satisfied with quality of electronic tracking and tracing information. Airline respondents correctly estimated that their customers are marginally satisfied with the quality of tracking information.

A comparison of cargo community systems (CCS) users and non-users found that CCS users express higher satisfaction with the accuracy and speed of electronic tracking and tracing information.

For forwarders, we also examined differences in information quality based on the level of cooperation between forwarders and airlines. Forwarders that had a higher level of
cooperation with airlines indicated higher levels of satisfaction with the frequency of scanning and the speed of information. More cooperation between forwarders and airlines may lead to better collection and exchange of information.

**Web Site Adoption**

Most forwarders (68%) and airlines (72%) at the time of the survey had a web site with few firms indicating that they do not plan to have some web presence.

While, at the time of the survey, most web sites appear not to have a great deal of functionality, the low threshold for adoption of web technology might suggest that web-based applications will have a faster adoption rate than that of EDI. Evidence gathered more recently suggests that the functionality of internet sites, particularly of the airlines has been significantly improved since our study was conducted.

**Electronic Commerce Adoption**

At the time of the survey, forwarders and airlines were to be at similar stages of adoption of electronic commerce. 27% of forwarders and 28% of airlines indicate that they are engaged in electronic commerce. In total, 63% of forwarders and 84% of airlines indicate they are using, experimenting or planning to use electronic commerce. It is noteworthy that 24% of forwarders and 15% of airlines indicate that they do not plan to invest in electronic commerce. Evidence gathered more recently suggests that e-commerce use has not changed significantly since our study was conducted.

**Wireless Communication**

Wireless communication is used by 26% of forwarders and 17% of airlines. A small percentage of firms indicate they plan to adopt in the future, but few were experimenting. The majority of forwarders (59%) and airlines (58%) indicated that they do not plan to use the technology.

**Radio Tracking and Automated Vehicle Location**

Very few respondents were using radio tracking of automatic vehicle location systems in their ground based transportation systems.
Information Technology Expenditures

We asked forwarders and airlines to estimate the percent of their gross revenue spent on IT. The results are shown in Figure 5. Most forwarders and airlines spend less than 5% of gross revenue on IT. However, 29% of forwarder and 28% of airline respondents spend more than 10%. A comparison of the largest and smallest firms found that small firms are investing more as a percent of gross revenue than larger firms.

Figure 5 IT spending as percent of gross revenue

Cargo Community Systems and Value Added Networks

We asked forwarders and airlines to indicate if they connect to a Cargo Community System (CCS) or Value-Added Network (VAN). 31% of forwarder respondents reported participating in a Cargo Community System in contrast to 88% of airlines. Of those using a CCS 50% of forwarders and 65% of airlines participate in more than one CCS. Of forwarders using a CCS, the most frequently used systems for forwarders were Traxon (50%) and SNS (35%). 91% of airlines using a CCS reported using SITA, 43% used Traxon.

CCSs provide many functions. Figure 6 summarizes the percent of forwarders and airlines that use each function. Tracking and tracing was by far the most commonly used function for both forwarders (81%) and airlines (96%). After that, forwarders reported e-mail (36%) and flight schedules (33%) as most frequent. Airlines reported AWB transmission (71%) and booking (54%).
The higher use of e-mail by forwarders suggests that forwarders have a higher need for unstructured communications. The nature of the forwarder business is such that unstructured communications are important to getting their work done, while airlines rely upon more use of formal communications for their work.

**Figure 6 Most commonly used CCS features**

<table>
<thead>
<tr>
<th>Feature</th>
<th>Airline (%)</th>
<th>Forwarder (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. AWB transmission</td>
<td>70.8%</td>
<td>25.9%</td>
</tr>
<tr>
<td>2. Agent-to-agent messages</td>
<td>-</td>
<td>5.2%</td>
</tr>
<tr>
<td>3. Tracking or tracing</td>
<td>95.8%</td>
<td>81.0%</td>
</tr>
<tr>
<td>4. Import AWB</td>
<td>-</td>
<td>12.1%</td>
</tr>
<tr>
<td>5. Flight schedules</td>
<td>41.7%</td>
<td>32.8%</td>
</tr>
<tr>
<td>6. Requesting or quoting rates</td>
<td>8.3%</td>
<td>5.2%</td>
</tr>
<tr>
<td>7. Booking</td>
<td>54.2%</td>
<td>20.7%</td>
</tr>
<tr>
<td>8. CASS file transfers</td>
<td>25.0%</td>
<td>10.3%</td>
</tr>
<tr>
<td>9. E-mail</td>
<td>16.7%</td>
<td>36.2%</td>
</tr>
<tr>
<td>10. Customs messages</td>
<td>33.3%</td>
<td>10.3%</td>
</tr>
<tr>
<td>11. Other</td>
<td>0.0%</td>
<td>12.1%</td>
</tr>
</tbody>
</table>

**Non-Users of EDI and Others Electronic Communication**

For those respondents that did not participate in a CCS, VAN, or EDI messaging system we asked them to indicate reasons for not communicating electronically with other parties.

Forwarders indicated their primary reasons were:

1. No partners with whom to communicate electronically
2. High cost of information systems and a lack of standards
3. Lack of standards

While the number of airlines indicating they do not use these technologies is too small to allow comparisons, airlines indicated their primary reasons for non-use as:

1. Lack of standards
2. No partners
3. Waiting for Internet

These responses emphasize the problems of network externalities and “bootstrapping” network technologies. Where there are high costs to entering a new technology and an absence of standards, firms are reasonably concerned that they might standardize on the wrong standards and find themselves locked into a network technology with few partners. The Internet, with lower entry costs, and a new array of emerging standards (e.g. ASPs, XML)
may change this scenario. However, given the small size of many forwarders' air cargo activities, the costs of re-engineering their activities to accommodate any new technology may likely be prohibitive.

Comparing the 40 largest and smallest forwarders we find that smaller firms indicate higher on cost of IS, lack of IT expertise, lack of IS partners, little value-added, higher management preference.

MEASURES OF OPERATIONAL PERFORMANCE

On-Time Performance

On-time performance is an important measure of operational performance that reflects the degree of coordination between organizations involved in the delivery of shipments. This measure is investigated in this study to see if the use of information technology is associated with improvements in on-time performance, and to determine in what context these technologies are more effective.

We asked respondents if on-time performance is a top priority for their companies. 56.1% of forwarders and 69.6% of airlines respond that on-time performance is a top priority (5 on a 5-point scale). A total of 76.1% of forwarders and 91.3% of airlines indicated on-time performance is a high or very high priority (4 or 5 on a 5-point scale).

While the majority of forwarders and airlines indicate that on-time performance is, in fact, a top priority. It is significant to note that for both forwarders and airlines there is a non-trivial percentage of respondents that do not feel that on-time performance is important for their business. There may be a number of explanations for this, including that these firms do not compete on the basis of on-time performance. An examination of firms that ranked low and high on the priority of on-time performance found that the low group were smaller firms with more business outside the U.S., and more of their business with Latin America.

Both forwarder and airline respondents were asked to estimate the percentage of shipments that arrived on-time, within 4 hours, within 12 hours, and so on. Forwarders were asked for both domestic and international on-time performance. Airlines were asked for international performance only. Forwarders report that 54% of domestic shipments arrive just before or just at the scheduled delivery time to the consignee. 77% of domestic shipments arrive within 4 hours. In international shipments, 38% arrive just before or just at the scheduled delivery
time, and 60% arrive within 4 hours. Higher domestic than international performance is not surprising given the increased complexity of international shipments. Airlines report 49% of U.S. export shipments arrive as scheduled.

Does information technology improve on-time performance? The literature suggests that information technologies that share information between organizations should increase operational efficiency. As barcoding is essential to knowing the whereabouts of shipments, we examine on-time performance of barcode users and non-users. We find that barcode users have higher performance. We also anticipate that electronic transmission of key documents could improve performance. Indeed, we find that higher use of electronic air waybills is associated with higher on-time performance. These findings support that the use of IT is associated with higher operational performance. However, we note that both barcoding and use of electronic documentation is associated with larger firms. An outstanding question is whether being large is a prerequisite for effective use of information technology.

How satisfied are firms with their level of performance? We asked forwarders to indicate their satisfaction with their international and domestic on-time performance. Figure 7 shows forwarder satisfaction with domestic and international performance.

Figure 7 Forwarder satisfaction with U.S. domestic and U.S.-international on-time performance

Airline respondents were asked to indicate their degree of satisfaction with export on-time performance (Figure 8). 16% indicated that they were satisfied to a very great extent. 52% indicated that they were satisfied to a high extent (4 or 5 on a 5-point scale).
Figure 9 Airline satisfaction with U.S. export on-time performance

An issue that became evident in the pretesting of the surveys is that forwarders and airlines do not measure on-time performance in a similar fashion. Forwarders tend to measure on-time performance based on when the shipments become available to the consignee because they are held accountable for performance. However, some forwarders measure this at the time of delivery, others at the arrival of the shipment at the warehouse. Airlines also vary in how they measure on-time performance. Some measure arrival time when the plane touches down or arrives at the gate, while others measure performance based on when the shipments are available to customs or at the warehouse. The absence of a common measure for on-time performance clearly inhibits the development of effective performance control systems.

AIRLINE-FORWARDER RELATIONS

The nature of the relationship between forwarders and airlines can influence how effectively information systems are used. The study investigated relationships between forwarders and airlines, hypothesizing that “good” relationships are crucial to the effective use of information systems in the logistics supply chain. The survey asked forwarders and airlines to examine their relationships along dimensions of trust, disagreements, joint action, power and dependence.

Trust and Disagreement

Respondents were asked to indicate the extent to which their relationships with airlines were characterized by trust. The measure of trust is made up of three items: adherence to
agreements, information sharing, and fair dealings. Forwarders and airlines were also asked to indicate the frequency of disagreements with their partners.

From the results were that:

- Forwarders perceive that their airline partners adhere to agreements more than airlines perceive that forwarders adhere to agreements.
- Forwarders perceive that their airline partners are fair in the dealings more than airlines perceive that forwarders are fair in their dealings.
- Forwarders perceive that their information relationship with airline partners is open and sharing less than airlines perceive their information relationship with forwarders.
- Forwarders indicate that they perceive less disagreement with airlines than airlines perceive disagreement with forwarders.

Together these findings suggest that there are significant differences in how forwarders and airlines perceive their dealings with one another. In particular, the difference in perceptions of their information relationship highlights the difficulty of developing information systems whose premise is to share information across organizational boundaries.

A comparison of forwarder EDI users and non-users found EDI users indicated their information sharing was less open then non-users and their partners less fair in their dealings. One interpretation is that EDI creates problems for relationships. We suggest that EDI as a technology that requires close collaboration between parties to implement effectively creates a heightened awareness of problems in interfirm relationships which results in EDI users reporting more issues with relationships.

**Forwarder-Airline Cooperation**

A cooperative environment between organizations may positively influence the adoption and effective use of information systems that exchange information across organizations. Cooperation is reflected in key activities and actions that forwarders and airlines pursue jointly. Therefore we investigate the extent to which forwarders and airlines participate in joint activities and joint actions together.

The most significant findings were that:

- On average, airlines perceive they cooperate more with their forwarder partners than forwarders perceive they cooperate with their airline partners
- On average, cooperation in most areas of joint action is low for both forwarders and airlines

We ask further if the differences in perceptions of cooperation are a function of the number of partners. Cooperation might be perceived differently when there are a few partners vs. a large number of partners. Examining the data we find that forwarders indicate they deal with an average of 33 airlines while airlines indicate they deal with an average of 635 forwarders. It is reasonable to expect that forwarders might expect closer relations with a few airlines than airlines can expect with many forwarders. This does not dismiss the problem of coordination, but highlights a problem of differing expectations of relationships.

Implementing information systems such as EDI or web-based applications with the expectation of improving operational performance requires cooperation. Where cooperation is low, or there are different expectations of cooperative relationships the effective use of information systems may be affected.
CONCLUSION

The study suggests that a strategy of "one size fits all" information systems is problematic. The development of information systems that do not support firms to invoke their desired modes of differentiation does not engage the existing structure of the industry. Forwarders and airlines and larger and smaller firms have different goals and strategies. To the extent that larger firms have different trust and cooperative relations with their airline partners, they will integrate information systems differently into their supply chains. Smaller firms may not be able to integrate information systems in the same manner as larger firms. Across dimensions of size and other attributes, these firms require appropriate information technology solutions. Further research into the nature and influence of heterogeneity in the industry may be useful in informing the direction of information technology developments in air cargo.

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