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A MULTI-CRITERIA APPROACH TO THE EVALUATION OF AVIATION E-MARKETPLACE PORTALS

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Abstract

After a proliferation of logistics e-Marketplaces during the dot.com boom of 1998-2000, there has been a high rate of failure and survivals are developing much more slowly than expected. This is the case of aviation industry where a large number of B2B e-Marketplaces emerged according to the focus of aviation companies' strategies on electronic B2B in the late 1990s. However, the current use of e-Marketplaces in the industry is low and many of them have ceased trading. The traditional e-Marketplaces model have been characterised by poor quality of portals and the lack of technical standards. Such an approach is unsustainable in today's competitive scenario. Improvements in websites quality attributes may strongly contribute to simplify the website functionalities by users and speed-up communication with all supply chain parties. In such context, it appears of critical importance to develop models for the evaluation of e-Marketplaces web sites. This paper, after a discussion about the development of e-Marketplaces in the transport and logistics service industry and its application in the aviation industry, proposes a multi-criteria model for assessing e-Marketplaces portals that has been subsequently applied to three different types of aeronautic B2B e-Marketplaces.

Keywords: ICT, Aviation industry, e-procurement, e-Marketplaces, evaluation model

1. Introduction

The landscape of the transport and logistics industry has been altered radically in recent years as a result of the adoption of information and communications technology (ICT). For example, the airline industry was at the forefront in early developments in commercial computing (for example, through the development of computerised reservation systems) and has in recent years pioneered developments in B2C platforms through the use of the internet as a sales channel. One development with further value creation potential in the industry is the use of B2B eMarketplaces. This can be achieved through demand aggregation, improved market and value chain transparency, transaction automation and disintermediation. However, the current level of use of this technology in the industry is low and many e-Marketplaces have ceased trading.

Much work has been carried out in recent years on the development of approaches for the evaluation of e-Procurement web sites and e-Marketplaces. The challenge is to develop a multi-objective and multi-criteria model which incorporates the most important assessment variables. One such approach is based on four key attributes: *textual language* which refers to the textual content of the web site with reference to comprehensibility; *visual language* understood as visual message legibility with reference to the layout of the site; *digitalization* which measure the technical performance of the site; and, *digital communication* which deals with the quality and grade of interaction.

This paper describes research that is aimed at the development of a tool for the objective assessment of e-Marketplaces in the aviation industry. The section 2 describes the development of e-Marketplaces in the transport and logistics service industry, with specific reference to the use of ICT as an enabling technology. The section 3 discusses the application of e-Marketplaces in the aviation industry, while in

section 4 the apparent mismatch between technological potential and practical reality has been analysed. It is suggested that one possible factor contributing to the relatively low adoption of this technology relates to quality of the e-Marketplace portals. In section 5, a multi-criteria approach to the evaluation of such portals has been described and applied to the three of the most popular aviation e-Procurement marketplaces. The paper concludes by drawing managerial and research implications derived during the study.

2. The Development of e-Marketplaces in Transportation and Logistics

The transportation and logistics industry as a whole has never been hailed as a leader in the technology field. However, in the last few years it has made significant progress in the implementation of Information and Communication Technology (ICT) and web technologies.

Such progresses has been made under the strong pressure of service users that continuously demand for complete end-to-end supply chain visibility from the third party logistics providers (3PLs). They are placing a high priority on process integration and continue to look for broad-based solutions from 3PLs including their technology capabilities. Information and Communication Technology (ICT) has a larger role to play in the growth of 3PLs and SCM services. New tools and technology such as Radio Frequency Identification (RFID) and web and voice technologies will also figure prominently. The availability of capable ICT-based services is an expected dimension of 3PL service. The cost of entry into the 3PL arena now includes technology and implementation capabilities for warehouse management, transportation management, and web-enabled communications. The widespread use of ICT in the 3PL industry is reinforced by the growing shipper's outsourcing of information applications. According to Lieb and Schwarz (2002), many users of 3PL services rely upon their 3PL providers for information technology support. Furthermore, logistics service users services anticipate that the near-term differentiators will include, supplier management systems, supply chain planning and electronic marketplaces.

Under this strong pressure, 3PLs have attached growing importance to ICT in the management their business. ICT appears of critical importance to achieving the innovations needed for 3PLs to succeed in the development of new logistics services in a customised supply chain context. In this regard, Sauvage (2003) noted that in a highly competitive business characterised by time compression, technological effort becomes a critical variable and a significant tool for differentiation of logistics service providers. Van Hoeck (2002) assigned a specific role to ICT for 3PLs aiming to perform customising operations for service users. The use of specific technological capabilities may leverage transport and logistics services and facilitate more effective organisational and flow integration across companies in the supply chain. For 3PLs, ICT capabilities may assure the rapid customisation of products and maintain competitive lead-times. At the same time, transparency of transport and logistics operations for the customer might be important to monitor performance and assure product availability.

Furthermore, the competitive scenario in the 3PL industry has become much more complex, taking into account the entry of new players in the market from unexpected industries spurred by the dissemination of ICT. With particular reference to the impact of ICT and web technologies on the 3PL industry, three trends seem to emerge (Evangelista, 2002):

- ⇒ the increasing integration of traditional services (i.e. transport and warehousing) with information services (i.e. shipment tracking & tracing, download of cargo documentation, etc.);
- ⇒ the formation of alliances between 3PLs and other firms operating in complementary sectors, (i.e. ICT, management consulting and financial services) that in some cases have given rise to the creation of a new category of service provider called Fourth Party Logistics Providers (4PLs).
- ⇒ the development of new virtual intermediaries such as infomediaries or online freight e-Marketplaces;

With particular reference to the last trend, the development of virtual logistics operators has opened up opportunities for the development of new roles and functions in the supply chain such as:

- to add value to the transport and logistics business through greater information transparency;
- to bring together buyers and sellers of transport and logistics services;
- to speed up communication;
- to improve integration, collaboration and synchronisation in supply chain operations.

It is worth to note that while there is a strong similarity between the services offered different portals, significant differences in the scope and objectives can be found (UNCTAD, 2000). Due to the extremely dynamic nature of e-logistics sector, it is not easy to set-up a comprehensive taxonomy of e-Marketplaces. Regan and Song (2001) has identified at least five different categories:

- *Spot Freight Markets (NTE, DATconnect)*: allows shippers and carriers to post available loads or capacity on the web;
- *Auction and Request for Quote - RFQ markets (Logistics.com, Celarix)*: provides automated RFQ and auction capabilities;
- *Exchanges (3PLEX, Nistevo, Leanlogistics, Trantislink)*: may provide spot market and auction capabilities but must also provide creative e-business solutions for shippers, carriers and 3PLs;
- *Applications Service Providers - ASPs (Manugistics, 2, Accuship, GoShip, Intershipper)*: are primarily developing web-enabling and e-business enabling technology for the logistics industry;
- *Purchasing Consolidation Markets (TruckersB2B, Transplace)*: these sites provide an opportunity for member companies (typically small carriers) to purchase equipment and supplies at bulk rates over the Internet.

The dividing lines between the first four typologies are somewhat blurred. Some Exchanges are typically ASPs or teamed with ASPs. Exchanges also offer spot market and auction services. For example, Logistics.com and Celarix, leaders in the auction and RFQ space, appear to be ASPs more than freight marketplaces. They will face stiff competition from companies previously in the off-line logistics solutions business like I2 Technologies and Manugistics and from new logistics ASPs like Accuship. Another interesting case of ASP includes those companies providing web-enabling technology to handle the package and LTL shipments generated by e-commerce companies. Relevant examples are GoShip and Intershipper. They work with a large number of couriers and develop solutions for customers who ship large or small volumes of packages each day. These companies compete directly with UPS and FedEx who provide similar web solutions for manufacturing companies that use e-commerce to sell their products and services.

The spread of e-Marketplaces tends to alter the role of traditional transport intermediaries and relations between these firms and other supply chain participants. e-Marketplaces may pose a threat to traditional intermediaries such as agents and freight forwarders that have based their business on information asymmetries. The result is that some intermediation functions risk to become redundant, and could be replaced by increasing disintermediation.¹

From a different point of view, the development of e-Marketplaces may provide a good opportunity to extend and differentiate the business of traditional intermediaries. For example, freight forwarders may focus on the entire supply chain process rather than on the narrow region of origin or destination under the traditional approach. Consequently their key competencies are shifting from traditional agency-based freight forwarding services (e.g. freight documentation, customs clearance) to optimise and synchronise the total transport and logistics needs of shippers. In the maritime transport industry, a similar process is affecting shipping agents and NVOCCs. In conclusion, logistics e-Marketplaces are able to provide traditional intermediaries with a tool for improving their efficiency and accessing new customers and new market segments. As a result, the use of e-Marketplaces by these companies could even be a means of entering into direct competition with the carriers themselves.

The above consideration have underlined that one of the main challenges for logistics e-Marketplaces is the effective management of a higher level of complexity. Many of them have failed to bring multiple parties together around the business model, financial structure and technical standards. Many others have invested in relatively cheap technologies, which have proven to be inadequate in terms of functionalities. Furthermore, eMarketplaces' business model are characterised by a deficiency in relationships management. The common model appears to focus on allowing buyers to get the lowest price possible price from suppliers. Such model is unsustainable in today's competitive scenario also because of the lack in website quality attributes (i.e. communication and technology).

¹ Stough (2001) defines the disintermediation process as "...the bypassing of intermediaries between buyer and seller by introducing a middle man."

The aviation industry is an interesting case as it has been invested by the dynamics illustrated above. In the following sections, B2B aviation e-Marketplaces evolution and their value creation potential is analysed.

3. The Emergence of e-Marketplaces in the Aviation Industry

In recent years, the aviation industry is becoming more and more globalised due to liberalisation trends and consequent construction of global strategic alliances. Moreover, the industry is characterised by complexity in terms of various regulatory needs. Bourgeois and Eisenhardt (1988) have described it as a high velocity environment, where there is sharp and discontinuous change in demand, competitors, technology, and regulation, overlapped with continuous dynamism or volatility. They argue that in this kind of environment, strategic decision making is problematic because of these dramatic changes and because of the difficulty of predicting the significance of a change. Imitation approaches may result in failure, as competitive positions change quickly and thus opportunities fade. Distinctive characteristics of the airline industry include: (1) few firms having (2) substantial market share, with (3) differentiated and/or homogeneous products, and (4) high barriers to entry. These traits lean toward an oligopoly market structure (Vo, 2002).

ICT has played a major strategic role in several steps of the airline value chain framework since the development of CRSs (Computer Reservation Systems) and EDI (Electronic Data Interchange). In the 1990s, the use of the Internet as a sales channel for airline tickets has been promoted as highly promising (e.g. Roy and Filiatrault, 1998) and nowadays public online booking portals are widely used. In the late 1990s, B2B eBusiness became more and more the focus of firms' strategies, while simultaneously a relatively large number of B2B e-Marketplaces emerged. A B2B e-Marketplace exchange is a central marketplace facilitated by ICT, in which multiple buyers and suppliers come together to gather information and buy and sell goods and services (Bakos 1998). One of the recent most meaningful developments has been the formation of strategic alliances, partnerships and mergers, which, beyond the co-ordination of schedules and fares, aims at cost reductions through the possibility of joint-procurement opportunities. More recently, airlines have studied intensively the potential of such joint-procurement possibilities and have taken measures in creating consortia-led e-Marketplaces as mediators for aggregating demand and to facilitate transactions. Christiaanse and Markus (2003) argue that e-Marketplaces have the potential to positively affect company and supply chain performance, thus altering industry structure. The following section examines the value creation potential of e-Marketplaces in the aviation industry specifically.

4. B2B e-Marketplaces in the Aviation Industry: Potential and Reality

Value Creation Potential

Weller (2000) notes that the types of e-Marketplaces that develop in a given industry will depend on the complexity and frequency of transactions, the extent of industry concentration and the relative power of buyers and suppliers. The emergence of B2B e-Marketplaces has the potential to add value to procurement by: Disintermediation, Reduction of Search Costs and Time Efficiency Enhancements, Increased Transparency of Supplier Base, Inventory Reductions and Joint-Procurement.

✓ Disintermediation

E-Marketplaces potentially facilitate the direct matching of buyers and sellers, and as a result traditional intermediaries may be reduced or even eliminated, leading to disintermediation (e.g. Gellmann, 1996; Gates, 1995).

✓ Reduction of Search Costs and Time Efficiency Enhancements

The power of Internet technologies to match buyers and sellers, share information, reduce search costs, and compare complex products, has been argued to alleviate market imperfections, resulting in more effective markets (Bakos, 1991).

✓ Increased Transparency of Supplier Base

The world-wide market for aviation parts and products is highly fragmented, with geographically dispersed suppliers. In a market of this nature, the use of eMarketplaces has the potential to improve the transparency of the supplier base, and thus lower product prices.

✓ Inventory Reductions

Bakos (1998) argues that e-Marketplaces improve information sharing between buyers and sellers, helping to lower the cost of logistics and promoting quick, just-in-time deliveries and thus reduced inventories. For airlines, this facilitates the shift away from relatively high levels of inventory holding, which have been a traditional characteristic of the sector.

✓ Joint-Procurement

An e-Marketplace can be seen as mechanism for realising joint-purchasing benefits by enabling aggregate buying. Through the aggregation of their spend in one basket, multiple buyers can reduce the unit price paid for products and services.

Realising the Benefits

Despite their value creation potential, e-Marketplaces have gained little momentum in the aviation industry to date and their failure rate is very high (Gill and Wu, 2001). Due to the lack of revenues they have generated, many have had to cease operations or merge with other industry players. It is predicted that only a few e-Marketplaces will survive in each industry by succeeding to reach a critical mass of participants, and the right variety of products and services to cover the needs of the particular industry (Oesterle and Fleisch, 1999).

A recent survey by the authors² into the value creation potential of eMarketplaces in the airline industry was based on a population of 59 eMarketplaces and aviation specific portals and service providers worldwide dedicated to the airline and aviation industry. In the year 2000, the industry as a whole witnessed a tremendous rise in numbers of new e-Marketplaces entering the market. However, the industry saw many failures, bankruptcies as well as mergers and consolidations within the population over the following years. As a result, out of these 59 portals identified, only 26 were still operational as aviation portals in 2002, whereas the rest of them ceased their operations fully or changed their business focus in another direction. This research suggested several possible reasons for this failure to capitalise of the apparent potential in terms of value creation. One possible reason relates to the technical performance of the e-Marketplace portals. The next section describes the evaluation of these portals using a multi-criteria analytical framework.

5. Evaluating e-Marketplace Website in the Aviation Industry: a multi-criteria analysis

The factors which can be influenced the comparative evaluation of web sites for the management of the e-procurement services are various and different. They can be individuated and grouped according to the following aspects:

- information and services have to be easy accessible by users;
- the navigation in the system should be the simplest and most comfortable possible, in such a way that the users should be stimulated to use it;
- the manager should be able to co-ordinate and evaluate the work of all the various professionals and consultants involved in the construction of the web site (eg: the webmaster, graphic designers, communicators, system administrators, etc.).

On the basis of these considerations, some indexes and attributes have been introduced which intend to represent the fundamental aspects connected to technology and communication. The attributes are defined through a set of quantitative indexes, which can be computed using automatic and/or semiautomatic tools. The hypothesis is that the main objective of such sites is to allow the widest number possible of users to have access to services (Mastroianni, Vellutino, 2002; Esposito *et al.*, 2003). In this way, the performance of an e-marketplace - as it is perceived by the user - can be measured. The indexes are subdivided into four groups; each group represents an attribute to which can be associated a specific skill. In table 1 has also been indicated the unit of measurement, the scale of measure and the tools necessary for their calculation. A low value of an attribute is a signal of an inadequate level in performance of the system. In order to improve that attribute intervention of associated skills is needed.

The indexes relative to the textual language measure characteristics of the textual content with reference to the ease of comprehension. Flesch (1951) and Gunning (1973) have demonstrated that a text is more or less comprehensible if its quantitative characteristics, objectively measurable and testable, reflect some criteria drawn from the use of formulas. On these bases, an index (Flesch index) has been proposed that measures, with a score system from 0 to 100, the comprehensibility of a document written in American English. The second index considered is the percentage of presence in the text of words in an English dictionary; for our purposes, we use the dictionary included in Microsoft Word.

² The detailed results of this survey are reported in Wagner, Sweeney and Smyth, (2004).

The indexes relative to visual language measure the visible legibility of the messages referring to screen layout of the site (position of the objects on the screen, font and size of characters, and colours contrast). Three indexes have been used to measure the recurrence of the equal elements in all the pages and the readability of the characters (Bernard, 2001; Bernard et al., 2002). The index of legibility measures the average value of the text legibility, as speed of reading (characters/seconds) of a sample text in terms of font and size. Bernard (2002) has measured the speed of reading and has set out these values in a table. The index of positioning measures the percentage of correct positioning of the objects, of the text and of the functions of interaction in the area of the page on the basis of a standard layout (Bernard, 2002). According to such an ideal position on the screen layout is assigned to each object in such a way as to assure a more rapid and simpler access to the system functions. The index of colour contrast is calculated through the numerical representation of the background and the foreground colour in web pages. In HTML language, the colour is identified using an additive representation called RGB (Red - Green - Blue) with three values, which represent the intensity of each fundamental colour (Foley et al. 1990). The index is then calculated as the Euclidean distance between the two colours of background and foreground.

Attributes(Associated skill)	Indexes	Unit of measurement/scale/tools
Textual Language (Text writer)	Flesch	Adimensional value / [0,100] / computation formula
	Text comprehensibility	Adimensional value / [0,100] / dictionary of the basic Italian lexicon
Visual Language (Designer/Graphics expert)	Legibility	Characters / seconds / [0,4] / Table of character legibility
	Positioning	Adimensional value / [0,100] / diagram of objects positioning
	Colour contrast	Adimensional / [0,442] / RGB colour representation
Digitalization (Computer science professional)	Connection speed	Bytes / seconds / [0,1 million] / ping command
	Page download speed	Pages / seconds / [0,50] / utility
	Broken links	Adimensional value / [0,100] / utility
Digital communication (Web designer)	Reachability	Adimensional / [0,100] / public access search engine
	Navigability	Adimensional value / [0,100] / utility
	Help and support for navigation	Adimensional / [0,3] / direct observation

Table 1 - Attributes and indexes of evaluation

The indexes relative to the digitalisation measure the technical performance of the web site. Also in this case three indexes have been used. The index of connection speed measures the speed of connection of the site in bytes/seconds; it is calculated as the inverse of the average time of "ping", measured using several public "traceroute" servers included in the list of www.traceroute.org. The index of downloading speed measures the speed of downloading of the pages, calculated by dividing the average size in bytes by pages for the value of 7.000 (= 56.000 bit/s, the maximum theoretical speed obtainable by a modem for domestic use). The index relative to the unconnected links represents the percentage of links that are not connected with respect to the number of total links present inside the site. The last two indexes are calculated using a tool of web sites analysis.

The indexes relative to digital communication measure the quality and the level of interaction between users and public sector. Three indexes have been used. The index of reachability. It calculates the average position of the site according to what has been noted by three different search engines (Google, Altavista, Lycos) The position is evaluated assuming as the search key the full name of the service and analysing the first 100 results. Index of navigability, calculated, according to Bernard

(2001 and 2002), as a percentage of the links present in the first 2 levels of the structure with respect to the total. Index of the presence of helps and support for navigation, that indicates the presence of tools for the support of the navigation of the site such as internal search engines, on-line help, site map.

Empirical Evidence

The following three aeronautic B2B e-Marketplaces have been measured:

- Aerexchange can be described as an open e-Marketplace for commerce in the aviation supply chain. It starts operations in late 2000 and was founded by 13 airlines (Air Canada, Air New Zealand, All Nippon Airways, America West Airlines, Austrian Airlines Group, Cathay Pacific Airways, FedEx Express, Japan Airlines, KLM Royal Dutch Airlines, Lufthansa, Northwest Airlines, Scandinavian Airline System and Singapore Airlines).
- ILSmart is a neutral e-Marketplace which helps customers to locate aviation parts, equipment and services from a wide range of sources, including manufacturers, distributors, aftermarket companies, and service and repair companies.
- OnePo is an Airline-to-Airline exchange only and no agents are involved in surplus parts sales. Its aim is to generate benefits through inventory pooling and direct purchase and disposal of surplus stock as well as the resolvment of AOG (aircraft on ground) situations through active stock visibility.

Attributes	Indexes	Aerexchange	ILSmart	OnePO
Textual Language	Flesch [min=0 - max=100]	53.6	51.3	58.3
	Text comprehensibility [0-100]	99.0	95.3	97.3
Visual Language	Legibility [0-4]	3.2	3.2	2.9
	Positioning [0-100]	42.1	58.9	52.3
	Colour contrast [0-442]	240	240	239
Digitalisation	Connection speed [0-1 million]	360	320	1600
	Page download speed [0-50]	0.18	0.66	0.33
	Broken links [0-100]	100	100	100
Digital communication	Reachability [0-100]	100	100	97
	Navigability [0-100]	75.3	68.0	50.0
	Help and support for navigation [0-3]	2	2	2

Table 2 - Results of three B2B aviation e-Marketplaces surveyed

The indexes used in the analysis of the emarketplaces considered show that Aerexchange and ILSmart have reached the best performance in comparison with OnePO that has poor values in terms of both communication and technology. The analysis of each group of indexes allows to identify strength and weakness of every single emarketplace surveyed. In the case of Aerexchange digital communication and visual language appears the areas in which such e-marketplaces has the point of strength. Attributes showing critical value are positioning and page download speed. About ILSmart, it seems that visual language is the area of excellence together with page download speed and reachability. Textual Language represents the area that needs urgent interventions. Finally, the poor performance of OnePO can be associated to visual language and digital communication areas. The only points of strength of this emarketplace are in the Flesch index (textual language) and the connection speed index (digitalisation).

6. Conclusion and Implications

The survey results enable some implications to be drawn both from a managerial and a research point of view. From the managerial standpoint, it emerges that aviation emarketplaces have to devote increasing attention to communication and technological aspects. The lack of emphasis on these areas can threaten the success of e-marketplaces, especially in an era where they have to handle a

higher level of complexity. With particular reference to B2B exchanges (OnePO), the business model utilised requires supplementary technology capabilities to increase the number of potential service users. From a research point of view, the model needs to be developed through the integration of further indexes that allow the assessment of different aspects such as the impact on the organisation and management of services supplied by e-marketplaces. In a subsequent stage, a model based on a multi-attribute function will be realised. The final aim is to set-up synthetic indicator for comparing solutions and business models adopted by different e-marketplaces. This will require the analysis of a sufficient number of case studies to better calibrate the parameters for improving the robustness of the model.

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