A Comparison of Electronic Infrastructures in the Air Cargo Industry in the Netherlands and Hong Kong SAR

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Reasons behind the failure and success of large-scale information systems projects continue to intrigue researchers. In particular in the airline industry very successful (passenger reservation) systems have been built which have totally changed the competitive arena of the industry. On the cargo side however attempts to implement large-scale community systems have largely failed across the globe. Air cargo parties are becoming increasingly aware of the importance of IT and, increasingly, they understand the value that IOS could provide for the total value chain performance. However, whereas in other sectors IOSs have been very successful, there are only fragmented examples of successful global systems in the air cargo community and the penetration of IOS in the air cargo industry is by no means pervasive. This paper describes the genesis and evolution of two IOSs in the air cargo community and identifies plausible explanations that lead one to be a success and one to be a failure. It draws on extensive fieldwork in Europe and in Hong Kong SAR that is complemented by secondary data analysis of relevant trade and company literature. We argue that in these two cases the complex, institutional and technical choices by the initiators of the system in terms of their competitive implications that were the main causes for the systems failure. The paper thus concludes that it was the institutional factors involved in the relationships of the stakeholders that led to the opposite manifestations of the two initiatives, and that such factors should be taken into account when designing and implementing large-scale information systems.

INTRODUCTION

The factors defining the success and failure of large-scale information systems developments have been the subject of many studies over the last two decades (Markus, 1983; Robey et al., 1993; Kwon & Zmud, 1987; Christiaanse and Huigen, 1995; Damsgaard and Lyytinen, 1998; Monteallegre and Keil, 2000). In 1982, Barret and Konsynski labeled interorganizational systems as IOSs and studied them as a class of their own. Since then the role and impact of IT in inter-firm relationships have been demonstrated to have significant impact on business processes and relationships along the supply chain (e.g. Clemons and Row, 1989; Zaheer and Venkatraman, 1994; Short and Venkatraman, 1992; Bakos, 1991; Christiaanse and Kumar, 2000; King and Konsynski, 1990).

IT provides new ways of acquiring, disseminating and utilizing information in inter-firm settings that can impact the governance structure and integration level in vertical relationships. System implementors therefore need to focus on the unique knowledge and insights of organizations and manage inter-organizational relationships. Prior research has focused more on the role of physical asset specificity due to the presence of dedicated systems (Christiaanse, 1999). Some later studies have gone further to focus on the role of systems in creating process specificity (Zaheer and Venkatraman, 1994).

Just as in other sectors, there is a growing interest in IT in the air cargo community. While most in-house functions became IT supported and re-engineered in the 1980's and in the early 1990's the air cargo community is currently looking beyond organizational boundaries to identify further improvements. Air cargo parties are becoming increasingly

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aware of the importance of IOS and, increasingly, they understand the value that IOS could provide for the total value chain performance. In recent years, many industries have undergone dramatic changes as a result of IT both within organizations and across. However, whereas in other sectors IOS has scored big successes, there are no real signs of deep penetration in the air cargo community yet. Although a large number of attempts have been made to automate air cargo processes across stakeholders, it seems that there is really no one single system or dominant design that truly fits the air cargo process structure and the demands of all air cargo parties (Christiaanse, O'Callaghan, Been and Van Diepen, 1995)

As Wrigley et al. (1994) convincingly point out the international cargo community is very complex. In spite of this complexity, there has been a shortage of research with a focus on the air mode of transport, as compared with other modes of transport such as civil aviation. In particular, *passenger* air transportation has been one of the most prominent examples of the use of IT/IOS for strategic advantage and electronic integration (Copeland and Mckenney, 1988; Christiaanse, 1994). The passenger reservation systems have provided airlines with considerable competitive advantages, because airlines gained considerable influence and control over their distribution channels (Bakos, 1991).

It is in fact, very surprising that in contrast to passenger reservation systems these air cargo community systems have been mostly failures, not only in Europe but in the US and Asia as well (Forster and King, 1995; King et al., 1994). This is also true in the air cargo business, where there have been numerous initiatives to replicate the success of Computerized Reservation Systems (CRS) and the implications such systems had on airline performance and marketing practices. However, none of the cargo systems has been able to replicate the success of the 1980s US-based CRSs (King, 1995a; King, 1995b; Meecham and Proctor, 1990).

In the situation as it exists, the air cargo community seems to be trapped in its own information technology infrastructure and power dependency. The web of networks, systems, computers, programs and procedures has weighed heavily on investment capacity without bringing any really positive results (Christiaanse and Zimmerman, 1999). The present information technology does not seem to fit the structure of the air cargo process and the demands of the market, resulting in a sector with 'under-utilized' technology and a deep need for new systems properly adapted to the community as a whole.

Objectives and Approach of the Study

The objective of this research study is to describe and compare two different mini case studies in the air cargo community in such a manner as to examine the underlying causes for information technology systems' 'failure' or 'success'. We provide an insight into the existing information systems and the evolving dynamics in the air cargo communities; we then analyze a set of determinants underlying the different outcomes of both initiatives. These issues are compared and explored from a theoretical institutional perspective. The basis of the empirical data was primarily obtained in exploratory fieldwork conducted in the European and Hong Kong air cargo community. The Dutch fieldwork involved over 25 interviews with key players in the industry over a 2-year period. The Hong Kong case study involved 15 interviews with key stakeholders covering the period from 1994 to 1998. The field study data was complemented with extensive secondary data such as company reports, newspaper clippings and other available material. The method was inclusive and it did not assume predefined hypotheses but instead was meant as an exploratory investigation into the challenges the air cargo community was confronted with.

THE AIR CARGO CHAIN AND PARTIES INVOLVED

Time is the single most important factor in an industry where the distribution of goods moves close to the speed of sound. In the early 1990's the average shipment time for airfreight was six days. Of that time, ninety per cent was spent on the ground. The need to coordinate, streamline and optimize all the ground-based activities in the air cargo community is clear.

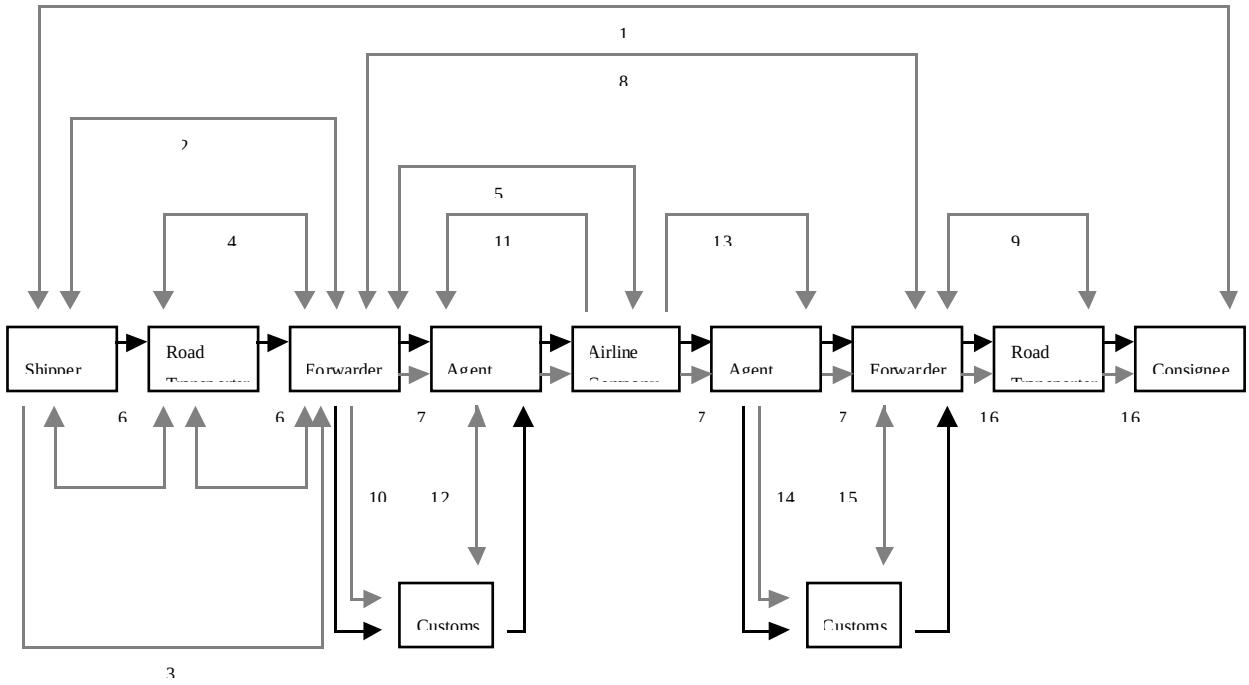
Based on weight, air cargo only accounts for 1 per cent of total general cargo transport. However, based on the market value of goods, the share amounts to approximately 25 per cent. Of the total $200 billion in world-scheduled airline operating revenues, the air cargo industry represents a relatively small share at around $30 billion (McCarthy, 1986).

As early as 1975, the International Air Transport Association (IATA) concluded that for 78 per cent of its total travel time, air cargo is at the airport "waiting" for transport and there are no clear signs that there has been much improvement since (Been & Van Diepen, 1995). According to IATA, this inefficiency was caused mainly by the lack of communication and integration of administrative processes on ground. It was expected that pre-defined document standards would reduce data-entry and re-keying of information and that coupling cargo and accounting systems would speed up billing processes by checking space availability, bookings, and reporting procedures.

We will address the fact that it might not be the available technology that is wrong and that it is not the fact that the air cargo community is short on talent to produce such IOS, but argue that the issue is the *nature of the business* instead of the *nature of the technology* or available talent, as also indicated by King (1994) and Ritz (1995). To provide more insight into the nature of the air cargo business, we will discuss the important dynamics in this business network.

The black arrows in figure 1 refer to the physical

Figure 1: Information flows in the traditional intercontinental air cargo chain. Adapted from Zijp, 1995



1. Consignee places an order with the shipper and he confirms receipt of the order;
2. Shipper places a transport order with the forwarder and he confirms receipt of the order;
3. Shipper passes on shipping instructions to the forwarder;
4. Forwarder reserves and books freight capacity with the road transporter and he confirms the reservation and booking;
5. Forwarder reserves and books freight capacity with the airline company and he confirms the reservation and booking;
6. Forwarder makes up the bill of lading for road transporter and this document goes with the freight during the road transport;
7. Forwarder makes up an Air Waybill and this document goes with the air freight from one airport to the other;
8. Forwarder gives an assignment to the forwarder at the airport of destination, to reserve and book freight capacity with the road transporter and he confirms receipt of this assignment;
9. Foreign forwarder reserves and books freight capacity at the road transporter and he confirms the reservation and booking;
10. Forwarder supplies information about the air freight sending with the customs and the customs provides the forwarder with the necessary documents;
11. Airline company provides the agent with a booking list for a specific flight;
12. Agent gives information about the load of a specific flight to the customs and the customs gives confirmation to the agent;
13. Airline company provides agent with details about the load of a specific flight at the airport of destination;
14. Agent at the airport of destination gives details about the load of a specific flight to the customs and the customs gives confirmation back;
15. Forwarder at the airport of destination provides the customs there with details about the load and gets information about this from the customs in return;
16. Forwarder at the airport of destination makes up a bill of shipment for road transporter and this document goes with the freight during road transport.

movement of cargo between the parties in this network while the dotted arrows refer to the information flows between members in this network. It should be clear that the movement of cargo is of a sequential nature and that the information flows can be done in parallel. An example might be the clearing of goods at customs, often cited as a bottleneck during fieldwork. The administrative information flows related to customs do not necessarily have to take place in parallel with the physical movement of cargo.

TWO CASES OF ELECTRONIC INFRASTRUCTURE DEVELOPMENT

In this section we provide two tales of electronic infrastructure development in Amsterdam and Hong Kong, both major hubs in international trade and transportation.

Hong Kong Special Administrative Region of the People's Republic of China is one of the four largest financial centers of the world, it has one of the three largest seaports in the world, and in 1996 Hong Kong's international airport, Kai Tak, overtook Tokyo's Narita airport in terms of *international* air cargo and became the world's largest. The throughput of Kai Tak was even surpassing its nominated cargo capacity of 1.5 million tons, which emphasized the urgent need for the new airport that was finally opened at Chek Lap Kok in 1998. The new airport was designed to be capable of handling three million tons of cargo a year, which was expected to be sufficient well into the new century.

The Netherlands has one of the three largest seaports in the world and serves as an important distribution center for cargo into Europe. The relatively close proximity of Rotterdam as a harbor and Amsterdam Schiphol as the airport connected by excellent infrastructure comprises the backbone of Netherlands' status as a distribution country. In addition, Schiphol airport is a main hub for passenger travel to and from Europe.

In 1999 the increase in the number of passengers and aircraft movements to Amsterdam Schiphol airport was less than in the preceding years. With growth of 6.6 per cent to 36,772,015 passengers, passenger traffic maintained its market position inside Europe. Freight tonnage remained at virtually the same volume for the second year in succession. The negligible growth of 0.8 per cent is clearly lower than for other European airports. In the year 1999 traffic growth was also affected by the capacity ceiling imposed by the noise abatement measures and the resulting slot allotment system for the airport. Schiphol achieved a freight volume of 1,180,717 tons, significantly less than expected. Its main competitors Frankfurt, London and Paris amounted to 5.7 per cent growth.

Case 1: The Hong Kong Situation: The Traxon Initiative

Four international airlines envisioned that electronic means of coordinating cargo related information was the key that could provide for more reliable, accurate and timely exchange of information, and eventually a smoother exchange of data that would speed up the processes in the entire air cargo industry (Damsgaard, 1998, 1999).

They took the initiative to form an international electronic network for coordinating transactions between freight forwarders and airlines. They set up three companies; Traxon Asia ltd., Traxon Europe ltd., and Traxon World Wide ltd. Traxon Europe is mainly run by Air France and Lufthansa, and Traxon World Wide. Traxon Asia is run by Cathay Pacific, Air Japan, and Traxon World Wide. Traxon World Wide plays a minor role its main function is to provide coordination between the two regional companies and the founding airlines.

The content of the Traxon system consists of three parts: 1) Scrolling of flight schedules 2) Making bookings 3) Status checking for shipments in transit. This seemingly limited functionality however provides significant benefits for both airlines and freight forwarders. The airlines benefit from Traxon by getting more detailed information about bookings and an increased number of bookings. They also believe that the use of Traxon reduces the amount of lost business due to busy telephones or absent (busy) sales personnel. The airlines are provided with better information about each booking because the Traxon system reduces the number of errors in the bookings by avoiding manual typing. The freight forwarders improve their efficiency using Traxon because they can find available space with different airlines, make bookings electronically, and therefore they can calculate and quote prices faster and more efficiently. Before Traxon, freight forwarders had to use the phone and call several airlines to find available space. Instead, by using Traxon, they can perform these activities simultaneously. Traxon also allows the freight forwarders to monitor cargo from the air cargo terminal in Hong Kong until it reaches its destination overseas.

Traxon is a powerful search, monitoring, and booking tool that is carefully designed to meet the requirements of a small niche of the air cargo chain. As such Traxon only support 5, 7, 10 and 15 of the information flows in figure 1. It is designed not to change but to maintain and enforce existing relationships and business structures. The Traxon system consequently does not carry any information about prices or discounts. This leaves the market opaque for outsiders and preserves the roles and power balance between the airlines and the freight forwarders.

Case 2: The Schiphol/Dutch Situation: The Reuters Initiative

In 1992 Reuters - the worldwide press agency and supplier of business information services - started developing an electronic information system on behalf of parties in the spot-markets for air cargo space. The so-called Reuters-initiative is an international initiative with terminals in Amsterdam, London, Paris and Frankfurt. The traditional air

cargo community consists of three broad functional domains: airlines (passengers/cargo carriers as well as cargo-only carriers), ground transport companies (truck and rail transport companies) and freight forwarders that coordinate the door-to-airport and airport-to-door activities at each end.

The content of the Reuters system consisted of three parts: 1) Scrolling news page consisting of general and specific air cargo news that can influence the market of air cargo space. 2) Summary of all available business information, such as oil prices and exchange rates. This information is helpful in increasing the insight in the influence of these factors. 3) Summary of indicative price quotes typed in. These quotes show to which degree sellers would like to buy or sell space. By changing the indicative prices contributors can give signals to other parties involved. In this way prices are assigned the function of information carrier. The three parts together provide a complete overview of the spot-markets for air cargo space. Changing circumstances can soon be made visible and in this way it is possible to react to these changes more quickly. Essentially the Reuters' system was designed to support all the information flows in figure one.

ANALYSIS

In the following we analyze the two implementation processes and describe the reasons as to why Reuters' initiative is deemed a failure and Traxon is deemed a success.

Reuters: The Implementation Process and Reasons for Its Failure

The information system ran on trial at the airport Schiphol from August 1993 to January 1994. After that - due to a lack of participation by key parties in the industry - the system was abandoned.

The interactions of customers, forwarders, integrators and carriers are based on the distinction of the two major activities in the business: transport space and shipping services. The market is structured along the lines of the so-called "space-capacity" principle, meaning that carriers provide space and forwarders and integrators provide services to fill capacity. This principle, however, is increasingly contested among the main parties in the market. The airlines are of the opinion that they offer not only space, but also services. The forwarders and integrators, however, maintain the strict distinction of activities in the market between airlines and themselves. Both parties, however, agree that the market itself is not (yet) a commodity market in which competition is conducted mainly on price. In contrast, the initiators of the Reuters concept claimed that the market for air cargo space could be separated from the market for air cargo service. They claim that the market for air cargo space has developed itself from a differentiated market to a commodity market. This could be incorporated in the design of the system if:

- it could only contain price information and no product or service information
- it treated the market as a commodity market where parties could only compete on price instead of in service attributes.
- in the system the sellers (the airlines and the integrators) are explicitly considered sellers of air cargo *space*.

All parties involved were reluctant to participate in the system. At first *the forwarders* had serious doubts, and in the end the support for the system was totally withdrawn. Some of the reasons provided during field-work were: fear for the elimination of the forwarder, fear for decreasing margins due to increasing transparency of the market and the negative attitude in general towards electronic business. The reaction of *the carriers* has not been positive either. The air cargo market was thus regarded as a commodity market by the Reuters initiative and thwarted the space-capacity coordination mechanism used by the parties involved. We believe the system did not take these issues into account during the design of the system and that this was an important reason for the parties not to participate. As a result of these conflicting interests the system has been abandoned. It was concluded that there is no viability for the system if the parties concerned refuse to cooperate.

Traxon: The Implementation Process and Reasons for Its Success

Network externalities are at play in this industry: the number of users is a strong determinant for success. The dilemma for Traxon was that the airlines would adopt the system insofar as a majority of the forwarders did. At the same time the freight forwarders would only adopt if most of the airlines did. How to get this spiral of self-enforcement going in favor of Traxon was the major challenge.

Thus the systems designers knew that it was essential that all parties would see the benefits of the arrangement, i.e. decide to participate. Traxon was therefore designed to accommodate the needs of the airlines and forwarders, but also to carefully preserve the sensitive distribution of power. It was therefore decided not to extend Traxon to any party beyond freight forwarders (for example to shippers and consignees). The Traxon system consequently does not carry any information about prices or discounts. This leaves the market opaque for outsiders and preserves the roles and power balance between the airlines, the freight forwarders, and the shippers.

Another key factor for Traxon's success was that the implementation process took advantage of the respective airlines' local strong holds. So in Hong Kong, Cathay Pacific was in charge of the local roll out, and in Japan it was Japan airlines. A similar approach was applied in Europe and later on in Korea. Furthermore, each local Traxon system had the other shareholder airlines as initial customers, which constituted a significant share of the air cargo market.

After its first years of operation Traxon was able to enlarge and sustain its position as the dominant electronic trading network provider in Hong Kong's air cargo community. As of January 1998 there were 187 freight forwarding agents connected to the system resulting in more than 8.8 million messages per year (1997). A number of airlines have given up their defensive actions and they have now joined, which essentially gives Traxon a de-facto monopoly in the airfreight community in the Hong Kong hub.

DISCUSSION

The air cargo market is characterized by a high degree of intransparency, which creates substantial market inefficiencies. However, these market intransparencies are, as we discussed, in the interests of some of the parties in this market place. Forwarders in particular derive their main reason for their very existence from this lack of transparency. The forwarders act as brokers and make their living from coordinating the market. In the present-day situation, the forwarders still have a far more extensive knowledge of the distribution processes than shippers do. The information asymmetry is clearly in favor of the forwarders and to the disadvantage of shippers. We argue, based on previous research (Bakos, 1991), that electronic markets usually favor the buyers and reduce sellers' profits and market power. It is therefore clear that sellers would want to stay away from any system that emphasizes price information. This was not recognized in the Reuters initiative, whereas in the case of the Traxon system it was carefully designed to preserve the secrecy of the price-setting process, and therefore Traxon was able to attract the forwarders to the system.

What is unique for the diffusion and adoption of these kinds of IOS systems is that if users decide not to join a network it is devastating for the IOS, as the Reuters initiative clearly demonstrates. Attracting users instantly is therefore a key requirement for success. For each individual user her/his decision to adopt an IOS creates positive externalities for the other users (Oliva, 1994), because the usability of an IOS increases dramatically with the number of adopters. However this also means, in contrast to many other technologies, that the benefits of being an early adopter can be relatively low compared to be being a "laggard". This is especially true when there are a number of competing and incompatible technological alternatives present in the market (Katz & Shapiro, 1985; Oliva, 1994). Thus potential participants of an IOS can effectively block its establishment by simply not adopting the technology. Table 1 summarizes the key differences between the two air cargo initiatives.

If the number of adopters reaches a critical mass of users the diffusion process will self-evolve until saturation is reached (Katz & Shapiro, 1994) and a monopoly is created. Established monopolies are hard to challenge and dissolve (Katz & Shapiro, 1986), and therefore Traxon has a strong position in Hong Kong. This effect is clear in the two cases.

Table 1: Main differences between Reuters and Traxon

	Traxon	Reuters
Initiators & owners	Four major airlines	External party: News agency
Initiators main interest	Make air cargo processes more efficient and coordinated	Collect rents
Customers	Freight forwarders and airlines	Forwarders and airlines
Dynamics of chain	Preserves existing chain	Attempts to by-pass intermediaries
Market dynamics	Preserves market intransparency	Attempts to create transparency
Initial market share	Four major airlines	Zero
Key Functionality provided	Checking and booking	Price comparison
Outcome	De facto monopoly	System abandoned

Reuters started with only pre-trade information and no users. The forwarders felt threatened and decided not to adopt which essentially made the system "useless". The Traxon system was owned by four airlines, which also were initial customers of the system and therefore Traxon had a substantial share of the market on the supply side to begin with. The forwarders soon followed once they noticed that their position was protected, the system useful, and that a growing number of airlines and fellow forwarders (competitors) were joining the system. Furthermore the Traxon system was first to market, which meant that it did not have to replace any existing and well-established system (Besen & Farrell, 1994). Replacing an institutionalized system can be quite a challenge as the battles between airline passenger CRS in the US demonstrate (McKenney, 1995).

Established monopolies may be short lived. Technological innovations on the Internet and its fast adoption are rearranging the provision of IOS in many industries. It also has a great impact on the international air cargo community. For the IOS owners the change is even more radical because the Internet is eroding their business foundation. The Internet is replacing the service providers as primary means of carrying electronic messages, and innovations in WWW technology are challenging the systems that the IOS providers are offering. The user-friendly interface and the low cost of access to the Internet are also opening the gates to Internet-based IOS for a number of players that earlier could not afford and/or lacked the skills to operate proprietary IOS systems. The advantage of having one IOS system that interconnects all players in an industry segment, as the Traxon system does, is being eroded since most players can build and offer their own services on the Internet and most players can access the system through the Internet. For example can non-share holder airlines that earlier were subject to Traxon's de facto

monopoly now be tempted to launch their own air cargo service on the WWW and reach just as many forwarders.

CONCLUSIONS AND SUGGESTIONS FOR FURTHER RESEARCH

Summing up the reasons behind the failures and successes, we would argue that in these two cases the complex, interdependent institutional and technical choices by the initiators of the systems in terms of their competitive implications were the main causes for the systems' success or failure. The social structure in this business network and the dynamics of this particular market should adequately be represented in the design of these systems since they have the potential to upset delicate power structures and information distribution.

The Dutch system was designed to a large extent to derive benefits from the reduction in market intransparency, thus leading to failure. In Hong Kong the system was designed to maintain and enforce existing structures and the keep the intransparency intact, this led to success.

Our exploratory description of the air cargo community and its systems might raise more questions than it solves. We see this exploratory fieldwork however as a necessary step towards more rigorous testing of some of the open-ended questions and dilemmas raised here. We hope that this paper will stimulate further discussion and empirical research along these lines, especially around how technological innovations such as IOS challenge existing industry structures and information distribution.

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