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Pacific Asia Conference on Information Systems (PACIS)

December 2000

The Dynamics of Factors Explaining EDI Diffusion in Hong Kong in the late 1990's

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Abstract
In this paper we analyze how factors of electronic data interchange diffusion evolve over time. Our premise is that factors that capture the diffusion of complex, standard-based and networked technologies are not static but change over time as the technology matures, the institutional arrangement changes and industries become more sophisticated in their technology application. Based on longitudinal field study data collected in 1994, 1995, and 1998 we deliver an account of the EDI diffusion factors in Hong Kong and how they evolved over time. The field study collected organizational, industry and environmental factors that together help explain the diffusion of EDI in Hong Kong. Our analysis shows that factors can change dramatically. This can provide interesting insights into how and why changes in EDI use have happened. On a theoretical level we call for more in-depth field studies when trying to capture and understand the diffusion of complex, standard-based, and networked technologies.

Keywords: Electronic infrastructure, Electronic Data Interchange, EDI, diffusion, Hong Kong, diffusion analysis, longitudinal field study.

1. Introduction

Hong Kong SAR PRC[1] is an integrated part of the emerging global economy and it is one of the principal trade and transportation hubs in Southeast Asia. Hong Kong's small geographical size and the vast amount of trade handled therein has encouraged an advancement of telecommunication, financial, trade, and transportation infrastructures, which are unmatched by most countries worldwide. This should make one expect that the diffusion of EDI services would take place swiftly, since its successful diffusion is often linked to the availability of these services. In reality, the contrary seems to be true. Hong Kong's community wide EDI service initiative Tradelink came into existence in 1988. Since then it has received attention as the sole EDI initiative in Hong Kong (King and Konsynski, 1990a; Surmon and Huff, 1995). Nearly all these studies argue that EDI diffusion in Hong Kong is troublesome and the fact is that after a decade of chronic attempts the former British Crown Colony is still struggling to establish its community wide EDI infrastructure (King and Konsynski, 1990a; Surmon and Huff, 1995).

Overall it is somewhat unclear which factors have caused Hong Kong to spend nearly a decade in setting up their EDI-based e-commerce infrastructure. Here we extend the traditional macro mode of enquiry to include specific industries and distinct locales and hope to reveal a vibrant and diversified picture of EDI diffusion in Hong Kong (Damsgaard and Lyytinen, 1997). In this study we seek to answer the following questions:

[1] Special Administrative Region of the Peoples Republic of China

What factors explain EDI diffusion in Hong Kong on organizational, industry, and socio economic levels? and how do they evolve over time?

The paper is organized as follows. First, we describe three levels of EDI diffusion. In section 3 we describe a longitudinal field study and its research design. In section four we describe and analyze the evolution of EDI diffusion factors, and finally in section five we make some conclusions and suggest promising areas for further research.

2. Levels of EDI diffusion

The concept of levels is applied to analyze diffusion events using a particularly frame of reference. Separating diffusion processes into specific levels helps us focus on specific traits of the diffusion process and to clarify distinct mechanisms that affects its proceeding. Each level brings specific factors in the diffusion domain into the foreground. To achieve this we shall distinguish between organizational, industry, and socio economic levels. The levels complement each other by suggesting explanations that are not available from other levels.

The organizational level focuses on characteristics of individuals or organizational units that use or might adopt EDI. Specific features are: the complex nature of the technology, its abstract content, and its capability to exhibit a large number of path dependencies. Concepts from economics and innovation theory (Perrow, 1986; Rogers, 1995) help to understand the diffusion among similar organizations and populations, i.e., within a narrow diffusion scope. They prominently carve out factors that affect individual EDI adoption decisions. However they ignore diffusion factors that prevail for longer periods of time and in broader scopes, i.e., they cannot account for differences due to variances in institutional or industry factors (Kambil and Short, 1994).

The industry level focuses, using strategy analysis and power dependency analysis, on networks of interacting agents, which shape the trajectory of innovation diffusion (Delhaye and Lobet-Maris, 1995; Kambil and Short, 1994; Kumar and van Dissel, 1996; Porter, 1985; Webster, 1995). This level is necessary to cater for the interorganizational nature of EDI, its dependency on infrastructure, and on third party operators. The level is valuable in understanding how extra-organizational power and resource dependencies shape and are being shaped by the diffusion process. Hence accounts of diffusion on this level are wider in scope as they lead to appreciate the impact of long term industry factors. Despite this broader scope the perspective fails to account for changes in regulatory regimes (such as standards and legislation), which embed the adopters.

The socio economic level establishes boundaries for the diffusion process by recognizing necessary regulatory regimes as focal points that constrain or enable the diffusion process. The dependency of EDI on advanced infrastructures, standards and its abstract and innovative nature legitimate the need for the socio economic level (Andersen, 1998; Damsgaard and Lyytinen, 1996; King, et al., 1994).

3. Field study

In the following section we describe the research design of the field study, the data collection method, and how we performed the analysis of the data.

3.1 Research Design

Combining the levels leads into a framework that organizes the analysis of EDI diffusion into a set of interrelated factors. The framework integrates a broad set of aspects into the study of EDI diffusion: EDI is perceived thereby as an uptake of technology standards and policies in some regulatory regime (socio economic level), as a technological move in some industry (industry level), and as an adoption decision in some user organization (organizational level). In the following we explain and justify how we extracted factors from each of the three levels and included them in our field study.

3.1.1 Socio economic factors

The government is a prominent actor for setting up a favorable regime for the diffusion of interorganizational systems such as EDI (Damsgaard and Lyytinen, 1999). On the other hand if the government refrains from getting involved this too has implications for the diffusion (King, et al., 1994). The most prominent example of government involvement in EDI diffusion is Singapore, where Tradenet has been set up entirely by government agencies (King and Konsynski, 1990b; Knoop, et al., 1995; Neo, et al., 1993). The government is also somewhat accountable for indirect support of EDI diffusion, for example by providing knowledgeable people and research efforts. Another important way in which the government can get involved is legislation. In our interview guide the government dimension is captured by asking the interviewee to evaluate and motivate the following factors that influence the EDI diffusion process in Hong Kong. 1) Lack of government support, 2) Lack of knowledgeable/skilled people 3) Lack of technological knowledge/skills and 4) Legal obstacles.

Due to EDI's interorganizational and networked properties the total number of adopters has a direct impact on an organization's decision to adopt. Betting on the wrong technology or too early before a technology has established itself can be costly (Katz and Shapiro, 1994) or before the majority of companies have become aware of the existence and usefulness of the technology (Oliva, 1994). Therefore we have included two factors that capture this into the sphere of attention. 5) Low number of companies doing EDI and 6) Lack of information in general.

Other socio economic factors relate to the type and management style of local companies. For example if the prevailing type of organization is a small family-run company this will impact the overall diffusion rate. Another factor is the language capabilities of local businessmen and the price of acquiring the technology. Three factors are included to capture this aspect. 7) Local organizational structures and incentives 8) Language barriers and 9) Technology is too expensive.

The final socio economic factor captures EDI's dependence on standards. If no standard has been set de facto or de jure no widespread diffusion of EDI can occur. This aspect is captured in 10) Lack of standards. All ten socio economic factors are depicted in table 2.

3.1.2 Business values

Factors in this collection capture industry dynamics of EDI diffusion and adoption. Industry constellations and configurations have always been influenced by technology innovation and

adoption. Much research has been done in this area and we have chosen to adopt Porter's widely recognized list of competitive forces into the sample (Porter, 1985) to capture EDI impact.

3.1.3 Organizational benefits

The third set captures EDI's impact on the adopting organizational unit and its immediate business relations. The factors are adapted from (Krcmar, et al., 1995), and distinguish between tangible and less tangible benefits derived from adopting EDI. The tangible benefits captures direct internal advantages on using the technology, captured in the following four factors 1) Reduced document handling 2) Reduced human resource 3) Reduced inventory levels and 4) Better cash management.

The less tangible factors capture more subtle and less quantifiable benefits of adoption, 1) Improved business relationships, 2) Better service to customers 3) Reduced lead times, 4) Better information 5) More competitive advantage, and 6) New business opportunities.

3.2 Research method

The study used a rich and flexible data gathering strategy, which sought to find a representative and unbiased set of data. The set of informants used in the study covered: government agencies, semi public organizations, trade and industry associations, EDI service providers, and individual user organizations. The primary data collection method was semi-structured interviews. Each interview was scheduled to last approximately two hours to allow a thorough examination and discussion of the factors.

We had the opportunity to collect data in three tempi (1994, 1995, and 1998). The second and third collection enabled an investigation of how the diffusion factors evolve over time, and to determine if any change has emerged; for example as a consequence of other factors.

The overall study sample included interviewees from three industries: transportation, retail and banking (See table 1). These three industries were chosen because of their importance for Hong Kong economy, their generally advanced use of IT technologies, and their largely oligopolistic structure that create fierce competition.

In March through June 1994 we conducted 18 interviews with key stakeholders. In the second data collection we sought to interview the same organizations and the same interviewees whenever possible. We were able to extend the field study coverage, especially in the area of government departments, and we also included two freight forwarders and a wholesaler. The second data collection is consequently larger than the 1994 collection (See table 1). Altogether we had 22 interviews, and the data gathering took place in May through June 1995.

In the third data collection we successfully contacted most of our previous contacts. We were able to re-establish contacts with the association of freight forwarders, the two freight forwarders we had interviewed in the 1994 study were not available, so we interviewed two different ones to include the view of freight forwarders in the sample. Altogether the 1998 data collection included 23 interviews. It took place in the months of January through May 1998.

Table 1. Field study coverage in 1994, 1995, and 1998

	1994	1995	1998
Government or semi government institutions:			
Tradelink	*	*	*
Trade and Industry Branch	*	*	*
Trade Department	*	*	*
Customs and Excise Department		*	*
Census and Statistics Department		*	*
HK Productivity Council	*	*	*
Industry associations (non profit)			
Association of freight forwarders	*		*
Association of retailers	*		
Hong Kong Article Numbering Association	*	*	*
VANS and Service providers (for profit)			
VAN (air cargo)	*	*	*
VAN (transportation)	*	*	*
VAN (international)	*		*[2]
Retail			
Dairy	*	*	*
Wholesaler		*	*
Finance			
Two banks	*	*	*
Transportation			
Two shipping lines	*	*	*
Two terminal operators	*	*	*
Air cargo operator	*	*	*
Airline	*	*	*
Two freight forwarders		*	*[3]
Interviews in total	18	22	23

4. Diffusion factor analysis

In this section we condense the observations made in Hong Kong by analyzing the degree of consensus between levels. The results are depicted in table 3,4, and 5. Table 2 was compiled by counting the number of "hits" in table 3, 4, and 5 respectively. For example the three stars in table 2 at "low number of companies doing EDI" (1995) indicates that this particular barrier was perceived as significant at the socio economic layer and the industry layer (both profit and non-profit) in table 4. For many factors there is a clear consensus but for some there is little consensus, which exhibits that among the primary players in Hong Kong there are major differences in how to best approach and apply EDI. These differences may further inhibit the adoption and cause policy makers to formulate inappropriate EDI policies. The three data collections therefore may identify some indicators as to how the perceptions of EDI are changing in Hong Kong, since they involved the same industries and when possible identical stakeholders. We will discuss the consensus and differences, and compare the development in the perceptions/experiences of EDI in Hong Kong from 1994 to 1998.

[2] In the 1998 study we interviewed a different international VAN

[3] In the 1998 study we interviewed two different freight forwarders

Table 2. Degree of consensus in Hong Kong 1994, 1995, and 1998. Six stars is maximum and that indicates that the factor is perceived as important on all three levels and in all three industries.

	Degree of consensus		
Barriers	1994	1995	1998
Lack of government support	*****	****	***
Low number of companies doing EDI	****	***	***
Local organizational structures	***	***	****
Lack of standards	**		***
Lack of knowledgeable/skilled people	*	***	
Lack of information in general	*	***	***
Technology is too expensive	*	*	*
Legal obstacles	*		*
Lack of technological knowledge/skills		*	
Language barriers			
Business values			
Competitive advantage	*****	****	**
Competitive necessity	*****	***	****
Cost reduction	***	*****	*****
Creating corporate image	***	*	
Differentiation	*	****	**
More power over suppliers	*		
Follow industry example		*	**
More power over customers			**
Higher switching costs			*
New entry barriers			
Benefits			
Better service to customers	*****	*****	**
Reduced document handling	****	***	******
Reduced lead times	***	**	***
Better information	***		
Improved business relationships	**	****	***
Reduced human resource	*	***	****
More competitive advantage		*	
Better cash management			
Reduced inventory levels			
New business opportunities			

4.1 Socio economic factors

When analyzing the socio economic barriers to diffusion in table 2 three factors stand out. The most emphasized one is the lack of government support that is mentioned on all layers and in all sectors except by government officials (of course) in 1994. This underscores that companies expect and are interested in getting government involved in clearing an arena for EDI diffusion. There are a number of ways in which government can stimulate the diffusion and adoption of interorganizational systems. One is to provide subsidies to companies that are willing to adopt when the technology is young, standards not set, and risks high. For a detailed discussion of government's role and mechanisms to further EDI diffusion see

(Andersen, 1998; Damsgaard and Lyytinen, 1996; Damsgaard and Lyytinen, 1999; King, et al., 1994).

In 1995 the vote from the retail industry representative is missing which indicates the involvement by the article numbering association in setting up an industry wide EDI network and coordinating EDI standardization. This has reduced the need for government action. In 1998 (after Hong Kong Government's franchised and sponsored EDI initiative Tradelink became operational) adopter organizations still call for government intervention, while the industry representatives and VAN suppliers are satisfied. This highlights the importance of government and the desire for its involvement to clear a "safe" arena for EDI diffusion.

The low number of companies that have adopted EDI is generally also highlighted as a factor. Thus the critical mass of EDI adopters in Hong Kong had not been reached by 1998 and consequently the network externalities were low. Recent developments in web technology and the widespread diffusion of the Internet may alleviate some of these problems. Many also agree that the peculiarities of Chinese management traditions and the high portion of small and family-run businesses in Hong Kong are major impediments. How to persuade and hook up these small infrequent traders remains a major challenge especially to government franchised Tradelink which has promised the Hong Kong Government to have 80.000 traders by December, 2003.

The lack of standards as a barrier to diffusion was important in 1994 and again in 1998. In 1995 many companies were implementing EDI for the first time, and everybody felt the standardization issue had been resolved once for all by committing to the UN/EDIFACT standard. We have observed that this is not necessarily the case. The reappearance of standards as a barrier to diffusion nicely reflects the problems associated with changing to new versions, renegotiating meaning and contents of EDI messages, building large EDI systems with hundreds of subscribers (retail, and air cargo), and the lock-in effects of earlier standard decisions (David, 1985; Shapiro and Varian, 1999; Damsgaard and Lyytinen, 1998).

The lack of information about what EDI is seems to be of growing concern, quite contrary to what one should expect. This may indicate that as more companies hear about the technology there is a growing need for companies to actually learn more about EDI. Nevertheless this underscores the importance and complexity of EDI as a technology that has profound implications. The need to know and understand how to integrate EDI with existing business processes therefore remains unfulfilled in Hong Kong.

For a number of factors there is varying accord. This indicates some cross-sectorial variations and also time variations. For example the problem associated with finding the right people was common in 1995 (just prior to the hand-over of Hong Kong when the brain-drain was peeking and/or there was an increased demand for IT skilled labor) but of no concern in 1998. A number of barriers are believed to be of less importance. This includes the problem of the bi-lingual mode of business operations, and legal arrangements. It also seems that skills and knowledge about how to best apply EDI is quite well established.

4.2 Business values

When comparing the value of EDI there is a clear shift from 1994 to 1995. The competitive value of EDI is toned down and the issue of differentiation is mentioned. The perceptions of the cost reduction aspects of EDI are also increased. This means that after gaining more

experience with EDI some of the major players perceived EDI in a slightly different light, i.e. not only as a competitive weapon but also as a business tool that drives down operating costs and as a differentiation factor that distinguishes adopters from (less competent) non-adopters.

1998 indicates another clear shift. The necessity of EDI capabilities is re-focused. The differentiation factor of EDI is toned down as the number of EDI adopters has increased. This is also reflected in the growing importance of following others. The power aspect of EDI also appears, and the image improving capabilities of EDI is no longer of importance. Instead the cost reduction aspects of EDI remain highly relevant.

4.3 Benefits

When assessing the benefits of EDI several interesting observations can be made. The service aspect of EDI is toned down throughout the period, and instead the operational benefits of handling fewer documents manually are mentioned more frequently. The benefits of fast response leading to a reduction in lead times remain high. In 1994 many expected that communication through EDI would improve the information flow. However the 1995 and 1998 did not indicate a richer exchange of information. The increasing labor costs in Hong Kong is reflected by our observation that EDI reduces resources allocated to routine administrative work, which is of increasing importance when justifying investments in EDI.

There is a consensus on a number of factors that all agree are of less importance when assessing the benefits of EDI. So far EDI does not seem to improve the cash flow, it does not seem to optimize stocks, and it does not lead to new business opportunities. Most of these factors are in the contemporary literature expected to change with EDI adoption. One reason could be that in Hong Kong the sophistication of EDI services has not yet reached that level.

5. Conclusions

In this paper we have provided an overview of EDI diffusion factors in Hong Kong. The diffusion factors were collected over a five year period in three industries and using three levels to observe the diffusion phenomenon. Our analysis shows that the factors are not static, but change over time, as the diffusion proceeds, the involved stakeholders gain experience, and the institutional arrangements change.

This change can be understood when using our data collecting strategy of engaging in open discussions and interaction with organizations and government authorities involved. In particular we question whether a traditional questionnaire-based approach alone could have yielded the same level of explanations as our approach has provided (Lyytinen and Damsgaard, 1998).

There is a natural need to collect data again in Hong Kong to learn how the constellation of EDI diffusion factors have changed and equally important to understand and explain why these changes occur. Replicating longitudinal field studies on other networked technologies using interviews to collect a wide array of data about diffusion factors is also a promising venue for further reach if we wish to understand deeper the diffusion dynamics of networked information technologies.

Acknowledgements
Thanks to all interviewees that participated in the field study for being so open and taking the time to talk to us. Thanks to the Department of Information and Systems Management, Hong Kong University of Science and Technology for providing a grant and resources that made the 1994 and 1995 studies possible. Also thanks to the Centre for Asian Business Cases, School of Business, Hong Kong University for providing a grant that made the 1998 study possible.

Government Players	Lack of information in general Low number of companies doing EDI Lack of knowledgeable/skilled people	*Barriers*
	More power over suppliers Competitive necessity Differentiation	*Values*
	Reduced document handling Reduced lead times Better service to customers	*Benefits*

	Non-Profit:	**Profit:**	
Industry players	Lack of government support Technology is too expensive Organizational structures and incentives	Low number of companies doing EDI Lack of government support Organizational structures and incentives	*Barriers*
	Competitive advantage Competitive necessity Cost reduction	Competitive advantage Competitive necessity Cost reduction	*Values*
	Reduced document handling Better service to customers Better information	Reduced lead times Better service to customers Better information	*Benefits*

	Retail:	**Transportation:**	**Banking:**	
Organizational players	Low number of companies doing EDI Lack of government support Legal obstacles	Low number of companies doing EDI Lack of government support Lack of standards	Lack of government support Organizational structures and incentives Lack of standards	*Barriers*
	Cost reduction Creating corporate image Competitive advantage	Competitive advantage Competitive necessity Creating corporate image	Competitive advantage Competitive necessity Creating corporate image	*Values*
	Better service to customers Better information Improved business relationship	Reduced lead time Better service to customers Reduced document handling	Reduced document handling Reduced human resource Improved business relationship	*Benefits*

Table 3. Pyramid of EDI diffusion in Hong Kong divided by sector and level, 1994. For example most the representatives in the transportation sector pointed to three barriers to widespread EDI diffusion (low number of companies doing, lack of government support and lack of standards (in that order))

Government Players	Lack of information in general Low number of companies doing EDI Lack of technological knowledge or skills	*Barriers*
	Competitive advantage Differentiation Cost reduction	*Values*
	Reduced human resources Reduced lead times More competitive advantage	*Benefits*

	Non-Profit:	**Profit:**	
Industry players	Technology is too expensive Low number of companies doing EDI Lack of knowledgeable/skilled people	Low number of companies doing EDI Lack of government support Organizational structures and incentives	*Barriers*
	Follow sector example Competitive necessity Cost reduction	Competitive advantage Competitive necessity Cost reduction	*Values*
	Reduced lead times Better service to customers Improved business relationship	Reduced document handling Better service to customers Improved business relationship	*Benefits*

	Retail:	**Transportation:**	**Banking:**	
Organizational players	Organizational structures and incentives Lack of government support Lack of information in general	Lack of government support Organizational structures and incentives Lack of knowledgeable/skilled people	Lack of government support Lack of knowledgeable/skilled people Lack of information in general	*Barriers*
	Cost reduction Competitive advantage Differentiation	Competitive advantage Competitive necessity Differentiation	Cost reduction Creating corporate image Differentiation	*Values*
	Reduced human resource Better service to customers Improved business relationship	Reduced human resource Reduced document handling Better service to customers	Reduced document handling Improved business relationship Better service to customers	*Benefits*

Table 4. Pyramid of EDI diffusion in Hong Kong divided by sector and level, 1995

Government Players	Low number of companies doing EDI Organizational structures and incentives Lack of standards	*Barriers*
	Cost reduction Competitive necessity Competitive advantage	*Values*
	Reduced document handling Reduced lead times Reduced human resource	*Benefits*

	Non-Profit:	**Profit:**	
Industry players	Organizational structures and incentives Low number of companies doing EDI Lack of standards	Lack of information in general Lack of standards Technology is too expensive	*Barriers*
	Cost reduction Competitive advantage Follow industry example	Cost reduction Follow industry example Competitive necessity	*Values*
	Reduced document handling Improved business relationship Reduced lead times	Reduced document handling Reduced human ressource Reduced lead times	*Benefits*

	Retail:	**Transportation:**	**Banking:**	
Organizational players	Low number of companies doing EDI Lack of government support Organizational structures and incentives	Lack of government support Organizational structures and incentives Lack of information in general	Lack of government support Legal obstacles Lack of information in general	*Barriers*
	Cost reduction Competitive necessity More power over customers	Cost reduction Competitive necessity Differentiation	Higher switching costs Differentiation More power over customers	*Values*
	Improved business relationship Reduced document handling Reduced human ressource	Better service to customers Reduced human resource Reduced document handling	Reduced document handling Improved business relationship Better service to customers	*Benefits*

Table 5. Pyramid of EDI diffusion in Hong Kong divided by sector and level, 1998

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