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# LEVERAGING EDIS TO IMPROVE ORGANIZATIONAL AND INTERORGANIZATIONAL PRODUCTIVITY: FINDINGS FROM THE WORLD'S BUSIEST PORT

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## ABSTRACT

Portnet is a successful EDIS in Singapore. This study examines the impact of several controllable organizational factors on the organizational and interorganizational productivity of Portnet participants. A survey was conducted among Portnet participants. Results show that Portnet participants with a strong need for high quality information and strong CEO support benefitted greatly in terms of organizational and interorganizational productivity. Initiators also gained more in terms of organizational productivity than reactors. EDIS sponsors could better promote their systems by targeting potential participants with a strong need for high quality information and by generating strong CEO interest in EDIS. EDIS participants could leverage their benefits by assessing their situation and planning ahead for adoption.

## 1. INTRODUCTION

The ability of information systems spending to raise organizational productivity has been challenged by researchers based on industry-level statistics (Bailey and Chakrabarti 1988; Davenport 1993; Loveman 1988; Roach 1991). However, in a recent study using firm-level data instead of industry-level statistics, Brynjolfsson and Hitt (1993) reported a positive association between information systems expenditure and organizational productivity. This discrepancy in findings results from the fact that industry-level statistics tend to understate organizational productivity (Brynjolfsson and Hitt 1993; Panko 1991). Given this new perspective, information systems effects on organizational productivity have re-emerged as an interesting issue for research.

This study examines the impact of an Electronic Data Interchange System (EDIS), a kind of interorganizational system (IOS), on the organizational and interorganizational productivity of its participants. Traditional studies on information systems have mainly investigated organizational productivity measures such as cost reduction, profit performance, and return on assets (Benbasat and Dexter 1986; Rivard and Huff 1984; Weill 1992). Besides these measures, this study examines interorganizational productivity

variables such as business relationships and the quality of information exchanged (Dearing 1990; Emmelhainz 1987; Johnston and Vitale 1988; Sokol 1989), which are critical in an IOS context. It adds an interorganizational perspective to the traditional notion of organizational productivity.

Johnston and Vitale (1988) contend that an IOS needs to confer tangible benefits on its sponsor and provide significant gains to its participants to remain viable. However, existing studies have focused their attention on IOS sponsors (Clemons 1990; Clemons and Row 1988; Clemons and Weber 1990; Copeland and McKenney 1988). Research focusing on IOS participants, lacking in current literature, has the potential to uncover factors which could promote successful use of IOS. This study surveys the participants of Portnet, a well-known EDIS in Singapore. It seeks to identify factors which distinguish more successful from less successful participants in terms of organizational and interorganizational productivity.

## 2. PORTNET

Port of Singapore Authority (PSA) manages one of the busiest ports in the world. Buoyant trade in the Asia-Pacific region has kept port activities increasing over recent

years. PSA handled 109 million freight tons of container cargo in 1992 compared to 31.5 million freight tons in 1986. Conventional cargo increased from 12.5 million freight tons in 1986 to 16.7 million freight tons in 1992. The number of arriving vessels rose from 40,722 in 1986 to 81,300 in 1992, resulting in an increase of shipping tonnage from 333.7 million gross registered tons in 1986 to 578.5 million gross registered tons in 1992 (Department of Statistics 1993). This increase in port activities was achieved simultaneously with a reduction of port employees from 10,198 in 1981 to 7,110 in 1992 (Port of Singapore Authority 1992).

In terms of shipping tonnage, Singapore has been the world's busiest port since 1986 despite strong competition from Hong Kong, Rotterdam, and other ports. Singapore has been named the Best Seaport, Best Warehouse Operator, and the Best Seaport Terminal Operator for the Asian Freight Industry since 1988 (Port of Singapore Authority 1992). Lim Kim San, Chairman of PSA, attributed this success to "a disciplined workforce that is receptive to change, a corporate commitment to modern technology for productivity, and a commitment to serving our customers."

PSA has traditionally used information systems to attain competitive advantage. It has developed a ship planning expert system to aid the loading and unloading of container cargo from container ships, for which it was awarded the Innovative Application Award by the American Association for Artificial Intelligence (PortView 1989). It has a computer integrated terminal operation system which manages the resources and operations of the port. It launched Portnet in January 1989, as part of a nationwide EDIS project, with the objective of drastically reducing the turnaround time for cargo handling (PortView 1990).

Portnet links PSA, shipping agents, freight forwarders, haulers, and traders to facilitate electronic communication between these parties. Through Portnet, shipping agents can apply for PSA services, transmit cargo manifests to PSA, advertise their shipping space and schedules, make enquiries on imported containers, and authorize haulers or freight forwarders to transport cargo. Besides providing these facilities, Portnet is connected to TradeNet to allow its participants to submit import and export declaration documents to the relevant customs authorities. Payments for Portnet services, customs duties, and other processing fees can be made electronically.

Portnet eliminates the need to make physical trips to apply for services or execute transactions. It eliminates the time consuming process of handling paper documents, reduces the need to raise multiple documents and obtain multiple signatures, and enables faster flow of information. This permits PSA and Portnet participants to better deploy their

equipment and manpower. It also results in faster cargo clearance at the port.

Portnet is a successful EDIS. Portnet participants have increased from 101 in January, 1989, to 1,049 in November, 1992 (PortView 1993). Portnet usage has correspondingly risen from 0.77 million transactions in January 1989 to 8.52 million transactions in July, 1992 (PortView 1993). The success of Portnet makes it an interesting candidate for research.

### **3. RESEARCH MODEL AND HYPOTHESES**

#### **3.1 Dependent Variables**

There is a lack of consensus on the definition of productivity in an information system context (Johnson and Rice 1987). Empirical studies had assessed productivity from both an effectiveness (achievements relative to objectives or resources) and an efficiency (input to output ratio) perspective. These measures have been criticized for their inability to reflect true outcomes (Brynjolfsson and Hitt 1993) and their inappropriateness under many circumstances (Packer 1983). EDIS operates in a unique environment where traditional measures of productivity could be inadequate. Besides contributing to organizational productivity, EDIS have the potential to offer long term benefits such as closer strategic relationships between trading partners, expansion of market share, strategic use of information, and spawning of new businesses (Dearing 1990; Johnston and Vitale 1988; Scala and McGrath 1992; Sokol 1989). In this study, productivity in an EDIS setting is measured from both organizational and interorganizational perspectives.

##### **3.1.1 Organizational Productivity**

Measures on organizational productivity can be elicited from information system literature. In a study which sought to measure the success of user-developed applications, Rivard and Huff (1984) included staff productivity as their measure of success. Lucas (1981) investigated the effects of computer graphics on decision quality. Delone (1990) suggests that information systems impact be operationalized in terms of staff productivity, efficiency of operations, decision quality, sales revenue and profit, and operating cost. Strassman (1985) posits that information systems can improve organizational decision-making by enabling organizations to attend to critical tasks with more relevant information.

Descriptive EDIS literature suggests that EDIS benefits include improved productivity, reduced financial exposure, and competitive advantage (Kavan and Van Over 1990).

Using EDIS to revolutionize their process of settling accounts payable, Ford and Supervalu Stores achieved a 75% reduction in accounts payable clerks (Hammer 1990) and an annual savings of US\$600,000 on clerical expenses (Dearing 1990) respectively. In this study, the two aspects of organizational productivity examined are staff productivity and decision quality.

### 3.1.2 Interorganizational Productivity

Few empirical studies investigate the notion of interorganizational productivity. As EDIS facilitate the exchange of information across organizational boundaries, they affect the productivity of activities that link an organization to its environment. A comprehensive EDIS survey on the US business community (EDI Research 1988) indicates that quick access to information, accuracy of information, and better communications were important reasons for using EDIS. Johnston and Vitale assert that IOS enhance interorganizational efficiency by permitting rapid electronic transmission of information and capturing more precise and timely information. Based on these arguments, an aspect of interorganizational productivity examined in this study is improved communications.

Dearing (1990) and Sokol (1989) suggest that EDIS can improve the relationships between trading partners in the long term. In an empirical case study of fifteen organizations in a purchasing environment, Emmelhainz (1987) found that EDIS improved buyer-vendor relationships by reducing incorrect orders, lost orders, and delays. In a case study involving three freight forwarders, Hellburg and Sannes (1991) reported that freight forwarders could forge closer relationships with their customers by using EDIS. Hence, an aspect of interorganizational productivity examined in this study is enhanced business relationship.

## 3.2 Independent Variables

Ein-dor and Segev (1978) categorized organizational variables into controllable, partially controllable, and uncontrollable variables. Controllable variables, such as top management support, adoption time of information systems, level of information systems planning, and proactive technology leadership, have been studied (Delone 1988; King, Grover and Hufnagel 1989; Dos Santos and Peffers 1992). This study focuses on four controllable variables: chief executive officer (CEO) support; adoption time; organizational proactiveness; and information need.

### 3.2.1 CEO Support

Information systems literature is unequivocal in suggesting CEO support as a critical success factor for information

systems implementation. CEO support may take the form of guidance in planning, design, development, and implementation activities (Bruwer 1984; Doll 1985). Lucas asserts that top management ability to secure resources and their role as change agents are critical aspects of their support. Rogers (1983) posits that individuals with high power, status, and technical expertise could influence the decision to adopt or reject an innovation in an organization. Visible CEO support encourages positive user attitudes toward the introduction of information systems. Hence, it is hypothesized that organizations with high CEO support benefit more from their participation in EDIS than organizations with low CEO support.

*H1a: Organizations with high CEO support will experience increased staff productivity more than organizations with low CEO support.*

*H1b: Organizations with high CEO support will experience enhanced decision quality more than organizations with low CEO support.*

*H1c: Organizations with high CEO support will experience improved communications more than organizations with low CEO support.*

*H1d: Organizations with high CEO support will experience improved business relationships more than organizations with low CEO support.*

### 3.2.2 Adoption Time

Rogers characterizes the adoption of innovation as a two-step process. First, the early adopters implement the innovation based on its qualities. Second, the late adopters focus on and learn from the experiences of the early adopters. The early adopters can attain and sustain competitive advantage through organizational learning and leveraging their unique resource strengths to make it difficult for competitors to duplicate their innovation (Clemons and Row 1988). Dos Santos and Peffers found that early adopters of automated teller machine technology experienced gains in market share. On the contrary, research evidence also suggests that the early adopters are only able to attain but not sustain competitive advantage (Clemons and Kimbrough 1986; Clemons and Row 1988) because most innovations are strategic necessities (Clemons and Knez 1988). In this study, organizations that participated in an EDIS early and late are labelled pioneers and followers respectively. Despite conflicting evidence, it is hypothesized that pioneers benefit more from their participation in an EDIS than followers.

*H2a: Pioneers will experience increased staff productivity more than followers.*

- H2b: Pioneers will experience enhanced decision quality more than followers.*
- H2c: Pioneers will experience improved communications more than followers.*
- H2d: Pioneers will experience improved business relationships more than followers.*

### 3.2.3 Organizational Proactiveness

Chan (1990) suggests that planning for EDIS adoption, streamlining workflow, and preparing for change are critical success factors for organizations using EDIS. Organizations can benefit from a proactive approach when deciding whether to participate in EDIS. Ginzberg (1981) asserts that the extent of project definition and planning is a key recurrent issue in information system implementation. Proactive planning policies and leadership in information technology were also found to play an enabling role for organizations seeking competitive advantage (King, Grover and Hufnagel 1989). Swatman and Swatman (1992) differentiate EDIS users into proactive and reactive users. In this study, organizations that planned for their involvement in the EDIS are labelled initiators while organizations that participated due to external pressures are termed reactors. It is hypothesized that initiators benefit more from their participation in an EDIS than reactors.

- H3a: Initiators will experience increased staff productivity more than reactors.*
- H3b: Initiators will experience enhanced decision quality more than reactors.*
- H3c: Initiators will experience improved communications more than reactors.*
- H3d: Initiators will experience improved business relationships more than reactors.*

### 3.2.4 Information Need

Like information systems implementation, EDIS implementation is a process of organizational change (Monzcka and Carter 1988; Swatman and Swatman 1992). The organizational change models by Lewin (1947) and Kolb and Frohman (1970) both stress the importance of establishing a "felt need" for change to realize a successful implementation. Rogers posits that adoption of innovation stems from recognition of a need or problem. Gross and Ginzberg (1984) suggest that uncertainty about needs is a barrier to

adoption of software packages. Zmud (1984) found that the chance of successfully using a technology is raised if a problem or need exists. Thus, it is hypothesized that organizations with high information need will benefit more from their participation in an EDIS than organizations with low information need.

- H4a: Organizations with high information need will experience increased staff productivity more than organizations with low information need.*
- H4b: Organizations with high information need will experience enhanced decision quality more than organizations with low information need.*
- H4c: Organizations with high information need will experience improved communications more than organizations with low information need.*
- H4d: Organizations with high information need will experience improved business relationships more than organizations with low information need.*

## 4. RESEARCH METHODOLOGY

### 4.1 Sample

The Portnet participants were selected from a database maintained by PSA. This database captures the names, addresses, and telephone numbers of the 1,049 organizations that participated in Portnet. The 1,049 organizations listed in the database come from diverse backgrounds which include the shipping, freight forwarding, trading, trucking, legal, and insurance sectors. Law firms and insurance companies (94) were discarded from the list on the advice of PSA because these organizations exhibit very low usage of Portnet. The questionnaire was sent to the remaining 955 organizations. It was addressed to the CEO for two reasons. First, they were likely to be cognizant of many aspects of their organization and more able to provide accurate and correct information. Second, even if they were unable to answer some questions, they could direct those questions to the appropriate employees in their organization.

### 4.2 The Survey

A parcel comprising a cover letter stating the purpose of the study, a copy of the questionnaire, and a self-addressed return envelope with postage was sent to each organization. After two weeks, follow-up telephone calls were made to all organizations that had not responded to encourage these

**Table 1. Portnet Participants Profile by Sector**

Category	Shipping	Freight Forwarding	Trading	Trucking
Population	312	241	108	294
Proportion (%)	32.7	25.2	11.3	30.8
Sample	59	36	18	41
Proportion (%)	38.3	23.4	11.7	26.6

organizations to respond. Similar follow-up telephone calls were made to all organizations that had not responded after another two weeks. Additional parcels were sent to 120 organizations that claimed they had misplaced their parcels. These measures helped to raise the response rate (Fowler 1988).

Among the 101 questionnaires that could not be delivered to the organizations specified, 66 were returned because their CEOs were not in town and 35 were returned because the organizations had changed their addresses or gone out of business. Responses were received from 206 out of the remaining 854 organizations. Out of the 206 responses, 52 could not be used because these questionnaires were incomplete despite repeated calls to these organizations to seek answers to unanswered questions. Responses from the remaining 154 Portnet participants were used for data analyses. All these respondents would be given a copy of the survey results.

To check for any possible response bias, the 154 respondents were compared to the population of 955 Portnet participants based on the sector in which they belong. Sector was chosen as the criterion for comparison because organizations in different sectors exhibit different patterns of Portnet usage. The respondents did not differ significantly from the population ( $\chi^2 = 2.239$ ,  $p = n.s.$ ). No response bias by sector was observed. Table 1 presents the number of observations by sector for both the respondent sample and the population.

#### 4.3 Measures

In accordance with the recommendations of Baroudi and Orlikowski (1988), attempts were made to use validated instruments where possible. Where standard instruments were not available, care was taken to ensure the questions used were valid. Five Portnet participants were randomly selected to pretest these questions. Feedback from the pretest was used to improve the clarity, conciseness, and layout of the questionnaire (Fowler 1988). The question-

naire comprised mainly close-ended questions requiring respondents to circle an appropriate answer. This made the task of completing the questionnaire easy and encouraged a higher response rate (Fowler 1988).

The four independent variables for this study are presented in Table 2, which includes a description of their components, reliability, and measurement scales. For CEO support, the median value of five was used to differentiate organizations with high CEO support (72) from organizations with low CEO support (82). For adoption time, organizations that joined Portnet in 1989 were labelled pioneers (75) while organizations that participated later were labelled followers (79). Organizations that participated in Portnet due to their own planning process (the first five reasons in Table 2) were termed initiators (84) while organizations that joined due to external pressures (the last three reasons in Table 2) were considered reactors (70). For information need, the median value of 5.7 was used to distinguish organizations with high information need (78) from organizations with low information need (76).

The four dependent variables for this study are listed in Table 3, which contains a description of their components, reliability, and measurement scales. Improved communication and business relationships variables, which were self-developed, had Cronbach's alpha of 0.91 and 0.92 respectively. These values exceeded Nunnally's (1978) criteria that the composite reliability of a construct should be at least 0.7.

## 5. DATA ANALYSES AND RESULTS

### 5.1 Data Analyses

All statistical tests were performed at a 5% level of significance. For all dependent variables, a higher value represents a better measure. A value of seven indicates a great improvement in productivity as a result of participating in Portnet while a value of one indicates a great deterioration. A value of four indicates no change in productivity. An

**Table 2. Independent Variables**

<b>Variable</b>	<b>Operationalization</b>	<b>Scale (Source)</b>
CEO Support (Cronbach's alpha = 0.82)	Level of CEO support CEO involvement in decision-making CEO involvement in monitoring	3 items 7 point scale (Yap, Soh and Raman 1992)
Adoption Time	Year of adoption	
Organizational Proactiveness	Participate due to: Corporate planning Information systems planning Top management request User management request Information systems management request Pressure from PSA Pressure from competitors Pressure from trading partners	
Information Need (Cronbach's alpha = 0.90)	Importance of current information Importance of reliable information Importance of relevant information Importance of accurate information Importance of timely information Importance of convenience in accessing information Importance of information exchange with external organizations	7 items 7 point scale

**Table 3. Dependent Variables**

<b>Variable</b>	<b>Operationalization</b>	<b>Scale (Source)</b>
Staff Productivity	Impact of Portnet on staff productivity	1 item 7 point scale (Delone 1990)
Decision Quality	Impact of Portnet on decision quality	1 item 7 point scale (Delone 1990)
Improved Communications (Cronbach's alpha = 0.91)	Impact of Portnet on: Timeliness of information from external organizations Accuracy of information from external organizations Currency of information from external organizations Convenience of accessing information from external organizations	4 items 7 point scale
Business Relationships (Cronbach's alpha = 0.92)	Impact of Portnet on: Quality of customer services Coordination with trading partners Relationship with trading partners	3 items 7 point scale

**Table 4. Mean (Standard Deviation) of Dependent Variables**

	Organizational Productivity		Interorganizational Productivity	
	Staff Productivity	Decision Quality	Improved Communications	Business Relationships
CEO Support	**	**	**	**
High CEO Support	5.42 (1.06)	4.88 (1.16)	4.99 (1.04)	5.01 (1.15)
Low CEO Support	4.85 (1.27)	4.38 (1.13)	4.23 (1.17)	4.31 (1.13)
Adoption Time				
Pioneers	5.31 (1.25)	4.69 (1.11)	4.69 (1.10)	4.73 (1.20)
Followers	4.94 (1.13)	4.53 (1.22)	4.48 (1.23)	4.55 (1.18)
Org. Proactiveness	**	**		
Initiators	5.35 (1.19)	4.85 (1.28)	4.65 (1.19)	4.79 (1.20)
Reactors	4.84 (1.17)	4.33 (0.96)	4.50 (1.15)	4.47 (1.16)
Information Need	**	**	**	**
High Information Need	5.50 (1.19)	4.88 (1.27)	4.85 (1.23)	4.96 (1.34)
Low Information Need	4.72 (1.09)	4.33 (0.99)	4.31 (1.05)	4.32 (0.91)

\*\* p<0.01 \* p<0.05

overall MANOVA test (Morrison 1990) involving all independent and dependent variables detected significant effects for CEO support ( $F = 4.6836$ ,  $p = 0.0014$ ), organizational proactiveness ( $F = 2.8683$ ,  $p = 0.0253$ ), and information need ( $F = 3.5415$ ,  $p = 0.0087$ ) but found no significant effect for adoption time ( $F = 0.4661$ ,  $p = 0.7606$ ). Based on these results, separate MANOVA tests involving each significant independent variable and all dependent variables were performed. These tests confirmed the significant effects due to CEO support ( $F = 6.1692$ ,  $p = 0.0001$ ), organizational proactiveness ( $F = 3.6769$ ,  $p = 0.0070$ ), and information need ( $F = 6.9221$ ,  $p = 0.0001$ ). Subsequent t-tests were carried out to examine how CEO support, organizational proactiveness, and information need affected the dependent variables individually. Where a dependent variable could not meet the homogeneity and normality requirements (Neter, Wasserman and Kutner 1990) of the t-test, the results were confirmed using the nonparametric Mann-Whitney test (Siegal and Castellan 1988). Table 4 presents the descriptive statistics of the dependent variables. Table 5 reports the results of the t-tests.

## 5.2 Results

The results demonstrated a strong positive association between CEO support and both organizational and interorganizational productivity. As hypothesized, organizations with high CEO support experienced greater improvement in organizational and interorganizational productivity compared to organizations with low CEO support ( $p = 0.0034$  for staff productivity,  $p = 0.0080$  for decision quality,  $p = 0.0001$  for improved communications, and  $p = 0.0002$  for business relationships). Hypotheses 1a, 1b, 1c, and 1d were supported. Contrary to expectations, adoption time had no significant effects on organizational and interorganizational productivity. Hypothesis 2a, 2b, 2c, and 2d were not supported. Organizational proactiveness had significant effects on organizational productivity ( $p = 0.0094$  for staff productivity and  $p = 0.0059$  for decision quality) but no significant effects on interorganizational productivity. Hypotheses 3a and 3b were supported but hypotheses 3c and 3d were not supported. Information need had significant effects on both organizational and interorganizational productivity. As hypothesized, organizations with high



**Table 5. Results of T-tests for Dependent Variables**

	Organizational Productivity		Interorganizational Productivity	
	Staff Productivity	Decision Quality	Improved Communications	Business Relationships
	**	**	**	**
CEO Support	F = 8.8396	F = 7.2261	F = 17.2687	F = 14.4447
	p = 0.0034	p = 0.0080	p = 0.0001	p = 0.0002
	**	**		
Org. Proactiveness	F = 6.9295	F = 7.8075	F = 0.6171	F = 2.7720
	p = 0.0094	p = 0.0059	p = 0.4334	p = 0.0980
	**	**	**	**
Information Need	F = 17.8650	F = 9.1828	F = 8.3981	F = 11.9683
	p = 0.0001	p = 0.0029	p = 0.0043	p = 0.0007

\*\* p<0.01 \* p<0.05

information need experienced greater improvement in organizational and interorganizational productivity than organizations with low information need (p = 0.0001 for staff productivity, p = 0.0029 for decision quality, p = 0.0043 for improved communications, and p = 0.0007 for business relationships). Hypotheses 4a, 4b, 4c, and 4d were supported.

## 6. DISCUSSION AND IMPLICATIONS

### 6.1 Discussion

As a whole, Portnet participants benefitted from their use of Portnet. The mean values for all measures of organizational and interorganizational productivity exceeded the neutral value of four. However, certain groups of Portnet participants benefitted more than others. CEO support and information need appear to be key factors influencing the realization of Portnet benefits from both organizational and interorganizational perspectives. Moreover, organizational proactiveness appears to have a big impact on organizational productivity among Portnet participants.

Portnet participants with strong CEO support reap greater benefits. In this study, CEO support is measured by their involvement in the decision to adopt Portnet, their involvement in monitoring the use of Portnet, and their overall

level of support in terms of resource and time commitment. A CEO who personally makes the decision to adopt Portnet could effect necessary changes in business procedures to make better use of the system. A CEO who personally monitors the use of Portnet could secure employee commitment to the system by providing necessary incentives for using it. This is particularly important because Portnet, being an externally introduced system, is likely to generate a considerable amount of user resistance. A CEO who spends time with Portnet is likely to be cognizant of system problems and be able to provide relevant feedback to PSA. This result agrees with Delone's (1988) finding that CEO support is a strong factor influencing the effective use of information systems.

Portnet participants with a need for high quality information also benefitted more from their participation. Organizations with a prior need for the exchange of high quality information with other organizations can meet their needs through Portnet. Portnet accords its participants with the convenience to access timely, current, reliable, accurate, and relevant information from external sources. Apparently, the need for high quality information and efficient information exchange with external sources justified the adoption and greater use of Portnet, which in turn made a significant positive impact on organizational and interorganizational productivity.

Organizational proactiveness contributes to organizational productivity. Initiators plan for their participation in Portnet. They are able to streamline their operating procedures and ensure that their employees undergo adequate training to harness the potential benefits of using Portnet. In contrast, reactors that participated in Portnet due to pressure are likely to be ill-prepared to tap the benefits offered by Portnet. Interorganizational productivity could only be achieved through the collective effort of several participants. An initiator may not benefit significantly from its participation if its trading partners are mostly reactors. This is a topic for further research.

Contrary to expectation, adoption time did not affect organizational and interorganizational productivity. Pioneers were not able to sustain their first-mover advantages (Clemons and Row 1991). Portnet is a relatively stable system. Serving a relatively mature and structured freight forwarding industry, Portnet has little scope for the addition of new functions and facilities. Followers that participate later could use Portnet as effectively as pioneers after a short learning period. In other settings where the EDIS evolves over time with the continual introduction of new functions and facilities, pioneers could sustain their first-mover advantages by continually learning these new functions and facilities and keeping ahead of followers. Adoption time remains an interesting topic requiring further investigation.

## 6.2 Implications for Practice

The findings of this study provide several practical suggestions to both sponsors and participants of EDIS. EDIS, being a kind of IOS, offers economics of scale and network externalities (Bakos 1991). EDIS typically requires a large investment in hardware, software, and maintenance. EDIS sponsors could leverage their investments by encouraging a wide adoption among its target participants to reap economics of scale advantages. These findings provide EDIS sponsors with two suggestions to induce adoption among participants.

First, EDIS sponsors could target their systems at potential participants with a strong need for high quality information. These participants could be identified through a survey. Reich and Benbasat (1990) found that customer awareness of need is an important factor differentiating fast and slow adoption and high and low penetration of customer-oriented strategic systems. Bouchard (1993) contends that organizations decide on their participation in EDIS based on whether their trading partners have joined the EDIS. Hence, EDIS sponsors could market their systems to potential participants with high need for quality information to create

a critical mass of participants. This would encourage laggards to participate to avoid loss of potential business. Second, EDIS sponsors could raise CEO awareness of EDIS benefits through education, training, and public seminars. Given that CEO support plays a critical role in ensuring the effective use of EDIS, EDIS sponsors could actively generate CEO interest among potential participants. Channels to clarify, discuss, and sell the EDIS concept should be made available.

EDIS participants also invest considerable resources in participation. Besides investing in hardware and software, time and effort need to be spent to streamline organizational procedures to tap the full benefits of EDIS. Organizations should carefully assess their information needs before committing their resources in an EDIS. Organizations that decide to participate in an EDIS should solicit CEO support and plan ahead for their adoption to maximize their gains. Planning for adoption includes activities such as streamlining organizational procedures, making relevant changes to business processes, and procuring adequate hardware, software, and manpower resources. These critical activities are likely to require strong CEO support and involvement. Organizations should assess their situation and plan ahead before hopping onto the EDIS bandwagon.

## 7. CONCLUSION

The findings of this study show that Portnet participants with a strong need for quality information, strong CEO support, and that plan for their adoption, benefit more from their participation. These findings emphasize the point that proper and timely organizational actions could help organizations to attain greater productivity in an EDIS setting. However, caution should be exercised when interpreting these findings. The nature of this study limits the generalizability of its findings to a specific industry operating in a specific economic environment. The cross-sectional rather than longitudinal nature of this study also implies that causality can only be inferred.

Several issues for further research are raised. First, the participants of a stable EDIS can be compared with those of an evolving EDIS to examine the differences in productivity between pioneers and followers. Second, factors such as prior IOS experience, prior information systems experience, and level of information systems investment can be investigated for their impact on productivity. Third, an EDIS operating in a different economic environment can be compared to study the mediating impact of economic structure on participant productivity.

## 8. REFERENCES

- Bailey, M. N., and Chakrabarti, A. *Innovation and the Productivity Crisis*. Washington: Brookings Institution, 1988.
- Bakos, J. Y. "Information Links and Electronic Marketplaces: The Role of Interorganizational Information Systems in Vertical Markets." *Journal of Management Information Systems*, Volume 8, Number 2, 1991, pp. 31-52.
- Baroudi, J. J., and Orlikowski, W. J. "A Short Form Measure of User Satisfaction and Notes on Use." *Journal of Management Information System*, Volume 4, Number 1, 1988, pp. 44-59.
- Benbasat, I., and Dexter, A.S., "An Investigation of the Effectiveness of Color and Graphical Information Presentation Under Varying Time Constraints." *MIS Quarterly*, Volume 10, Number 1, 1986, pp. 1348-1364.
- Bouchard, L. "Decision Criteria in the Adoption of EDI." In J. I. DeGross, R. P. Bostrom, and D. Robey (Editors), *Proceedings of the Fourteenth Annual International Conference on Information Systems*, Orlando, Florida, 1993, pp. 365-383.
- Bruwer, P. J. S. "A Descriptive Model of Success for Computer-Based Information Systems." *Information and Management*, Volume 7, Number 1, 1984, pp. 63-67.
- Brynjolfsson, E., and Hitt, L. "Is Information Systems Spending Productive: New Evidence and New Results." In J. I. DeGross, R. P. Bostrom, and D. Robey (Editors), *Proceedings of the Fourteenth Annual International Conference on Information Systems*, Orlando, Florida, 1993, pp. 47-65.
- Chan, P. "The Success Factors of EDI." *Proceedings of the Asia Pacific Conference on EDI*, 1990, pp. 28-33.
- Clemons, E. K. "MAC — Philadelphia National Bank's Strategic Venture in Shared ATM Networks." *Journal of Management Information Systems*, Volume 7, Number 1, 1990, pp. 5-25.
- Clemons, E. K., and Kimbrough, S. O. "Information Systems, Telecommunications, and Their Effects on Industrial Organization." In L. Maggi, R. Zmud, and J. Wetherbe (Editors), *Proceedings of the Seventh Annual International Conference on Information Systems*, San Diego, California, 1986, pp. 99-108.
- Clemons, E. K., and Knez, M. "Competition and Cooperation in Information Systems Innovation." *Information and Management*, Volume 15, Number 1, 1988, pp. 25-35.
- Clemons, E. K., and Row, M. "McKesson Drug Company: A Case Study of Economost — A Strategic Information System." *Journal of Management Information Systems*, Volume 4, Number 1, 1988, pp. 141-149.
- Clemons, E. K., and Row, M. "Sustaining IT Advantage: The Role of Structural Differences." *MIS Quarterly*, Volume 15, Number 3, 1991, pp. 274-292.
- Clemons, E. K., and Weber, W. B. "London's Big Bang: A Case Study of Information Technology, Competitive Impact, and Organizational Change." *Journal of Management Information Systems*, Volume 7, Number 2, 1990, pp. 9-28.
- Copeland, D. G., and McKenney, J. L. "Airline Reservation Systems: Lessons from History." *MIS Quarterly*, Volume 12, Number 3, 1988, pp. 353-370.
- Davenport, T. H. *Process Innovation: Reengineering Work Through Information Technology*. Boston: Harvard Business School Press, 1993.
- Dearing, B. "The Strategic Benefits of EDI." *The Journal of Business Strategy*, Volume 11, Number 1, 1990, pp. 4-6.
- Delone, W. H. "Determinants of Success for Computer Usage in Small Business." *MIS Quarterly*, Volume 12, Number 1, 1988, pp. 51-61.
- Delone, W. H. Opening Remarks at the Panel "Lessons Learned From Information Technology Research on Small Organizations," In J. I. DeGross, M. Alavi, and H. Oppeland (Editors), *Eleventh International Conference on Information Systems*, Copenhagen, Denmark, 1990.
- Department of Statistics, Singapore. *Yearbook of Statistics: 1992*, Singapore: Singapore National Printers, 1993.
- Doll, W. J. "Avenues for Top Management Involvement in Successful MIS Development." *MIS Quarterly*, Volume 9, Number 1, 1985, pp. 17-35.
- Dos Santos, B. L., and Peffers, K. "The Effects of Early Adoption of Information Technology: An Empirical Study." In J. I. DeGross, J. D. Becker, and J. J. Elam (Editors), *Proceedings of the Thirteenth Annual International Conference on Information Systems*, Dallas, Texas, 1992, pp. 127-140.
- EDI Research, Inc. "The State of EDI: 1988." 1988.
- Ein-Dor, P., and Segev, E. "Organizational Context and the Success of Management Information Systems." *Management Science*, Volume 24, Number 10, 1978, pp. 1064-1077.

- Emmelhainz, M. A. "Electronic Data Interchange: Does It Change the Purchasing Process?" *Journal of Purchasing and Materials Management*, Volume 23, Number 4, 1987, pp. 1-8.
- Ginzberg, M. J. "Key Recurrent Issues in the MIS Implementation Process." *MIS Quarterly*, Volume 5, Number 2, 1981, pp. 47-60.
- Gross, P. H. B., and Ginzberg, M. J. "Barriers to the Adoption of Application Software Packages." *Systems, Objectives, Solutions*, Volume 4, Number 4, 1984, pp. 211-225.
- Fowler, F. J. *Survey Research Methods*. Newbury Park, California: Sage, 1988.
- Hammer, M. "Reengineering Work: Don't Automate, Obliterate." *Harvard Business Review*, Volume 68, Number 4, 1990, pp. 104-112.
- Hellburg, R., and Sannes, R. "Customs Clearance and Electronic Data Interchange — A Study of Norwegian Freight Forwarders Using EDI." *International Journal of Production Economics*, Volume 24, Number 1, 1991, pp. 91-101.
- Johnson, B. M., and Rice, R. E. *Managing Organizational Innovation: The Evolution from Word Processing to Office Information Systems*. New York: Columbia University Press, 1987.
- Johnston, H. R., and Vitale, M. R. "Creating Competitive Advantage with Interorganizational Information Systems." *MIS Quarterly*, Volume 12, Number 2, 1988, pp. 152-165.
- Kavan, B. C., and Van Over, D. "Electronic Data Interchange: A Research Agenda." *Proceedings of the Twenty-Third Annual Hawaii International Conference on System Sciences*, Volume 4, 1990, pp. 192-197.
- King, W.; Grover, V.; and Hufnagel, E. "Seeking Competitive Advantage using Information Intensive Strategies: Facilitators and Inhibitors." In K. C. Laudon and J. A. Turner (Editors), *Information Technology and Management Strategy*. Englewood Cliffs, New Jersey: Prentice Hall, 1989, pp. 50-63.
- Kolb, D. A., and Frohman, A. L. "An Organizational Development Approach to Consulting." *Sloan Management Review*, Volume 12, Number 1, 1970, pp. 51-65.
- Lewin, K. "Frontiers in Group Dynamics." *Human Relations*, Volume 1, Number 1, 1947, pp. 5-41.
- Loveman, G. W. "An Assessment of the Productivity Impact of Information Technologies." Working Paper, Massachusetts Institute of Technology Sloan School of Management, 1988.
- Lucas, H. C., Jr. *Implementation: The Key to Successful Information Systems*. New York: McGraw-Hill, 1981.
- Monczka, R. M., and Carter, J. R. "Implementing Electronic Data Interchange." *Journal of Purchasing and Materials Management*, Volume 24, Number 2, 1988, pp. 1-9.
- Morrison, D. F. *Multivariate Statistical Methods*. New York: McGraw-Hill, 1990.
- Neter, J.; Wasserman, W.; and Kutner, M. H. *Applied Linear Statistical Models: Regression, Analysis of Variance, and Experimental Designs*. Homewood, Illinois: Richard D. Irwin, 1990.
- Nunnally, J. C. *Psychometric Theory*, Second Edition. New York: McGraw-Hill, 1978.
- Packer, M. "Measuring the Intangible in Productivity." *Technology Review*, Volume 86, Number 1, 1983, pp. 48-57.
- Panko, R. R. "Is Office Productivity Stagnant?" *MIS Quarterly*, Volume 15, Number 2, 1991, pp. 191-203.
- Port of Singapore Authority. *Annual Report*, 1992.
- PortView. "Number of Portnet Subscribers Increases." 1993.
- PortView. "Portnet: Container Operations." 1990.
- PortView. "Ship Planning Expert System Wins International Award." 1989.
- Reich, B. H., and Benbasat, I. "An Empirical Investigation of Factors Influencing the Success of Customer-Oriented Strategic Systems." *Information Systems Research*, Volume 1, Number 3, 1990, pp. 325-347.
- Rivard, S., and Huff, S. L. "User Developed Applications: Evaluation of Success from the DP Department Perspective." *MIS Quarterly*, Volume 8, Number 1, 1984, pp. 30-50.
- Roach, S. S. "Services Under Siege: The Restructuring Imperative." *Harvard Business Review*, Volume 69, Number 5, 1991, pp. 82-92.

Rogers, E. M. *Diffusion of Innovations*. New York: The Free Press, 1983.

Scala, S., and McGrath, R., Jr. "Advantages and Disadvantages of Electronic Data Interchange." *Information and Management*, Volume 25, Number 2, 1993, pp. 85-91.

Siegel, S., and Castellan, N. J. *Nonparametric Statistics for the Behavioral Sciences*. New York: McGraw-Hill, 1988.

Sokol, P. K. *EDI: The Competitive Edge*. New York: McGraw-Hill, 1989.

Strassman, P. *The Information Payoff: The Transformation of Work in the Electronic Age*. New York: Macmillan, 1985.

Swatman, P. M. C., and Swatman, P. A. "EDI System Integration: A Definition and Literature Survey." *The Information Society*, Volume 8, Number 1, 1992, pp. 169-205.

Weill, P. "The Relationship Between Investment in Information Technology and Firm Performance: A Study of the Valve Manufacturing Sector." *Information Systems Research*, Volume 3, Number 4, 1992, pp. 307-333.

Yap, C. S.; Soh, P. P. C.; and Raman, K. S. "Information System Success Factors in Small Business." *Omega*, Volume 20, Number 5, 1992, pp. 597-609.

Zmud, R. W. "An Examination of 'Push-Pull' Theory Applied to Process Innovation in Knowledge Work." *Management Science*, Volume 30, Number 6, 1984, pp. 727-738.