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Complexity and the Companies' Informatization: The Case of EDI within the Tunisian companies

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Abstract- *Complexity is a recent phenomenon, characterized by incompleteness and unpredictability. With the globalization of business and technological changes, companies are not immune to the complexity. To control the inevitable growth of complexity, they are increasingly adopting more Information and Communication Technology ICT, such as EDI. It is then necessary to consider the impact of the use of EDI on the performance of complex transactions. A study was conducted among 32 Tunisian companies using EDI technology. Linear regression is used to test our model of dependence relation between exogenous variables (using EDI, product complexity, process complexity) and endogenous variable (delivery performance). Thus, we used the MRA (Moderated Regression **Analysis**), followed by the subgroup analysis to analyze the moderating effect of product complexity on the relationship between the use of EDI and delivery performance. The results show the positive effect of the use of EDI by personnel on delivery performance and the moderating effect of product complexity on the relationship between the number of partners using EDI and delivery performance.*

Keywords: *Complexity; electronic data interchange (EDI); delivery performance*

1. INTRODUCTION

The company faces a constantly changing environment, marked by changes in concepts: simplicity, rigidity, certainty and predictability give way to complexity, responsiveness, uncertainty and unpredictability. In recent years, the phenomenon of complexity has evolved in a remarkable way in the world, having an important place as a new field of modern science (Mack, 1997). Generally, the complexity should not be considered a source of difficulty, but it is an opportunity for progress (Genelot, 2011). Considering the enterprise as a system interacting with its environment, it is more organized at a higher level of complexity; it is more likely to give competitive advantages. In addition, the transmission and processing of information can be considered as a backbone of the business structure (Sanders, 2007). As a result, Companies must change their structure, organizations and the way they communicate.

Previous researches on the use of information technologies such as EDI and its impact on business transactions (Anderson and Lanen, 2002; Sanders, 2008 Sanders, 2007; Banerjee and Golhar, 1994) confirm the relationship between the use of EDI and performance of business transactions. Thus, recent researches on the use of integrated information systems in the supply chain of companies (Supply Chain Management) and with the applications of other enterprises focus on collaboration between trading partners and its impact on business performance (Wu and Chang, 2012; Fayard and Al., 2012; Sodero and al., 2013).

Banerjee and Golhar (1994), found that the use of EDI improves not only customer relations, but also the supplier relationship. In addition, Wu and Chang (2012) and Fayard et al (2012) found that the use of inter-organizational information systems improves their business performance in terms of cost, delivery time and customer satisfaction. From this result, the use of EDI can improve the performance of business transactions and procurement processes with suppliers. Therefore, the informatization of companies is the best solution to adapt to a complex environment. EDI is an information technology used by companies to transfer data in the form of electronic messages which providing a time saving, better communication and more reliable information. Hence, there will be an improvement in the performance of business transactions. In this context our research problem is as follows: What is the impact of using EDI on the performance of complex transactions?

In this perspective, the goal of this study is to identify the role of informatization of enterprises in mastering the complexity of the transactions. In other words, we examine whether the informatization improve the performance of business transactions or not. We take into consideration the case of using EDI for the execution of customer orders.

To realize the objective already mentioned, this paper will be divided into five sections. After introducing the topic, the next section is a theoretical framework,

describes the conceptual framework, and presents our hypothesis. The third one, it will deal with the methodology. As for the fourth section, it will be a description of the results of our analyses. Finally, the last will be a discussion followed by the conclusion of this study.

Theoretical framework and hypotheses development

The globalization of business and technological developments lead to reorganization of businesses, consumers, the economy and society in general. Hence,a new economy is introduced where the consumer is more demanding and where we give more importance to the immaterial (and JanissekFreitas, 2003). These changes intensify the complexity of the business environment and result in the emergence of complex situations. These situations are usually accompanied by continuous changes and forecasting issues.

The notion of complexity has several characteristics. It is characterized by unpredictability and the dogmatism of situations and systems (Genelot, 2011). The complexity of a system is characterized by the presence of a large number of interacting entities and several loops allowing the system to restructure or modify relationships (Thietart, 2000). The uncertainty, undecidability and the existence of different logics are still faced with complex situations (Genelot, 2011). By examining these characteristics, a complex system is presented as a combination of several actors interacting with unpredictable behavior and decentralized initiatives.

Complex systems present organizations as complex systems governed by nonlinear dynamic laws. The company is not immune to the complexity. It is considered as an open, finalized system which consists of a diversity of elements (materials, intangible and human) in interaction (and Groward Mestro 1998; Darbelet, Scaramuzza and Izard, 1998). It operates in an environment with which a constant exchange resource, energy and information takes place (Langrand-Escure and Thiétart, 1998). The multiplicity of relationships and interaction between these elements create a universe of great complexity.

The Electronic Data Interchange (EDI) is an inter-organizational information system for data transfer or management actions in the form of electronic messages (Reix, 2002; Pateyron and Salmon, 1996). Indeed, the Internet with its extensive network, offering new opportunities for companies using EDI. This technology allows the extension of its network of trading partners, simplifying and reducing the cost of communication process (Threlkel and Kavan, 1999). An alternative offered by the Internet is the application of XML (Extensible Markup Language) in electronic commerce (Purchase and Shih, 2000).XML allows structured information to be displayed in a web-based Format. This format makes it easy for organizations with different systems to import and export data in a simple format (Goswami and Kundi, 2013). The XML/EDI provides application integration, cost reduction and expansion of e-commerce for small and medium-sized enterprises, many of whom cannot afford custom software required for traditional EDI transactions (Purchase and Shih, 2000).

Companies are forced to take advantage of the benefits offered by EDI technology to improve the performance of their transactions; particularly those conducted in a highly complexity.

Informational integration with partner aims to automate, fluidize and reliable information exchange and the acceleration of transactions (Detchessahar et al. 2003; Blandin and Hintermann, 2000). The automation and fluidity of customer order processing, and the fact of receiving orders in real time(24/24); which is provided by EDI links(Pateyron and Salmon, 1996; Lepers, 2003) could make business transactions more flexible. As our research problematic deals with the impact of using EDI on the performance of complex transactions, the validation of our model of research is subject to a hypothesis of direct dependences as well as a moderation hypothesis. First of all, we propose that the complexity of products and processes has a negative effect on the performance of order delivery. Anderson and Lanen (2002, P720) examined the relationship between the complexity of an order (product complexity and process complexity) and its delivery performance. They found that the complexity of the product and the process is associated with delays of acknowledgments. Thus, Closs et al (2010) have shown the negative effect of the product and process complexity on service performance. Hence, we need to test the following hypothesis:

H1: Product and process complexity reduces orders delivery performance

Moreover, we propose that the use of EDI has a positive effect on the order delivery performance. Sanders (2008) found a positive impact of IT use on organizational performance (operational and strategic). Anderson and Lanen (2002) showed a positive relationship between the EDI use and performance of accounting transactions. The study presented by Banergee and Golar (1994) on the use and non-use of EDI by firms show the satisfaction of the users of EDI. A significant level of user satisfaction derived from the speed of communication, the capacity of interface, growth potential, reliability, compatibility, and the control system. Hence the following hypothesis:

H2: using EDI improves orders delivery performance

The complexity of products creates difficulties in the execution of supply chain processes related to product development, procurement, manufacture, delivery and support (Closs, 2008). This complexity may be a carrier of opportunity and threat. It is therefore essential to effectively manage the growing complexity of the products. So Anderson and Lanen (2002) found that the benefits of controls without error presented by EDI offset most of the negative effects of product complexity. We propose that the benefits from the use of EDI increases with the complexity of a product order. Thus, we hypothesize the following:

H3: product complexity modifies the relationship between the use of EDI and order delivery performance.

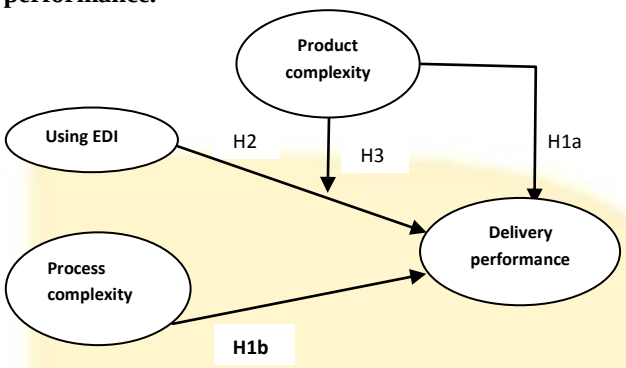

Figure1: Conceptual framework

2. METHODOLOGY

Sample Description

The research methodology used is based on empirical data collected through a questionnaire sent to Tunisian companies using EDI. Given the limited number of companies in our country, we have not limited our sample to one industry. Indeed, the constitution of our sample has passed through two stages; first we consulted several sources of information such as the promotion agency of Industry (API), Centre for Export Promotion (CEPEX) the National Informatics Centre (NIC), Ministry of Commerce and Tunisia trade Net (TTN). Faced with the absence of official data on companies using EDI and the confidentiality of information, the consultation of these organizations was not sufficient to constitute the sample. Second, we opted for an exploratory sample to identify companies that use EDI. This sample consists of approximately 200 companies from various sectors. The selection criteria for this sample are size indicators. These companies are interviewed by telephone. The question is if the company uses an EDI system or not. The question was addressed primarily to the persons in charge of data processing and logistics. Companies that emerged following the pre survey were 38 in total, six of which have subsequently refused to answer the questionnaire. Hence, our final sample is 32. The administration of the questionnaire was conducted through the following two modes: face to face administration and administration by e-mail. The questionnaire is addressed to managers and people in charge of data processing and logistics.

Measurement of constructs

We used a principal component factor analysis PCA, aimed to synthesize items. The counting of our results is done in SPSS. Appendix 1 presents the instruments used to measure the main constructs. The use of EDI was measured by four items developed by Banerjee and Golhar (1994). Respondents were asked to indicate the number of years of use EDI, the number of business partners using EDI, the number of staff using EDI, the percentage of sales made through the EDI. A high score indicates a greater use of EDI.

Thus, the product complexity was measured by four items used by Anderson and Lanen (2002). The four items are: the number of lines per order, the number of products per order, the number of items personalized per order, the average item cost. A high score indicates a high level product complexity.

The process complexity is measured by four items used by Anderson and Lanen (2002). Respondents were asked to give an approximate percentage of the commands executed per year that require manual pricing, programming manual production, manual verification of stock products, change product design (custom products). A high score indicates a high level of complexity of the process.

Measures used to measure delivery performance are used by Ferdows and Meyer (1990) and Whybark and Vastag (1993) and Klassen and Whybark (1999). Four items are used to measure this factor ranging on a five-point Likert-type scale (1 = strongly decreased, 2 = greatly increased). Respondents were asked to assess changes in recent years, delivery speed, on time delivery, output time control of manufacturing, time of product design.

To establish the reliability of each construct, we examined the Cronbach Alpha and composite reliability. The internal validity of each construct is delivered to a value greater than 0.7 (Thiétart 1999; Nunnally, 1978). In addition, to verify convergent validity, the variance extracted must exceed the recommended cut-off point of 0.5 to reflect acceptable validity. Besides, to ensure the adequacy of the model, it is important to ensure the discriminant validity of the constructs. Discriminant validity was tested by the correlation between the items of each scale, as it is established by using the Kaiser criterion. A high standard of Kaiser, indicates that there is an acceptable factor solution representing the relationships between variables. Norusis(2000) presents six situations Kaiser value which is less than 0.5 is acceptable. The results of the **PCA** after Varimax rotation, made on the various items of the four variables adapted in our research has confirmed the existence of three factors Comprod **(Three items are retained)**, comproc and perfliv variables corresponding to product complexity, process complexity, delivery performance. Concerning the processing of the variable use of EDI, the application of **PCA** has not yielded satisfactory results. Hence we will consider four items corresponding to this variable as the observable variables. Table 3 shows the correlation between all factors in the model. Significant correlations verify the consistency of the measurement scale.

3. DATA ANALYSIS

The data analysis involves the following steps: linear regression is used to test our model of dependence relation between exogenous and endogenous variables. Indeed, multiple regression is to explain a dependent variable (endogenous) with a set of other independent variables

(exogenous) (Ervard and al.2003). The interpretation of the results of a linear regression is done at three levels: those that measure the strength and significance of the relationship between the dependent variable and the independent variable with a significance level of $\alpha < 0.05$. Indicators that evaluate the contribution of each exogenous variable in explaining overall model; each endogenous variable of the model is being tested to determine its variance (R^2) explained (R2 must be close to 1) and a Fisher test (F value must be> 5) and finally Durbin Watson test to check the hypothesis of independence between the explanatory variables and residuals.

Thus, based on the work of Choe (2004), we used the MRA (Moderated Regression Analysis) to analyze the moderating effect on the relationship between product complexity and delivery performance.MRA results are presented in Appendix 2.Choe (2004) suggest if the results of MRA are not significant, we used the method of subgroup analysis. This method is to divide the observations of product complexity into two groups with a median value being used as a dividing point. In each group spearman correlation was performed.

Table 1: Correlation factors

	nbryears	nbrpart	nbrstaff	saledi	comprod	comproc	delivperf
number of years of use EDI (nbryears)	1.00						
number of business partners using EDI (nbrpart)	0.021	1.00					
number of staff using EDI (nbrstaff)	0.197	0.536**	1.00				
the percentage of sales through the EDI (saledi)	0.093	0.274	0.224	1.00			
Process complexity (comproc)	-0.238	-0.021	-0.222	0.067	1.00		
Product complexity (comprod)	-0.002	0.704**	0.308*	0.195	-0.067	1.00	
Delivery performance (delivperf)	-0.027	0.446**	0.618**	0.035	-0.294	0.295*	1.00

**** The correlation is significant at 0.01(unilateral)**
*** The correlation is significant at 0.05(unilateral)**

4. RESULTS

Table 2 presents the results of linear regression of the overall model, dependency ratios, the overall quality of regression R2, the coefficient of Fisher and signification indicators. Table 3 presents the results of subgroup analysis.

Table 2: Results of linear regression

Independent variable / Dependent variable	Delivery performance
nbryears	-0.174ns
nbrpart	0.182ns
nbrstaff	0.529*
saledi	-0.105ns
comprod	-0.206ns
comproc	0.010ns
R2	0.473
Fisher test	3.743
p-value	0.009
Durbin Watson coefficient	2.174

*p< 0.01
ns : not significant

Table 3 : Results of subgroup analysis

	Delivery performance	
	High product complexity (N=16)	Low product complexity (N=16)
nbryears	0.146ns	0.168ns
nbrpart	0.647**	0.755a
nbrstaff	0.719**	0.686**
saledi	0.112ns	- 0.179ns

**p < 0.01, ns not significant
a : difference between significant correlations at p <0.10 (Fisher's Z transformation)

The evaluation of the overall quality of the regression gives us a value of R2 equal to 0.473 and Fisher coefficient equal to 3743 and a p-value less than 0.01. The results of the overall model reflect a significant direct relationship between the number of staff using EDI and the dependent variable delivery performance. This suggests the importance of the dissemination of the use of EDI in all departments of the company to ensure a smooth flow of orders. These results partially verify the hypothesis (1) direct dependency between the use of EDI and delivery performance. In Table 4, the correlation coefficients were compared between groups. Fisher Z statistics can be used to determine the significance of the difference in

correlation coefficients between groups. (Choe, 2004,p76). The value of standard Z for nbrstaff were 4,744 (p = 0.073). Therefore, in firms that hose low product complexity, the use of EDI partners is more likely to increase delivery performance.

5. DISCUSSION

In this article we tested a model of the relationship between the use of EDI and performance of complex transactions. We used a multiple regression model to study the one hand, the effect of the use of EDI delivery performance and on the other hand, the effect of product and process complexity on performance. A moderating effect of product complexity on the relationship using EDI - delivery performance was also tested.

A number of theoretical contributions and practical implications can be drawn from our results. From a theoretical perspective, this study contributes to the management of complexity and information management by providing the role of information communication and technology to control the growth of complexity within and outside the business. So, the evolution of the phenomenon of complexity is to push companies to rethink their organizational methods. Companies must renew their ways of working to find ways to adapt to the increase of complexity. The informatization of companies contributes significantly to their effectiveness in a complex environment. Overall, we can say that companies have an incentive to automate their business transactions procedures to adapt to imprecision permanently and faster. For this reason, they should benefit from the advantages offered by ICT for business performance. However, the results show the dependence of delivery performance to the number of staff using EDI. This relationship is positive, which proves the importance of the widespread use of EDI in the entire company; this ensures the rapid movement of orders in the various departments. This research has helped to clarify the concept of complexity and introduce measures to be adopted by companies to think about their work with and not against complexity. EDI is a system designed for efficient business transactions. This improves the responsiveness of firms, especially in the case of complex transactions.

In fact, the results of our research have not produced significant results regarding the relationship between delivery performance and variables percentage of sales via EDI, number of years of using EDI, number of partners using EDI, product complexity and process complexity. Thus, we could not prove the moderating effect of the product complexity on the relationship between the delivery performance and the measures of the use of EDI, except the number of partners use EDI. These non-significant results do not deny the existence of theoretical relationships.

6. CONCLUSION

Complexity is a recent phenomenon in the management literature. Several authors (Moigne, 1995, Mack 1996; Thiétart, 2000; Genelot, 2011) helped to clarify the concept of complexity and present theories of complex systems. Thus, more research (Closs and Al, 2010; Sanders, 2008; Banergee and Golar Anderson and Lanen, 2002) has treated the relationship of business computerization, the complexity and performance of business transactions.

Using data from 32 Tunisian companies, we tested a model of the impact of using EDI on delivery performance taking into consideration a complex product and process. To test the research hypotheses, we conducted the following analysis techniques: AFCP, correlation, linear regression. The results show the dependence of delivery performance to the number of staff using EDI. Although our research model emphasizes the importance of EDI use by all staff of the company, it is possible that there are other configurations with other categories of variables that explain delivery performance. Indeed, even a model robust enough, cannot fully represent the reality of the proposed relationship. However, our research is based on 32 companies belonging to various sectors. This methodological limitation is due to the limited number of companies that use EDI in Tunisia.

This research allows one to open new research horizons. We can try to determine the impact of IT use on the complexity of the process. It may be useful to try to test the extent of the use of EDI in business.

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Appendix1

Factors and questionnaire items
Use EDI

Items	Communality factor analysis
Number of years of using EDI	0.309
Number of business partners using EDI	0.804
number of staff using EDI	0.824
percentage of sales made through the EDI	0.575
KMO	0.552
P : Bartlett Test	0.031
Cronbach alpha	0.3978

Product complexity (Please give a normalized value of each of the following items?)

Items	Factor loadings	Communality factor analysis
number of lines per order	0.932	0.869
number of products per order	0.985	0.969
number of items personalized per order	0.965	0.931
KMO	0.677	
variance extracted	92.298%	
P : Bartlett Test	0.000	
Cronbach alpha	0.9528	

Process complexity (please give an approximate percentage of each of the following items)

Items	Factor loadings	Communality factor analysis
the commands executed per year that require manual pricing	0.778	0.501
programming manual production	0.552	0.305
manual verification of stock products	0.822	0.678
change product design (custom products)	0.894	0.800
KMO	0.661	
variance extracted	57.62%	
P : Bartlett Test	0.000	
Cronbach alpha	0.7362	

Delivery performance (Please express the evolution of the following items in recent years)

Items	Factor loadings	Communality factor analysis
delivery speed	0.746	0.864
on time delivery	0.815	0.903
output time control of manufacturing	0.730	0.854
time of product design	0.366	0.605
KMO	0.749	
variance extracted	66.424%	
P : Bartlett Test	0.000	
Cronbach alpha	0.8095	

Appendix 2

Dependant Varriable	Independent Variable	Beta Coefficient	F	R^2
delivperf	(1) nbryears	-0.027[ns]	0.022	0.001
	(2) comprod	0.295[ns]	1.399	0.088
	(3)nbryears* comprod	-0.218[ns]	0.908	0.089
	(1) nbrpart	0.446[b]	7.443	0.199
	(2) comprod	-0.037[ns]	3.613	0.199
	(3)nbrpart* comprod	0.146[ns]	2.348	0.201
	(1) nbrstaff	0.618[a]	18.543	0.382
	(2) comprod	0.116[ns]	9.436	0.394
	(3)nbrstaff* comprod	0.300[ns]	6.202	0.399
	(1) saledi	0.035[ns]	0.037	0.001
	(2) comprod	0.3[ns]	1.396	0.087
	(3)saledi* comprod	1.109[ns]	1.150	0.022

[a] $p<0.01$, [b] $p<0.05$, ns non significatif

(1) $Y = b_0 + b_1X + \xi$
(2) $Y = b_0 + b_1X + b_2Z + \xi$
(3) $Y = b_0 + b_1X + b_2Z + b_3XZ + \xi$

Avec Y = delivperf
X = { nbryears, nbrpart, nbrstaff, saledi}
Z = comprod (Moderator Variable)
ξ = constante