Assessing "Transaction Climate" Influencing the Adoption of Innovative ICT and E-business in the Greek Agri-food Sector

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Abstract. Recently, a large number of innovative ICT systems and network tools facilitate the use of e-business frameworks. Modern organizations through innovative ICT models can confront competition, uncertainty and complexity. Supply chain faces organizations as a chain of interrelated entities, and provides a complete aspect of their prospects. A survey has been contacted to test the impact of the factor "transaction climate" on agri-food firms in Greece. A total of 20 variables was initially proposed to determine the factor "transaction climate" related to the four organizations that companies deal with, customers, suppliers, carriers and 3rd Party logistics provider companies, while for each one of the four were investigated separately 5 features: Commitment, Reliability, Firm's Satisfaction, Satisfactory Information Exchange and Long-lasting Relationships. Finally, through factor analysis, were expressed all 10 of the original 20 variables that describe the "transaction climate" in an agri-food firm, as linear combinations of the fewer and derived 2 component constructs/factors, leading firms in agri-food sector in Greece to adopt innovative IT and web-based technologies aiming to enhance e-business, supply chain management, organizational productivity, flexibility and competitiveness. Each factor is described with 5 questions of the questionnaire that load highly in each factor. The 2-factor model has to be further confirmed in a second sample.

Keywords: factor analysis, innovative ICT, ICT adoption, supply chain, agri-food sector.

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1 Introduction

Information and Communication Technologies (ICTs) have been highly recognized lately in all aspects of human endeavors, primarily as a result of the improvements in the effectiveness and efficiency in business (Andreopoulou et al, 2008).

Innovative ICT components influence organizational structure, firm strategy, information exchange, operational procedures, buyer and supplier relationships and bargaining power (Zioupou et al., 2010).

E-business applications are changing relationships in the business world, linking businesses, consumers, building new models and communities. Companies and individuals have become more familiar to do business as and when they like, therefore conventional companies in every area of interest are increasingly searching for internet-enabling their products and services (Krueger & Swatman, 2004). Traditional manufacturing and service environments have been transformed into more physically distributed enterprise environments, which include supply chains, e-commerce and virtual enterprises (Gunasekaran & Ngai, 2007).

Enterprises are now required to come up against multiple and significant challenges, arising from market globalization, increasing competitiveness among businesses and a constantly changing business environment. The concept of supply chain is an area of growing interest, both for the scientific community and for businesses worldwide. This growing interest accounts for the existence of a multitude of definitions and approaches, by many authors and from different points of view.

Supply chain is defined as "*Product life cycle processes comprising physical, information, financial, and knowledge flows whose purpose is to satisfy end-user requirements with physical products and services from multiple, linked suppliers"* in "Handbook of Supply Chain Management" (Ayers, 2006) According to APICS Dictionary (Blackstone, 2008), supply chain is the global network used to deliver products and services from raw materials to end customers through an engineered flow of information, physical distribution, and cash.

In addition, the definition of supply chain management includes design, planning, execution, control, and monitoring of supply chain activities with the objective of creating net value, building a competitive infrastructure, leveraging worldwide logistics, synchronizing supply with demand, and measuring performance globally.

According to Robinson and Malhotra (2005), management of the supply chain poses challenges such as the building of trust and cooperation between the chain's parts, the ability to recognize optimum practices to help align and accomplish its processes, and successfully implement information technologies that will lead to efficiency and quality throughout the supply chain.

In recent decades, the acknowledgment of supply chain as a key area for business success has been a great change and challenge for the businesses' operation. In many cases, firms' ability to compete was linked to their ability to interact with others. Over the years, many authors have found an increased necessity for cooperation,

recognizing the establishment of lasting partnerships with suppliers, at different levels of the supply chain, as a mean of creating a more efficient and responsive supply chain. The partnership includes organizations and companies working together on a level beyond simple commercial relations. In terms of supply chain collaboration means, members of the chain involved in coordination activities exceed the limits of own business (Bowersox, 1990).

Nowadays, organizations have realized that real improvement cannot come from individual business practices anymore, but from cooperative action between organizations. Thereby, organizations can expand their boundaries as individual firms. Changes in the organizational characteristics of firms involve changes at a functional level. The relationship among businesses has been transformed from simple transactional relationships, to cooperation characterized by smooth communication and extensive sharing of information.

The employ of network technology within e-business results into the elimination of the required cost and time for the transactions, yet the gap between the production site and the final users of the products can be bridged using the Internet. Moreover, Pan, Gunasekaran & McGaughey in their recent paper explore the impact of company size on an important financial consideration affecting the decision to adopt e-business in international trade, and they assert that firm size will influence the choice of payment method in global e-commerce (Pan et al., 2006). Moreover, the role of managers has changed from managing physical assets and people to managing knowledge assets in digital enterprise environments and it has become critical to look into the management function and the role of managers in the so-called 'digital enterprise' environment (Gunasekaran & Ngai, 2007).

The agri-food sector is an key-sector, which includes organizations from both the food industry (processing plants, manufacturers, wholesalers, retailers, catering companies, etc.) and the agricultural sector (farmers, producer groups, cooperatives, suppliers of agricultural raw materials, etc.).

Vorst (2001) distinguishes two main types of supply chain in the agri-food sector:

1) Supply chain for fresh agricultural products, such as fresh fruit, vegetables and flowers
2) Supply chain for processed foods, such as deserts, canned goods and more. However, the distinction cannot be absolute, since in many cases, a supply chain may be a subtotal of another one, and partners may differ from a supply chain to another.

Certain particular characteristics of agri-food sector however, prevent the extensive employ of ICT. The resistance in the change, the attachment in tradition, the lack of familiarity with the technology, the different nature of the rural products and transactions are some of the issues that differentiate and prevent the integration of the new practices of electronic business in the rural sector (Andreopoulou et al., 2008).

1.1 Theoretical model

The theoretical model proposed by Patterson et al. (2003), quotes seven factors important for the adoption of innovative ICT by organizations.

The 1st factor is "organization's size", for many researchers have concluded that firms' size influences their decision to adopt Innovative ICT. However, different opinions have been expressed as far as the direction of this relationship is concerned. Theoretically, larger organizations have the financial and technology resources to invest in new technologies and absorb the associated risks (Grover & Goslar, 1993). However, there is evidence that smaller firms are more flexible, and consequently more likely to adopt new information technologies (Patterson et al., 2003).

Table 1. Variables used to measure "transaction climate"

Variable	Question
V1	Commitment between customers and firm
V2	Reliable customers
V3	Firm's satisfaction with customers
V4	Satisfactory information exchange with customers
V5	Long-lasting relationships with customers
V6	Commitment between suppliers and firm
V7	Reliable suppliers
V8	Firm's satisfaction with suppliers
V9	Satisfactory information exchange with suppliers
V10	Long-lasting relationships with suppliers
V11	Commitment between carriers and firm
V12	Reliable carriers
V13	Firm's satisfaction with carriers
V14	Satisfactory information exchange with carriers
V15	Long-lasting relationships with carriers
V16	Commitment between 3rd party logistics providers and firm
V17	Reliable 3rd party logistics providers
V18	Firm's satisfaction with 3rd party logistics providers
V19	Satisfactory information exchange with 3rd party logistics providers
V20	Long-lasting relationships with 3rd party logistics providers

The 2nd factor is "organizational structure" that occupies the majority of researchers, regarding the adoption of innovative ICT. The approach of Bowersox and Daugherty (1995) reasons that organizations which have adopted a more transparent, flatter and more decentralized structure are expected to adopt more innovative technologies in order to improve both internal and external communication and coordination.

Past performance is the 3rd factor that seems to have an impact on organizations decision to adopt or not innovative ICT. Companies that have been successful in their past performance are expected to be more reluctant to change their strategies by adopting new and possibly risky new technologies (Clemons et al., 1996). Therefore, less successful companies are more likely to adopt innovative ICT in order to improve their performance.

The 4th factor mentioned is the "integration of supply chain management strategy into the overall strategy of the organization". According to Bowersox and Daugherty

(1995), the successful implementation of ICT depends on its consistency with the overall corporate strategy, and this consistency can lead to the overall firm's success.

An inter-organizational factor that can lead an organization to adopt supply chain technology is "enacted power by supply chain partners" (Premkumar et al., 1997) or by the industry. For example, a supply chain partner can either encourage or coerce the company to adopt some particular technology. This kind of pressure is usually exerted in order to improve information flow and communication between organizations. However, such a pressure can sometimes lead to extensive organization risk or business loss. Furthermore, Reekers and Smithson (1994) claim that the initiating firm obtains more benefits than the follower (Table 1).

Past research reveals another important factor, as many researchers focus on the "transaction climate" between partners, which represents the relationships and social elements between organizations (Patterson et al., 2003). Thus, a favorable "transaction climate" combined with enduring and trusting relationships between organizations (customers, suppliers, carriers and 3PL provider companies), is assumed to be a factor encouraging companies adopt innovative information technologies (Konsynski & McFarlan, 1990) (Table 1).

The last factor researched in the present study is "environmental uncertainty". Previous research has shown that environmental uncertainty is positively related to a greater need for innovation (Ettlie, 1983), and the consequent adoption of new information technologies. According to Ahmad and Schroeder (2001), an uncertain environment requires more frequent exchange of information between business partners so that activities can be prioritized as changes occur and delivery expectations met, and demands faster and more accurate decisions.

In a recent research (Zioupou et al., 2010) it was identified that the critical factors, relating to the adoption of ICT, are company's size and the integration of the supply chain strategy pursued by the company into the overall corporate strategy. As far as the first factor is concerned, larger companies seem more likely to adopt new information technologies in their supply chain management. Regarding the second factor, the consistency of the supply chain management strategy with the overall corporate strategy appears to be a prerequisite for the successful implementation of new information technologies.

This paper through factor analysis, tested a 20-variable model regarding the "transaction climate" leading firms in the agri-food sector in Greece to adopt innovative IT and web-based technologies aiming to enhance e-business, supply chain management, organizational productivity, flexibility and competitiveness. Finally, a model will be confirmed having an acceptable fit, including correlated factors.

2 Methodology

The survey was conducted by sending questionnaires to businesses, via e-mail. Furthermore, a structured questionnaire, including questions representing both the independent and the dependent variables, was used to collect the necessary data in order to investigate the relationships among the variables. Businesses included in the survey's sample were agri-food sector, located in Greece that manages their supply chain activities using innovative ICT. These firms were identified by the companies,

which provide those information technologies. A prerequisite for participation in this research was the adoption of any information technology for the management of supply chain activities. The innovative ICT proposed by the existing literature and included in the present study are listed below:

1) Supply Chain Management (SCM)
2) Customer Relationship Management (CRM)
3) Enterprise Resource Planning (ERP)
4) Warehouse Management Systems (WMS)
5) Manufacturing Execution Systems (MES)
6) Transportation Management Systems (TMS)
7) Bar Coding Technology
8) Radio Frequency (RF) Identification systems
9) Geo-coded Tracking Systems
10) Electronic Commerce Technologies

Therefore, the questionnaire included questions referring to the size of the organization, past performance of the company, the organizational structure, the external environment, the relations between partners of the supply chain, and finally questions about the adoption of new information technologies by the companies.

The majority of questions were formulated using a 5-point Likert scale, where the respondents were requested to indicate the degree of implementation of information technologies or agreement with the given statements. There were also some open-ended questions, where the respondents were free to formulate their own answers.

The research is based on the theoretical model proposed by Patterson et al. (2003), and attempts to empirically apply this model in the case of Greek agri-food sector.

Past research reveals another important factor, as many researchers focus on the "transaction climate" between partners, which represents the relationships and social elements between organizations (Patterson et al., 2003).

To investigate the 5th factor in Patterson's model «transaction climate» affecting companies in deciding whether to adopt new ICTs in their supply chain management, a total of 20 factors were proposed to determine the variable. These 20 factors were related to the four organizations that companies deal with. These are customers, suppliers, carriers and 3PL provider companies. For each one of the four organizations, were investigated separately, the following factors:

- Commitment,
- Reliability
- Firm's satisfaction
- Satisfactory information exchange
- Long-lasting relationships

They resulted in 20 variables, named "x", x=1,..,20, presented in Table 1.

Sample companies had to define whether they were satisfied by the proposed factors, describing relations with their partners. To do so, a graded Likert scale was used, where 1 represents 'not at all ', 2 'very little', 3 'somewhat', 4 'a significant amount' and 5 represents 'to a great extent'.

Further, through factor analysis, it was tested the 20-factor model regarding the "transaction climate" leading firms in the agri-food sector in Greece to adopt

innovative IT and web-based technologies, aiming to reduce the number of factors describing the variable «transaction climate».

Factor analysis is a technique, which seeks a simpler structure for a complex set of multivariate 20 variables. The emphasis of factor analysis is to explain the co-correlation (or covariance) of the original 20 variables. The intent of factor analysis is to express all p of the original 20 variables as linear combinations of the fewer, derived F factors.

Initially, the correlation matrix was estimated using PASW Statistics, aiming to check inter-correlations between variables and exclude variables that represent questions from the test. If questions measure the same underlying dimension then it is expected to correlate with each other. Variables that do not correlate with any other variables should be considered excluded before running the analysis. The opposite problem is when variables correlate too highly. It is important to check for variables that are highly correlated (multicollinearity) or perfectly correlated (singularity).

A KMO and Bartlett's Test was measured. Then, the Kaiser rule was used to decide the number of extracted factors in parallel with a Scree plot. The first i factors are chosen where with eigenvalues (l) greater than the average eigenvalue (for factors analysed by the R matrix, the average l is 1) in parallel with using a Scree test for the scree plot of eigenvalues of R such that if the graph drops sharply to a shallower-slope line, we choose i as the number of eigenvalues before the shallow-slope line;

Communality, or achieved communality, (h) was also estimated that is that part of the variance which is accounted for by that factor. It is the common variance of the common factors. Rotation was estimated using Varimax method.

3 Results

The companies representing agri-food sector are in their majority public limited companies (SA), while some of them state their activities and are Industrial and Commercial Limited Companies. The majority of firms are located in the Prefecture of Attica (12 companies), while five of them are located in the Prefecture of Thessaloniki, and the last 5 are located in other prefectures of Greece (Figure 1).

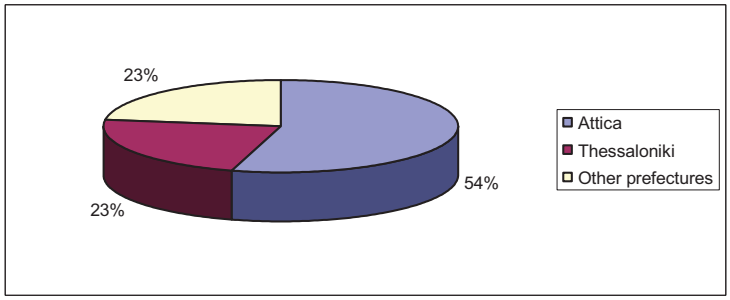

Figure 1. Geographical location of sample firms

The following table summarizes the characteristics of the companies that participated in the sample.

Table 2. Summary of the companies' characteristics

Legal Form	Number of Firms	Average Turnover (in €)	Minimum Turnover (in €)	Maximum Turnover (in €)	Average Number of Employees
SA	14	146,750,842	2,557,874	714,100,000	504
Industrial and Commercial SA	8	119,636,803	10,975,338	630,232,000	622

The number of the companies' employees was the main criterion for measuring the firms' size, which is hypothesized to be one of the most important factors affecting the adoption of innovative information technologies. The classification of companies regarding the number of employees is presented in Figure 2. It should also be mentioned that businesses' turnover varies widely, as can be seen in the Table 2.

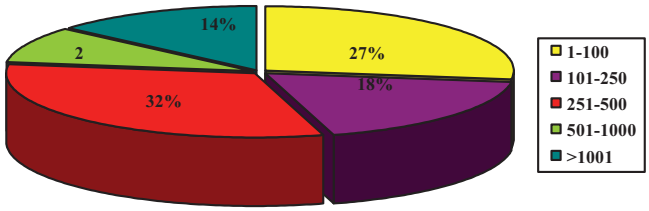

Figure 2. Classification of companies based on their number of employees

The geographical scope of the sample companies is not limited only to the prefecture of their location. Twelve of the companies operate globally, seven of them at a national level, while only three companies are limited to a regional level, which includes the prefecture of company's location and its neighboring prefectures. The wide geographic spread of businesses action also states the existence of fierce competition.

1.1 Results of factor analysis

Initially in factor analysis, inter-correlations between variables are checked. At this early stage, we look to eliminate any variables do not correlate to any other variables or that correlate very highly with other variables ($R<0.9$). Also, multicollinearity can be detected by looking at the determinant of the R-matrix.

Using the correlation matrix, the pattern of relationships was checked.

In variables V2, V3, V5, V6, V10, V15, V17, V18, V19, V20, which represent questions in the questionnaire (Table 1), the majority of significance values in the correlation matrix, are greater than 0.05, hence a problem can arise due to singularity of data.

Moreover, the initial determinant, while running the analysis with all 20 variables is 7.13×10^{-14} which is less than the necessary value 0.00001. There is need to eliminate questions from the questionnaire, that are attributed to variables. By

successive eliminations of the above variables, the determinant is found to be 3.96x 10^{-5}, which is acceptable.

However, the questions from the questionnaire attributed to the following variables: V2, V3, V5, V6, V10, V15, V17, V18, V19, V20 are excluded from the questionnaire before running the analysis

Further, the KMO Kaiser-Meyer-Olkin test that measures sample adequacy is 0,791 being between 0 and 1. A value close to 1 indicates that patterns of correlations are relatively compact so factor analysis should yield distinct and reliable factors. Kaiser recommends that values between 0.7 and 0.8 are good while values close to 1 are superb. Bartlett's test of sphericity is a measure that tests the null hypothesis that the correlation matrix is an identity matrix. For these data, Bartlett's test is highly significant ($p<0,001$) and therefore factor analysis is appropriate.

In Table 3, the total variance explained by factors is presented, thus we can decide on the final factor to be extracted, based on eigenvalues greater than 1, as recommended by Kaiser's rule.

Table 3. Total Variance Explained

Component	Initial Eigenvalues			Extraction Sums of Squared Loadings			Rotation Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	6,503	65,026	65,026	6,503	65,026	65,026	3,902	39,018	39,018
2	1,080	10,797	75,824	1,080	10,797	75,824	3,681	36,806	75,824
3	,764	7,645	83,468						
4	,545	5,446	88,915						
5	,374	3,744	92,659						
6	,235	2,347	95,005						
7	,194	1,944	96,950						
8	,150	1,495	98,445						
9	,105	1,049	99,494						
10	,051	,506	100,000						

Extraction Method: Principal Component Analysis.

Table 3 lists the eigenvalues associated with each linear component (factor) before extraction, after extraction and after rotation. Factors with eigenvalues greater than 1 are extracted, which results in 2 factors. Rotation optimizes the factor structure and the relative importance of the 2 factors is equalized. Finally, eigenvalues after rotation associated with each factor represent the variance explained by that particular linear component, having excluded other factors also presented in percentage of variance explained. Factor 1 explains 65,026% of total variance explained and the 2 factors explain together 75,824%.

Communalities in the extraction column reflect the common variance in the data structure. The amount of variance in each variable that can be explained by the

retained factors is represented by the communalities after extraction. According to Kaiser criterion the average of the communalities should be more than 0.7 after extraction when there are less than 30 variables in the analysis and we have a small sample.

However, a Scree plot is used to assess the final number of factors (Figure 3).

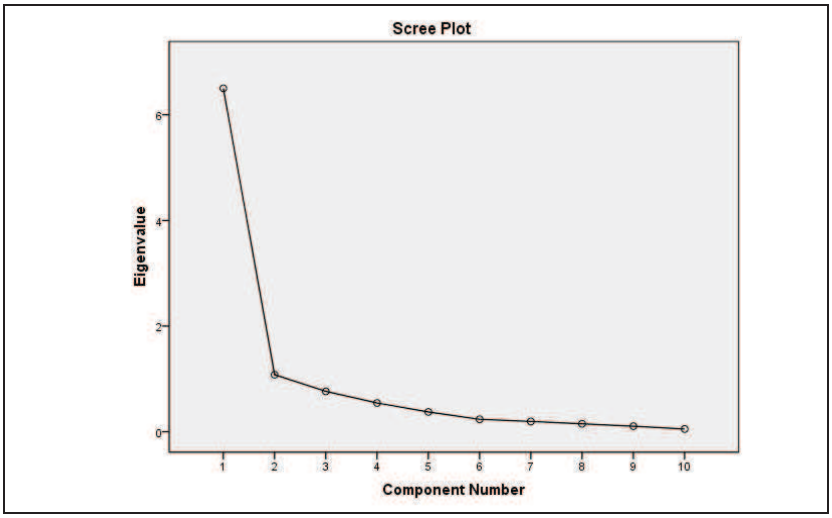

Figure 3. Scree plot

It is evident in Figure 3 that the curve begins to tail after 2 factors.

Table 5 presents the rotated component matrix, where rotation method was Varimax with Kaiser normalization. It is a matrix of the factor loadings for each variable onto each factor. The variables are listed in the order of size of their factor loadings.

Table 5. Rotated Component Matrix

	Component	
	1	2
V16	**,858**	
V12	**,804**	,378
V7	**,801**	,384
V13	**,765**	,473
V1	**,544**	,494
V8		**,872**
V4	,316	**,809**
V9	,461	**,782**
V11	,608	**,684**
V14	,557	**,655**

In Table 6 are presented the questions of the questionnaire that load highly in factors 1 and 2. These two constructs are sub-components of "climate change" in the firm.

Table 6. Questions loaded in the 2 extracted factors

Factor 1.
Is there a strong commitment between firm and the customers?
Is there a strong commitment between the firm and 3rd Party Logistics suppliers?.
Is the firm satisfied with the level of cooperation with carriers?
Are the carriers reliable?
Are the suppliers reliable?
Factor 2.
The exchange data system between the firm and suppliers is satisfactory??
The exchange data system between the firm and carriers is satisfactory??
The exchange data system between the firm and customers is satisfactory??
Is the firm satisfied with the level of cooperation with suppliers?
Is there a strong commitment between firm and carriers?

Also, component scores coefficient matrix is presented in Table 7.

Table 7. Component Score Coefficient Matrix

	Component	
	1	**2**
V1	,095	,064
V4	-,146	,328
V7	,272	-,096
V8	-,309	,464
V9	-,060	,256
V11	,055	,145
V12	,276	-,100
V13	,218	-,032
V14	,039	,149
V16	,439	-,315

4 Conclusion

Using factor analysis we have expressed all 10 of the original 20 variables that describes the "transaction climate" in an agri-food firm, as linear combinations of the fewer, derived 2 factors. The 2-factor model has to be further confirmed in a second sample.

Decisions regarding the adoption of new information technologies in supply chain management in the Greek food and drink industry are not affected by most of the factors investigated by many researchers in the past. Nevertheless, the following can be summarized.

Businesses sense the risk of development and its speed. In their effort to move forward to the latest technologies, they make choices and decide to adopt those technologies that would make the company more profitable, or, will help, at least, in this uncertain period, to maintain the existing profit.

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