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Supply Chain Management Information Systems and Organisational Performance in economic turbulent environments

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Abstract Supply Chain Information Systems (SCIS) and their impact on organisational performance has been studied by a number of studies. This research seeks to extend this body of knowledge by adopting a fresh lens to explore empirically the relationship between organisational performance and SCIS in circumstances of economic downturn and financial turbulence. The statistical relationship between Supply Chain Information Systems' (SCIS) 'Effectiveness' and 'Organisational Performance' is tested and measured by financial and non-financial variables. So, even though complexities associated with measuring SCIS efficiency and Organisational Performance continue to dominate research discussions, these are somewhat limited to just explaining the phenomenon without addressing the misalignment of the information provided by SCIS, business expectations and Organisational Performance. In consequence, this paper reports findings from a large survey of 168 SCIS managers in Greek SMEs where, even during economic downturn, a strong correlation between SCIS and non-financial Organisational Performance is evidenced. In considering the findings, this study proposes guidance to enhance SCIS Effectiveness and Organisational Performance.

Key words: SCM Information Systems, Financial and non-Financial measures, Balanced Scorecard, Organisational Performance

I. INTRODUCTION

Studies suggest that Supply Chain Management (SCM) is a key strategic factor for increasing organisational effectiveness and for realisation of organisational goals such as competitiveness, enhanced customer care and increased profitability [1]. Organisations view their supply chains as critical determinants of efficiency and effectiveness in particular when facing turbulent business environments that demand shorter product lifecycles and rapid market fluctuations. Towards this recent studies have highlighted the importance of dynamic information exchange and information systems (IS) alignment with organizational strategic priorities [2].

Availability of key operational information such as inventory levels, delivery schedules and lead times become critical to guide decision making during rapidly changing market environments ([3], [4]). Information sharing across the supply chain allows collaborators to retain the visibility that is needed to act upon changing business conditions, however the degree of visibility impacts performance gains within the supply chain ([5], [4]). There is an assumption that 'competition is no longer between organisations but through their supply chains'. As such, research interest has focused on supply chain

practices, supply chain performance and organisational performance [6]. For example, a survey of Taiwanese manufacturers, found that supply chain practices have an indirect impact on financial performance [7], whereas a survey of US manufacturers found a strong relationship between supply chain practices and organisational performance [8]. These findings were also confirmed by further research that tested the impact of supply chain information strategy on supply chain performance and organisational performance [2]. The reported results confirmed a significant and positive link between supply chain performance and firm performance.

However, empirical research examining the relationship between SCIS and Organisational Performance is somewhat limited in unstable economic settings. The current complex economic and technological environment in Greece, where organisations face more challenges as they struggle to remain profitable and competitive is the motivation for this study. We wish to addresses this gap by offering a theoretical and empirical basis for exploring the impact of SCIS on the performance of organisations, measured by financial and non-financial factors.

II. LITERATURE REVIEW

The literature review considers the important questions of SCIS efficiency measurement and how it impacts on the performance of SME organizations. In addition this paper studies these theoretical questions under a researchcontext of current economic austerity measures that have been implemented in Greece thus providing an opportunity to introduce the conditions in which Greek Small and Medium Companies (SMEs) operate.

The performance of a supply chain often relies on the infrastructure of the information system in which provides the necessary functional support to the information supply chain [9] (Lau and Lee, 2000). SCIS perform certain tasks within the context of supply chain and networks [6] (Goswani et al 2013). SCIS complement and supplement the physical supply chain for the efficient performance of the whole supply chain network [9]. SCIS have become prevalent in the business environment and have evolved significantly over the last two decades as web technologies rapidly grow [10] and cloud computing advances [11]. So organisations have to adapt their SCISs to keep up with technological changes as well as to support complicated and sophisticated business requirement changes. SCIS provide an infrastructure to facilitate the exchange of data among various value chain components for coordination and monitoring the operations within the supply chain. The ability of an organisation to exploit the capabilities / benefits offered by SCIS became the key motivator of this paper which

aims at exploring the relationship between SCIS effectiveness and Organisational Performance.

Organisational performance is a continuous open research question with many studies using it as their 'ultimate dependent variable' [12] with diverse measures and different definitions [13]. Scholars have utilised a variety of indicators and variables to define and measure Organisational Performance reflecting their research backgrounds. Modern operations management theories and concepts such as the balanced scorecard measure Organisational Performance from the perspectives of financial, customer, internal process and learning and growth [14]. The authors view organisational performance "as a term that encompasses three specific areas of firm outcomes: (a) financial performance (profits, return on assets, etc.); (b) product market performance (sales, market share, etc.); and (c) shareholder return (total shareholder return, etc.)".

Formulating Research Questions

The academic background of this paper draws from the Information Processing Theory (IPT) which considers organisations "as information processing entities that collect, analyse, and coordinate information" to facilitate operational and strategic decision-making [18]. Using IPT as the theoretical lens to guide implementation of SCIS would mean that information produced by the system should be effective to enhance operational and strategic decision-making. Adopting IPT would involve using a number of structural means such as rules, procedures and lateral communication mechanisms or through the application of IS [2]. Scholars also argued that in addition to the aforementioned rules and procedures, weaving holistic SC strategy alignment (i.e. supply chain information processing needs) with relevant supply chain IS strategies (i.e. supply chain information processing abilities) would amplify performance benefits.

Schoenherr and Swink, (2012) [15] adopted IPT to supply chain processes, and their research showed that integration of external (i.e. supplier and customer facing) processes leads to improved supply chain performance and that integration of internal (i.e. intra-firm logistics, operations and supply chain management) processes positively moderates this relationship. In other words, the implementation of Information Systems should integrate the Supply Chain processes in a way that the whole supply chain is managed effectively [16] which in turn can have a positive impact on Organisational Performance. In light of the above analysis this paper explores how Supply Chain Information Systems (SCIS) affect Organisational Performance when this is measured with financial and non-financial measures. The research questions we seek to answer here are:

RQ1: Is Supply Chain Information Effectiveness positively related to organisational performance in financial measures

RQ2: Is Supply Chain Information Effectiveness positively related to organisational performance in non-financial measures

Eight items were used for the operationalisation of SCIS Effectiveness (independent construct). These are based on the Information Systems strategy for efficiency (ISSE) and flexibility (ISSF) measures developed by Sabherwal and Chan (2001) and used by Chang and King (2005) and recently tested by Qrunfleh and Monideepa (2014) ([17], [16], [2]). For the operationalisation of Organisational Performance (dependent construct), the study used 26 items representing the four Balanced Scorecard (BSC) perspectives ([18], [19]). Financial measures incorporated traditional measures like income, profit, and costs. Non-financial measures, on the other hand, meant to measure the organisational performance in relation to customers (e.g. customer satisfaction- retention), innovation and forecasting ability, organisational flexibility etc.

III. METHODS AND ANALYSIS

This study was executed in 4 phases: (1) Large-scale data collection, (2) Sample Characteristics. (3) Exploratory Factor analysis to reduce a large set of variables identified in the literature to a manageable number of factors whilst, however, maintaining as much as possible the original variance (Fabrigar et al. 1999) and (4) Hypothesis development and testing using multiple regressions analysis. These phases are described in the following paragraphs.

Large Scale Data collection

Data for this study were collected by means of a Web-survey across a sample of 700 Greek companies of different sizes operating in various industries. A web-link was provided to the IT managers of the targeted companies who were considered to be the most knowledgeable respondents [20]. This web survey started on April 2010 with a pre-notification inviting the IT managers to participate in our research and a link to the survey was sent one week later with another cover letter. Two reminders were issued subsequently one week after the first call notifying those that had not responded of a forthcoming deadline for the closing of the questionnaire. 168 usable responses were collected from different industries and company sizes.

Non-response bias

The Mann–Whitney test was run between late and early respondents to examine the null hypothesis that there is similarity in all the variables across the early and late respondents. The test showed that no significant differences were found among the variables used. As a result, we could argue that non-response bias was not an important issue and the data were unlikely to be biased of non-response errors.

Descriptive Statistics

Table I shows that the participating companies represent many different industries with nearly 60% of the companies in manufacturing, pharmaceuticals and diary firms followed by commercial firms /retailers (25%) and services like banking, hospitals and consulting companies (15%).

Table 1-Industry classification

Type of industry	Number of responses	Percentages
Manufacturing and construction	99	60%
Commercial	42	25%
Services	27	15%

As it is seen in table II, the sample comprised mainly companies employing more than 50 people which was expected as this had been determined for our targeted group as micro SMEs were unlikely to have implemented IS for our research.

Table II Number of employees

No of employees	Frequency	%	Valid Percent	Cumulative Percent
<50	17	10.1	10.1	10.1
50 -100	53	31.5	31.5	41.7
100-250	46	27.4	27.4	69.0
250-500	27	16.1	16.1	85.1
>500	25	14.9	14.9	100.0
	168	100.0	100.0	

Assessing Common method Bias

Since data were collected from a single respondent from each firm, we tested for common method bias using Harman's single factor test. It should be noted that all possible measures were taken as suggested by the literature to avoid Common, Method Variance: "identification of the most informative person, attempt to motivate key informants to co-operate with the study, minimisation of elapsed time, consideration of the impact of alternate framing of questions and finally, the use of pre-tested and structure questions" ([21], [22]). The Harman's single factor test, when using exploratory factor analysis, showed that no single factor accounted for the majority of the variances explained, which means that common method bias was not a major concern in our research [21]

Before proceeding to any statistical test, the variables were tested for normality. All skewness values were much less than ± 2 and all kurtosis values were much less than ±7. The cut off points are: for skewness < ± 2 and kurtosis < ± 7 [23].

Factors extracted from the Exploratory Factor Analysis

Exploratory Factor Analysis (EFA) was followed as there was limited empirical basis regarding the number of the a priori factors that could exist [24]. We followed the steps and advice recommended by Fabrigar et al (1999) to "arrive at parsimonious model and extraction of the common factors needed to account for the pattern of correlations among the measured variables" (p. 277) [24]. Varimax and Promax rotation techniques were employed but the final decision favoured Promax to test the reliability of the scales and obtain the minimum number of factors. The latent root criterion, the scree test and the percentage of variance explained were used in the analysis [25]. Cut off point for item loading was 0.5 and the

Promax rotation, the pattern mix indicated 5 extracted factors: One factor could be attributed to the dimension of SCIS effectiveness and four factors were extracted for the measurement of organisational performance. The reliability test results along with the new factor names are depicted in table III.

Table III Factors extracted from EFA

Factor Name	Cronbach a
SCIS effectiveness	0.894
Growth and development	0.962
Dynamism and Vigilance	0.955
Financial performance	0.940
Marketing performance	0.942

All the extracted factors satisfied the statistical and conceptual criteria for acceptance, and were included in the proposition tests. In this research, reliability analysis was performed in order to assess the internal consistency of the factors. Reliability was assessed by using Cronbach's Alpha coefficient (Cronbach, 1951), which is the most common way to estimate the reliability of such scales (Nunnally, 1994). Nunnaly's (1994) threshold level of acceptable reliability being an alpha coefficient of 0.70 or greater was adopted. All scales were found to satisfy this criterion with Cronbach's a coefficient comfortably higher than the cutoff point of 0.70 (Hair et al, 2010).

The SCIS effectiveness factor measured the perception of the respondent's regarding the information produced by the company's systems in terms of supplier control, product flow, reduction of process time and cost etc.

The Growth and development factor contained variables that measure the organisation's ability and flexibility to grow by sharing information in a timely and comparative manner (information sharing and cooperation between departments, timely decision making etc).

The Dymanism and vigilance factor contained variables that measure the organisation's ability and flexibility to learn and respond fast to changes (new product/service development, defect free deliveries, range of new products, innovation capability etc)

The Marketing performance factor referred to a firm's ability to perform competitively e.g. customer retention and customer satisfaction, on-time delivery etc.

The Financial performance factor referred to typical financial measures such as income, various costs and gross profit.

In light of the extracted factors, four hypotheses were formed (see fig 1).
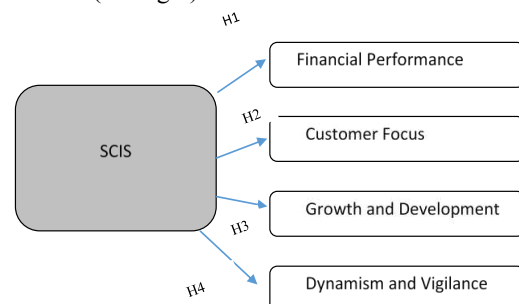
For the purposes of this research, the SCIS Effectiveness factor was considered as the independent variable (IV) and the factors that measured Organisational Performance became the dependent variables (DVs).

Hypothesis testing

Previous studies in the SC literature supported a positive relationship between Supply Chain performance and Financial Performance. Hendricks et al. (2007) argued that ERP and SCM integration can help firms increase profitability. [28]. We hypothesise that

H1: Financial Performance increases if Supply Chain Information Effectiveness (SCIE) increases

Similarly, there is a high correlation between supply chain systems and non-financial firm performance because effective IS will help companies adapt to changes introduce and deliver products that are likely to meet changing demand [29]. We hypothesise that

H2: Marketing Performance increases if SCIE increases
H3: Growth and Development increase if SCIE increases
H4: Dynamism and Vigilance increase if SCIE increases

The next step of the analysis was to discuss and investigate the related statistics of the regression models. A critical part is the measurement of goodness-of-fit of the model and the statistical significance of the estimated parameters. The common measure for the goodness-of-fit is the R^2. The statistical significance of a regression coefficient can be measured when using an F-test of the overall fit, followed by t-tests of the individual parameters. [30]. The F-test is, in simple words, the ratio of the explained to unexplained variance in the equation which means that when the F statistic is greater than the critical value of F, it can be accepted that the regression equation is statistically significant (Bowerman et al., 2005).

The results from the statistical tests show a positive correlation between SCIS Effectiveness and all Organisational Performance factors. To assess the statistical significance of the results we checked the ANOVA model summary which tests the hypothesis that multiple R in the population equals 0. All four models reached statistical significance (sig.=.000 meaning p<.0005) and all hypotheses are accepted. In this exploratory research, it is found that Supply Chain Information Effectiveness has a positive impact on the financial and non-financial performance of an organisation. Looking at the model summary box (Table IV), we see that the financial performance has the lowest R^2. The highest R^2 value is .454 for the correlation with Growth and Development. This means that 45.4 % of the variance in our dependent factor Growth and Development is explained by Supply Chain Information Effectiveness. Interpreting the statistical finding, it can be argued that the quality of the information produced by SCIS can become a strong contributor for a firm that wishes to grow by sharing the right information in a timely and comparative manner.

Table IV results from the Hypothesis tests

	R²	Beta	F	Sig	Result
Financial Performance increases if SCIE increases	0.350	0.591	89.313	0.000	accepted
Marketing Performance increases if SCIE					
Growth and Development increase if SCIE Effectiveness increases	0.454	0.615	137.948	0.000	accepted
Dynamism and Vigilance increase if SCIE increases	0.394	0.628	108.007	0.000	accepted

IV DISCUSSION-CONTRIBUTION

The study makes a number of contributions. First, it theoretically explains and empirically demonstrates how and why SCIS can affect organizational performance. Our results reinforce previous findings from Hendricks et al. (2007) who argued in favor of ERP and SCM integration which can help a firm gain competitive advantage. These findings are further confirmed by a recent publication from Ganesh Kumar and Nambirajan, (2013). Following a comprehensive review of the older and more recent literature, this study identified the items used by researchers for the measurement of both constructs. Exploratory Factor Analysis was employed as there was no theoretical basis to specify a priori the number and patterns of common factors [32]. especially for the extraction of factors measuring the non-financial performance of a firm. In this regard, it would be logical to say that this paper contributes to the SCM field by providing scales for financial and non-financial performance constructs, and by exploring how those are improved by the adoption of specific Supply Chain Information Systems.

Contribution to the field of Organisational Performance

In realising the value of both financial and nor-financial performance, this study used the balanced scorecard [18,19] to derive conclusions for Organisational performance. Motivated by the BSC approach, we conducted a comprehensive literature review to identify which items had been adopted in related studies and how they had been used. The financial measures that were used captured the way the key informants see the impact of SCIS on the financial performance of a firm [33].

The non-financial measures included the impact of IS on customers [32] market position and strategic objectives [33] and several items found in the recent literature capturing internal capabilities

4 distinct factors were extracted from the Exploratory Factor Analysis that can be related to the four BSC perspectives. The financial performance clearly comprises items of financial nature. Marketing performance is the factor that reminds of the customer perspective as it includes customer oriented variables. The growth and development factor measures the ability of the company to develop and expand in the internal and external environment. The dynamism and vigilance factor measures the ability of a company to learn and respond fast. The names of the last two factors are new in the literature and we believe that they can be further used in future research by academics that wish to employ non-financial constructs and items.

Limitations and future research directions

The first limitation was the timing of the research.

disappointment if not frustration and managers did not really have the enthusiasm and the time to complete our rather long questionnaire. Despite the various measures taken to increase response rate, we managed to collect 168 answers from a sample of 700 IT managers.

The second limitation can be the nature of the study which is cross-sectional. This makes it difficult to infer conclusions about cause and effect relationships. A longitudinal design could examine the answers form the same sample and same model. This will introduce time lag between the measurement of the predictors and dependent constructs, (Podsakoff et al., 2003 Reio 2010). In this way, future research can be directed towards a confirmatory factor analysis to establish the construct validity of the scales and to shed more light on the factors that are more instrumental to the success of Supply Chain Information Systems.

REFERENCES

[1]   Ganesh, Kumar C. and Nambirajan, T. (2013) "An Integrated Model for Supply Chain Management Components, Supply Chain Performance and Organizational Performance: Purification and Validation of a Measurement Instrument", The JournalContemporary Management Research, Vol.8, No. 2, pp.37 - 56.

[2]   Qrunfleh, S. and Monideepa, T. (2014), "Supply chain information systems strategy: Impacts on supply chain performance and firm performance", International Journal Production Economics, Vol. 147, No. Part B, pp. 340-350.

[3]   Gunasekaran, A and Ngai, E.W.T (2004) "Information systems in supply chain integration and management", European Journal of Operational Research, Vol. 159, No. 2, pp. 269–295

[4].   Vickery,S.K, Jayaram, J., Droge, C. ,Calantone,R.(2003) The effects of an integrative supply chain strategy on customer service and financial performance: an analysis of direct versus indirect relationships, Journal of Operations Management, 21 (5) pp. 523–539.

[5]Lee, H.L. (2002), "Aligning supply chain strategies with product uncertainties", California Management Review, Vol. 44 No.3, pp.105–119.

[6] Goswami, S., Engel, T., Krcmar, H. (2013) "A comparative analysis of information visibility in two supply chain management information systems", Journal of Enterprise Information Man,Vol 26,3, pp.276 – 294

[7] Ou, C.S., Liu, F.C., Hung, Y.C., & Yen,D.C., (2010), "A structural model of supply chain management on firm performance", International Journal of Operations and Production Management, Vol. 30, No.5, pp 526-545.

[8] Cook, L.S., Heiser, D.R., & Sengupta, K., (2011) "The moderating effect of supply chain role on the relationship between supply chain practices and performance: an empirical analysis", International J of Physical Distribution & Logistics Management, Vol. 41, No.2, pp104-134

[9] Lau, H.C.W. and Lee, W.B. (2000) "On a responsive supply chain information system", International J of Physical Distribution& Logistics Management,Vol.30, 7/8, pp.598- 610

[10]Cheng, F., Yang, H., & Huang, E. E. (2002). Develo pment of an educational supply chain information sytemusing object web technology. JournalOf Chinese Institute Of Engineers, Vol 6, pp735-752.

[11] Wu, Y., Cegielski, C. G., Hazen, B. T., & Hall, D. J. (2013). Cloud Computing in Support of S upply Chain Information System Infrastructure: Understandingto go to the Cloud. Journal Of SupplyChain Management, 49 (3), pp. 2541.

[12] Cameron, K.S. (1986) 'A study of organisational effectiveness and its predictors', Management Science, 32(1):87-112.

[13] Kirby, J. (2005) 'Toward a theory of high performance', Harvard Business Review, 83:30–39.

(2009) 'Measuring Organisational Performance:Towards Methodological Best Practice', Journal of Management, 35(3):718-804

[15] Schoenherr and Swink, (2012), "Revisiting the arcs of integration: Cross-validations and extensions', *Journal of Operations_Management,*Vol 30, Iss1–2, Pages 1-166

[16] Chang, Cha-Jan J. and King, W. R., (2005), "Measuring the Performance of Information Systems: A Functional Scorecard", Journal of Management Information Systems, Vol. 22, No. 1, pp. 85-115.

[17] Sabherwal, R. and Chan, Y.E (2001), Alignment between business and IS strategies: a study of prospectors, analyzers, and defenders, Information Systems Research, 12 (1) pp. 11–33

[18] Kaplan, R.S. and Norton, D.P. (1992), "The balanced scorecard-measure that drive performance", Harvard Business Review, Vol. 70, No. 1, pp.71-79.

[19] Kaplan, R.S. and Norton, D.P. (2005), "The balanced scorecard: measures that drive performance", Harvard Business Review, Vol. 83, No. 7/8, pp.172-180.

[20] Forza, C. (2002) "Survey research in operations management: a process-based perspective", International Journal of Operations & Production Management, Vol. 22, No.2, pp.152-194

[21] Podsakoff, P.M., MacKenzie, S.B., Lee, J.Y. and Podsakoff, N.P. (2003), "Common method biases in behavioural research: A critical review of the literature and recommended remedies", Journal of Applied Psychology, Vol. 88, No.5, pp.879-903.

[22] Reio, Jr.T.G. (2010) 'The Threat of Common Method Variance Bias to Theory Building', Human Resource Development Review, Vol. 9, No.4, pp.405-411.

[23] Curran, P.J., West, S.G. and Finch, G.F. (1996) "The robustness of test statistics to nonnormality and specification error in confirmatory factor analysis", Psychological Methods, Vol. 1, No.1, pp 16–29.

[24] Fabrigar, L.R.; Wegener, D.T.; MacCallum, R. C&; Strahan, E.J. (1999) Evaluating the use of exploratory factor analysis in psychological research, Psychological Methods, 4(3):272-299.

[25] Hair, J.F., Black, W.C., Anderson, R.E., Babin, B.J (2010) Multivariate Data Analysis with Readings. 7th edn. New York: Pearson Publishing.

[26] Cronbach, L.J. (1951) "Coefficient alpha and the internal structure of tests",Psychometrika,Vol 16, No3,pp.297-335. Galbraith, J. (1973) Designing Complex OrganizationsReading, Addison-Wesley Longman Publishing Co, MA. [27] Nunnally, J.C. and Bernstein, I.H. (1994) Psychometrictheory. 3rd ed. New York: McGraw-Hill.

[28] Hendricks, K.B., Singhal, V.R. and Stratman, J.K. (2007) "The impact of enterprise systems on corporate performance. A study of ERP, SCM, and CRM system implementations", Journal of Operations Management, Vol. 25, No. 1, pp.65-82

[29] Sanchez, A. and Perez, M. (2005) Supply chain flexibility and firm performance International Journal of Operations and Production Management, 25 (2005), pp. 681–700

[30] Bowerman, B.L., O'Connell, R.T. and Koehler, A.B. (2005) Forecasting, time series, and regression: an applied approach. 4th edn. Cole Belmont CA: Thomson Brooks.

[31] Hurley, A. E., Scandura, T. A., Schriesheim, C. A., Brannick, M.T., Seers, A. and Vandenberg, R.J. (1997) "Exploratory and confirmatory factor analysis: Guidelines, issues, and alternatives", Journal of Organizational Behavior, Vol. 18, No. 6, pp. 667–683.

[32] Nicolaou, A.I. (2004) 'Quality of post-implementation review for enterprise resource planning systems', International Journal of Accounting Information Systems, Vol. 5, No.1, pp.25-49.

[33] Grover, V. and Davenport, T.H. (2001) 'General perspectives on knowledge management: Fostering a research agenda', Journal of Management Information Systems, Vol. 18, No. 1, pp.5-21.