A broad-spectrum orientation of supply chain network integration challenges: an empirical investigation using PLS path modelling

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Abstract: In order to achieve efficient supply chain integration for the processes or activities; the organisations should recognise and understand all the integration challenges of supply chain and the relations between those challenges. Our goal in this paper is to construct a novel statistical model that explores all challenges of supply chain integration and the relations between them. In this paper, we validated our proposed model through an empirical investigation using partial least square (PLS) path modelling.

Keywords: supply chain; supply chain integration; challenges of supply chain integration.

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1 Introduction

To succeed in the digital economy, organisations must manage the integration of business, technology, people, and processes not only within the enterprise but also across extended enterprises. Supply chain management (SCM) system facilitates inter-enterprise cooperation and collaboration with suppliers, customers, and business partners. Although this system can bring benefits and competitive advantage to organisations, the management and implementation of this system pose significant challenges to organisations. Process integration and redesign is important component in SCM implementations. Integration involves not only implementing enterprise resource planning (ERP) systems and ensuring they communicate or interface with legacy systems, but it also involves integrating ERP and SCM systems with customer relationship management (CRM), product lifecycle management (PLM), e-procurement and e-marketplaces, as well as making them available over the web to foster cooperation and collaboration across the entire value chain. In today's dynamic business environment, many companies are expanding, merging, contracting, or otherwise redesigning their supply chain. Due to the rapid advancements of technology such as pervasive or ubiquitous wireless and internet networks, the basic supply chain is rapidly evolving into what is known as a supply chain network. The supply chain network is a dynamic and integrated system in which all firms integrated to increase the value of every chain. Integration is a process of redefining and connecting parts of a whole in order to form a new one (Juanqiong et al., 2007).

In the 21st century, there have been a few changes in business environment that have contributed to the development of supply chain networks. First, as an outcome of globalisation and the proliferation of multi-national companies, joint ventures, strategic alliances and business partnerships, there were found to be significant success factors, following the earlier 'just-in-time', 'lean management' and 'agile manufacturing' practices. Second, technological changes, particularly the dramatic fall in information communication costs, which are a paramount component of transaction costs, have led to changes in coordination among the members of the supply chain network (Chopra and Meindl, 2001). These factors created many challenges to the integration of supply chain network.

2 Supply chain integration

A supply chain consists of all stages involved, either directly or indirectly, in fulfilling a customer request. A supply chain includes manufacturer, supplier, transporters, warehouses, retailer, third-party logistic provider, and customer. The objective of SCM is to maximise the overall value generated rather than profit generated in a particular supply chain (Simchi-Levi et al., 2000). The US Professional Association defined the SCM, "Supply chain management encompasses the planning and management of all activities involved in sourcing and procurement, conversion, and all logistics management activities. Importantly, it also includes coordination and collaboration with channel partners, which can be suppliers, intermediaries, third party service providers, and customers" (CSCMP, 1984).

Throughout the 1980s and 1990s the concepts of customer and supplier integrative relationships gained renewed attention. Business in general began to develop extremely

close relationships with selected clients, sometimes termed strategic customers, and significantly more emphasis was placed on improving working arrangements with suppliers. This trend with increased collaboration throughout the SC could be explained as a result of three factors (Brown, 1998), these factors are:

- manufacturing takes place in a global context where local markets are subject to global standards
- manufacturing systems are required to develop and operate environmentally benign products and processes
- the business and organisational structures, within which manufacturing operates, are under increasing stress.

The driver behind such collaboration was the desire to extend the control and coordination of operations across the entire supply process, replacing both the market and vertical integration as the means of managing the flow process (Larsen, 2003). According to Lee and Whang (2001), the definition of integration is "the quality of the state of collaboration that exists among departments that are required to achieve unity of effort by the demands of the environment". While this definition refers to integration internal to a firm or organisation, our emphasis here goes beyond the firm and encompasses external entities that are players in a supply chain.

Recent development in SCM offers the potential not just to cut cost but also to generate new revenues and high profits. The remaining challenge is to link those novel approaches together to garner the competitive advantage of a seamless flow of SC (Larsen, 2003).

3 Challenges and obstacles of supply chain integration

SCM executives face unique challenges, with respect to integrating supply chain-specific strategies with the overall corporate business strategy. In recent years, given changing business realities related to globalisation, the supply chain has moved up on the chief executive officer's (CEO) list of priorities (Ales, 2009), but it is not always for the right reasons, in many cases, CEOs only pay attention to the supply chain when they want to cut costs or when something is wrong. Since the supply chain essentially moves the lifeblood of the organisation, process efficiency on a global scale is essential to optimised business operations. The importance of global integration to the multi-national company (MNC) lies in the differential advantage to be gained from the ability to exploit differences in capital and product markets, to transfer learning and innovation throughout the firm, and manage uncertainty in the economic or political environment in different countries or regions. However, the general understanding of the business environment in most industries is that competition has increased and the conditions under which business is made are more turbulent (Morten, 2003).

After extensive reading to the supply chain integration challenges that the literature mentioned in different resources we found that the researchers take two direction; first: researches try to enumerate the challenges from one perspective such as Phillip and Ropert (2009), Pender (2001), Tom (2009), Peter (2000), Jaffer and Khatib (2004), Karkkainen and Ala-risku (2003), Kelly (2007), Hewlett-Packard (2004), McDermott and Chan (1996), Boxall (1991), Craft (2006), Lesley (2007), McGuffog and Wadsley (1999),

Gunasekaran et al. (2004), Bass et al. (2003), Hussain and Mohammad (2010a), second researches try to enumerate and classify the challenges such as Stanley et al. (2005), Kussman (2005), Paigude (2005), Macpherson (2001) and Deep (2005).

The researchers in the previous tow directions discuss the challenges from three perspectives:

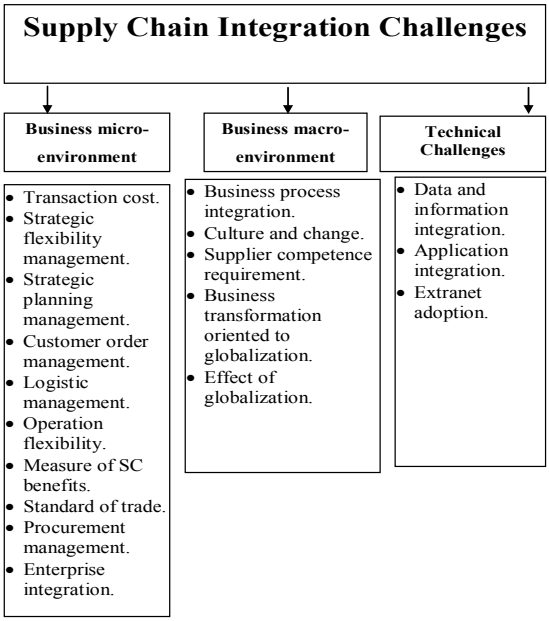
- technical perspective (Pender, 2001; Peter, 2000; Jaffer and Khatib, 2004)
- managerial perspective (Hewlett-Packard, 2004; McDermott and Chan, 1996; Boxall, 1991; Lesley, 2007; McGuffog and Wadsley, 1999; Gunasekaran et al., 2004; Bass et al., 2003, and others)
- relationships perspective (Jaffer and Khatib, 2004; Karkkainen and Ala-risku, 2003; Kelly, 2007; Hewlett-Packard, 2004; Ezutah and Kuan, 2009).

We found that the previous two directions did not include the following issues:

- no paper was able to present all supply chain integration challenges
- no paper was able to introduce a comprehensive classification that includes all perspectives (technical, managerial, and relationship).

A recent paper which was introduced by Hussain and Mohammad (2010b) was able to deal with the previous two issues. Hussain and Mohammad (2010b) introduced a comprehensive classification that encompasses all the challenges mentioned in the literature, Hussain and Mohammad divided the challenges into three main categories (classes), each main category encompasses a number of sub-challenges (see Figure 1).

Figure 1 Classification of challenges of SCN integration



Source: Hussain and Mohammad (2010b)

In this paper, we are going to construct and validate a new and novel statistical model based on Hussain and Mohammad classification. To the best of our knowledge, this statistical model is not available in the literature.

To test the validity and the reliability of the proposed statistical model we will conduct an empirical investigation using partial least square (PLS) path modelling. According to PLS methodology we proposed two kinds of hypothesis:

Measurement model hypothesis: this kind of hypothesis will be used to validate the relation between sub-challenges and their class.

Structural model hypothesis: this kind of hypothesis will be used to validate the relation between the classes.

3.1 Measurement model hypothesis

3.1.1 Business micro-environment challenges

This part of challenges related to the challenges that effect the supply chain integration from inside the organisation's environment.

Transaction costs

The decision to outsource business processes and create a supply chain outside the organisation requires an assessment of where the boundary of the organisation should reside. As such, an economic assessment is required of the various merits of integration versus market provision, thus, the decision is based on a transaction costs approach where there is an "examination of the comparative costs of planning, adapting and monitoring task completion under alternative governance structures" (Williamson, 1981). The outsourcing decision is focused primarily on the management of recurrent transactions; the key dimensions of this context are the uncertainty and asset specificity germane to the transaction. Since these dimensions will vary, this creates a variety of contexts and the result will be diversity within governance structures.

This lead to the hypothesis:

H1.1 There is a direct significant relationship between transaction cost and the business micro environment supply chain network integration challenges.

Strategy and planning

SCM is an essential component of long-term business competitiveness, so it is sensible to consider how SCM relates to strategy theory and concepts (Steve, 2009). An effective supply chain must be able to cope with uncertainty; it follows that it must also be flexible. Therefore, SCM will be one of the organisational processes, or functions, that are a key to strategic success if the organisations look for achieving its mission in an adaptive and changing environment (Hewlett-Packard, 2004).This lead to the hypothesis:

H1.2 There is a direct significant relationship between strategy and planning (strategic flexibility management and strategic planning management) and the business micro environment supply chain network integration challenges.

Customer order management

Customers are becoming more demanding; their expectations are evolving toward greater levels of service and response with higher degrees of product and service customisation (IBM, 2008). Value chain partners (suppliers, and service providers) integrated to provide differentiated customer segment product/service bundling and superior customer service levels. Increased profitability is the top driver of customer order management performance. This centred attention on profitability is probably resulting from the economic market conditions of the past few years, but may be a short-term view. Customer responsiveness leads to customer retention and revenue growth. In the longer term view, concentration on customer-facing initiatives and improvements will be significant to profitability achievement (Boxall, 1991).

This lead to the hypothesis:

H1.3 There is a direct significant relationship between customer order management and the business micro environment supply chain network integration challenges.

Logistic management

The supply chain logistics problems facing multi-site companies can be complex, involving multiple stakeholders and constraints across the entire enterprise. The more complex the supply chain, the more difficult it becomes for companies to answer basic questions, such as which crude should they purchase and how should they transport it? Which facilities should process it? What will the best product slate be? Which components should they buy and which should they make? In many cases, different departments or divisions within a company trade, supply chain planning, operations and blending to name a few have a hand in these decisions, but communication among these entities is not always clear or consistent, and each may optimise to their own objectives without regard for others. The results can drastically affect profitability (Craft, 2006).This lead to the hypothesis:

H1.4 There is a direct significant relationship between logistic management and the business micro environment supply chain network integration challenges.

Manage operation flexibility

A firm gains flexibility to quickly realign the supply/demand mix to satisfy changing global demand. Switching costs and coordination costs are a barrier to operating flexibility. Switching costs can be reduced if all SC partners standardising their products and processes globally which is seams to be challenge. Coordination costs can be significant for global integration of cross-functional supply chain processes. A well-structured global demand forecasting and planning process is an important mechanism for global coordination across functions. Regional representation to ensure all relevant input is considered important (Walfried et al., 2009). A globally integrated process with regional representation requires costly resources, information infrastructure, and travel. Globally integrated information systems are critical to reduce the cost of communications and to make relevant information readily accessible or to reduce coordination costs (Lesley, 2007). This lead to the hypothesis:

H1.5 There is a direct significant relationship between operation flexibility and the business micro environment supply chain network integration challenges.

Measure SC benefits

Another problem is that the companies often tend to optimise their own performance, while doing this; companies disregarding the benefits of the SC as a whole (local instead of global optimisation). The maximum efficiency of each chain however does not necessarily lead to global optimisation (Gunasekaran, 2004). In addition, human factors should also be taken into consideration since the decision-makers at various points along the SC do not usually have a whole view to the SC due to the lack of information or their personal hindrances (McGuffog and Wadsley, 1999). This lead to the hypothesis:

H1.6 There is a direct significant relationship between measure of SC benefits and the business micro environment supply chain network integration challenges.

Setting up standards of trade

For small and medium enterprises (SME) and their suppliers, the high cost of technology is exacerbated by the lack of a widely accepted international electronic information standards governing the financial supply chain. The solution is a standard mechanism for communications protocols, rather than many standards. Several organisations have made some headway towards creating such standards, but there are no comprehensive and internally consistent open standards now, which is why automating the supply chain is so costly (Bass et al., 2003). This lead to the hypothesis:

H1.7 There is a direct significant relationship between standard of trade and the business micro environment supply chain network integration challenges.

Procurement management

A typical manufacturing company needs to procure thousands of products from hundreds of suppliers; the challenge here is how to manage the complexity of the procurement process, and establishing a strong procurement infrastructure to execute on strategic supply initiatives, using an empowered organisation structure, fully integrated to the stakeholder and finance organisation. Moreover, people training and development was the key challenge for procurement organisations, includes skill development; the right recruiting and retention practices, and career paths in other functions outside of procurement. That is, how to set up and how to manage global sourcing offices (Gunasekaran, 2004). This lead to the hypothesis:

H1.8 There is a direct significant relationship between procurement management and the business micro environment supply chain network integration challenges.

Enterprise integration

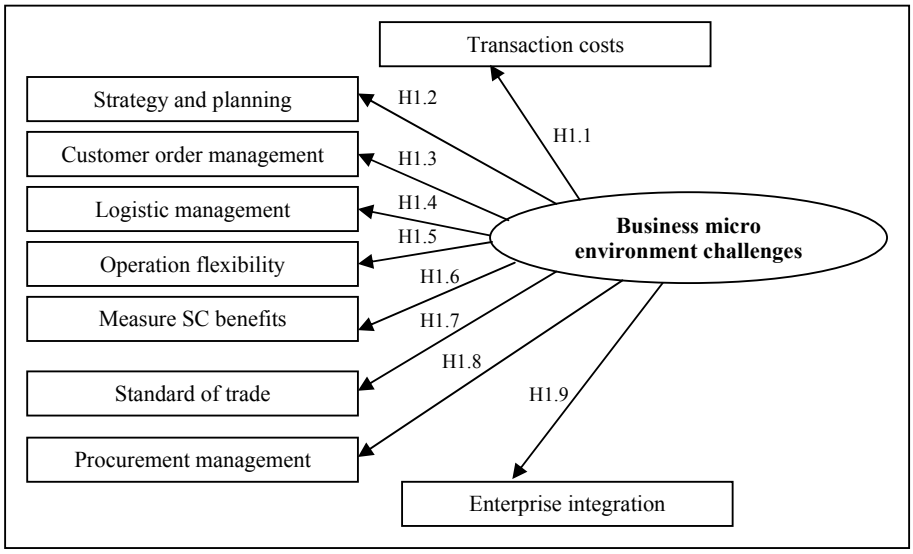
Enterprise integration doesn't happen naturally, it needs to be planned, yet the planning cannot be precise, as business processes and facilitating technologies will change, creating different needs and different potential solutions (David, 2009). The reference architecture efforts mentioned define methodologies for building integrated architectures.

The problem of integration is exacerbated by the limits of human cognition, by behavioural issues, by the difficulty of aligning the goals of individuals with organisational units, and by the relentless need for faster changes (Jaffer and Khatib, 2004). This lead to the hypothesis:

H1.9 There is a direct significant relationship between enterprise integration and the business micro environment supply chain network integration challenges.

Figure 2 shows the proposed hypothesis related to the business micro-environment challenges.

Figure 2 Business micro environment challenges



3.1.2 Business macro-environment challenges

This part of challenges related to the challenges that effect the supply chain integration from outside the organisation's environment.

Business process integration

Processes must be coordinated between all the firms in the value chain to achieve improved performance and service (Chen et al., 2009). This form of external process integration, which is called value chain coordination, is the focus of modern SCM. The e-commerce helps organisations to be able to connect its internal processes with its stakeholders. The challenge in business process improvement is that the processes must be coordinated between all firms in the value chain to achieve improvement in performance and service. Integration must happen between decision making and business process layers which occur whenever human operator (or software agent) makes a decision that change the flow of work through a process. Decision makers must care about the compatibility issues; business process integration effected by compatibility

challenges in a technical, operational, strategic, and political/legal environment (Jaffer and Khatib, 2004). This lead to the hypothesis:

H2.1 There is a direct significant relationship between business process integration and the business macro environment supply chain network integration challenges.

Culture and change

"The pattern of beliefs, values and learned ways of coping with experience that have developed during the course of an organisation's history, and which tend to be manifested in its material arrangements and in the behaviour of its members" (Brown, 1998). This definition of culture clearly foregrounds the cumulative effects of history and experience which have important practical outcomes that are manifest in employee behaviours. This is important for supply chain integration, since the accumulated history of relationships and experience, within and between organisations, will provide part of the context within which the inter-organisational activities are enacted. If there is a drive to closer relations within supply chains, this will involve the replacement of existing governance structures and will challenge existing supply chain behaviours associated with traditional bid-buy relations (Karkkainen and Ala-risku, 2003). This lead to the hypothesis:

H2.2 There is a direct significant relationship between culture and change and the business macro environment supply chain network integration challenges.

Supplier competence requirements

If customers are moving to fewer suppliers, and investing in strategically important supply chain relations, then SME suppliers that cannot make themselves attractive purely through economies of scale and scope must increase their asset specificity and decrease uncertainty. This requires the supplier to invest in activities that are alien to traditional bid-buy supplier interactions. Thus, it will require suppliers to respond to the changing context and develop stronger relational and organisational competences. Since those issues of quality and performance are the baseline measure for the customer-supplier interaction, any existing competences must support the achievement of this standard. Thereafter, it is the capabilities that create differentiation that will be a key (Kelly, 2007). This lead to the hypothesis:

H2.3 There is a direct significant relationship between supplier competence requirement and the business macro environment supply chain network integration challenges.

Globalisation

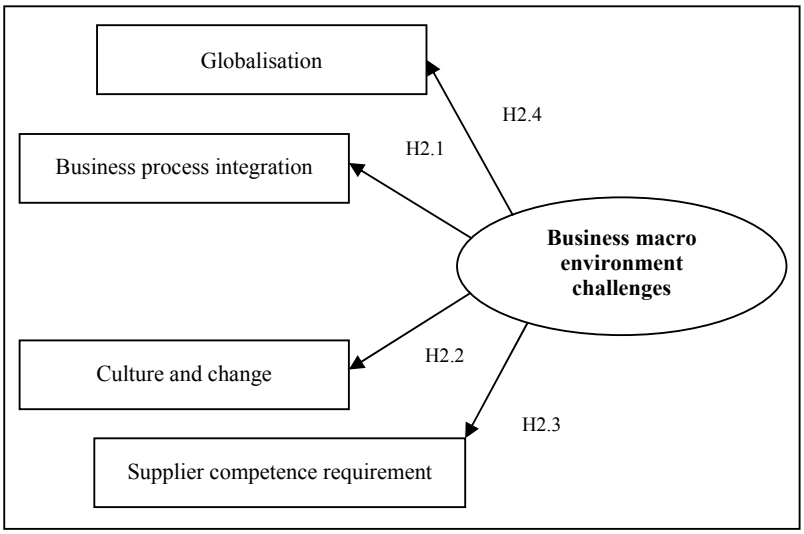
The forces of globalisation and commoditisation in today's business world are unstoppable. Globalisation and commoditisation have created a challenge for companies, which it's how to cut costs and grow simultaneously. During the industrial revolution, companies looked for new markets, new sources of raw material and new sources of labour. The revolution was fuelled by globalisation and companies thrived by taking advantage of economies of scale. Senior executives now understand that they can't just focus on supply chain operations to create efficiencies. The challenge is to integrate supply chain execution with the overall corporate business strategy, and to use the supply

chain as a catalyst for business transformation or business reinvention (Hewlett-Packard, 2004). This lead to the hypothesis:

H2.4 There is a direct significant relationship between globalisation and the business macro environment supply chain network integration challenges.

Figure 3 shows the proposed hypothesis related to the business macro-environment challenges.

Figure 3 Business macro environment challenges



3.1.3 Technical challenges

This part of challenges related to the technical challenges that effect the supply chain integration from inside-outside the organisation's environment.

Data and information integration

Information integration refers to the sharing of information among members of the supply chain. The ability to seamlessly connect with customers, partners, and co-workers is vital for success; yet most enterprises store and exchange data in dissimilar formats, such as databases, electronic data interchange (EDI) systems, text files, and, increasingly, XML-based applications. The ability to map between these different formats is mission-critical. This includes any type of data that could influence the actions and performance of other members of the supply chain (Chen et al., 2009). The meaning of all data items must be understood and the same data item must have the same definition across multiple applications both within and outside the firm. To make the integration process worth the effort, the data must be of high quality, timely, accurate and relevant (Jaffer and Khatib, 2004). This lead to the hypothesis:

H3.1 There is a direct significant relationship between data and information integration and the technical supply chain network integration challenges.

Application integration

ERP systems achieve application integration because ERP vendor-developed applications that perform common business functions are united through a common database (also providing data integration – one of the selling points of ERP systems.) The integration of the functional applications also implies that integration at the next layer, business processes, is achieved. However a major issue with ERP systems is that they fail to bridge the gap between the application and process layers in a flexible fashion. To reach the application integration firms must break down complex processing; to cope with application integration they must support interactive process. Finally applications must integrate with the business processes (Peter, 2000). This lead to the hypothesis:

H3.2 There is a direct significant relationship between application integration and the technical supply chain network integration challenges.

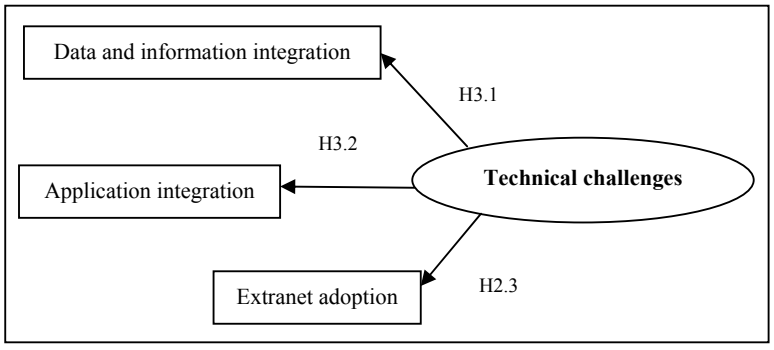
Extranet adapting challenges

There are several issues to consider while adopting extranet as a facility of SC integration. A firm must use systems such as phone, fax, and written record, (instead of relying on the automated supply chain system) and it influences the firm's processes as well (Pender, 2001). Issues that we should consider while adapting the extranet include costs of implementation for extranet adapting, loss of trust in the ability of the new technologies to achieve the desired results, unable to adapt to change because the new changes requires the employees to change their working procedures; this change usually undesirable for the employees, losing the inimitability of product, unnecessary liability, lack of security, uneven partner benefit, increased independences, and keeping up with the change in expectations. This lead to the hypothesis:

H3.3 There is a direct significant relationship between extranet adoption and the technical supply chain network integration challenges.

Figure 4 shows the proposed hypothesis related to the technical challenges.

Figure 4 Technical challenges



3.2 Structural model hypothesis

3.2.1 Relationship between the business macro, business micro environment, and technical challenges

In this section, we try to validate the relations between the challenges classes; using the following hypothesis:

This lead to the hypothesis:

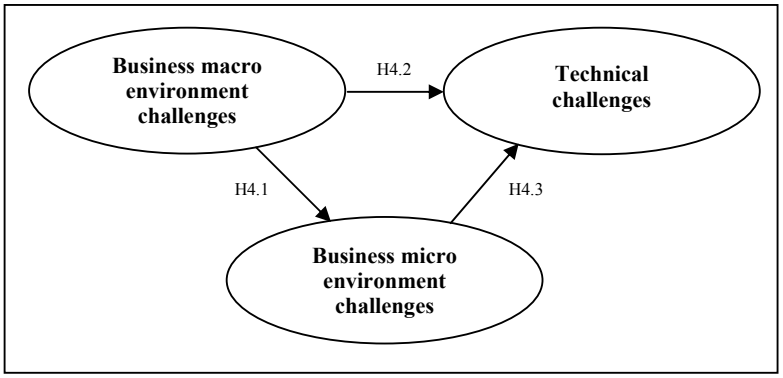
H4.1 There is a direct significant relationship between business macro environment challenges and the business micro environment challenges.

H4.2 There is a direct significant relationship between business macro environment challenges and the technical challenges.

H4.3 There is a direct significant relationship between business micro environment challenges and the technical challenges.

Figure 5 shows the proposed hypothesis related to the relations between the challenges classes.

Figure 5 The relation between challenges



4 Method

The research site was Jordan Industrial Estate Corporation (JIEC). It was selected by the researcher because it had the long history in Jordanian industry and it is the primary and most popular crowd of corporation in the Jordan. This industrial area had recently applied its supply chain network and had faced a great deal of criticism for doing so. According to the purposes of the study and the circumstances of the distribution of the questionnaire; it was impossible to apply a systematic type of sampling method. The researcher had requested that the employee questionnaire be distributed among 200 companies. However, only 150 completed questionnaires were returned at the end of the two week period. As participation was voluntary, it was not possible to get more responses, especially as there was no direct contact between the researcher and the employee respondents.

Therefore, convenience sampling was used. The final corporations sample population consisted of 150 of the industrials' companies and they belonged to various industry groups. The final group of local senior and middle managers and professionals' workers (engineers and technical who are not hold as managers) sample consist 150 respondents, In other words, both sample populations were varied. The data collection method was questionnaires because; like Creswell (2003) explains, questionnaires allow the researcher to collect a large volume of information on a limited budget and in a short time. It should be noted that the questionnaires were handed to the HR department at the JIEC. The HR department then sent the questionnaires to its branches and corporations, later forwarding the results to the researcher by hand.

5 Measures

In this study, we applied a set of statistical methods; we applied correlation analysis on the answers of the questionnaire which was a vital first step that ensured that each of the questions actually had a relationship amongst them. Another useful statistical method that was performed during this study was the factor analysis. The factor analysis showed us, with minor deviations that if the selection of the three key rations; business micro environment challenges, business macro environment challenges, and technical challenges will seem to be appropriate components for describing the questions.

We feel that the most important statistical method used to analyse the survey data in this study was in fact the PLS regression analysis. As mentioned in PLS regression analysis, the method is well suited for ordinal survey data as it does not require an assumption of normality. The method is however somewhat dependant on a set of statistical methods that we suggest should be performed first to ensure that the results from the PLS regression analysis are reliable. As for the assessment of the measurement and structural model in PLS regression analysis, there are a number of different software's available on the market, but we feel that SmartPLS well enough does the job. We believe that by using a programme such as SmartPLS facilitates the process of conducting such an analysis. As of today, the software SmartPLS is free of charge. It incorporates the most important functions in PLS regression analysis. There are a number of steps in assessing the measurement and structural model. Most of the values needed to asses both models are received when performing PLS regression analysis in SmartPLS. We believe that there are a number of important statistical scores that needs to be considered when evaluating the models and these are presented in the next part of the paper.

6 Results

PLS is a structural equation modelling technique that simultaneously assesses the reliability and validity of the measures of theoretical constructs and estimates the relationships among these constructs. PLS can be used to analyse measurement and structural models with multi-item constructs, including direct, indirect, and interaction effects, and is widely used in IS research (Chin et al., 1996; Chin, 1998). PLS requires a sample size consisting of ten times the number of predictors, using either the indicators of the most complex formative construct or the largest number of antecedent constructs

leading to an endogenous construct, whichever is greater. Although the measurement and structural parameters are estimated together, a PLS model is analysed and interpreted in two stages: the assessment of the reliability and validity of the measurement model, and the assessment of the structural model.

6.1 Measurement model

The first step in PLS is to assess the convergent validity of the constructs by examining the average variance extracted (AVE). The AVE attempts to measure the amount of variance that a latent variable component captures from its indicators relative to the amount due to measurement error. AVE values should be greater than the generally recognised 0.50% cut-off, indicating that the majority of the variance is accounted for by the construct. In addition, individual survey items that make up a theoretical construct must be assessed for inter-item reliability. In PLS, the internal consistency of a given block of indicators can be calculated using the composite reliability (ICR) developed by Werts et al. (1973). Acceptable values of an ICR for perceptual measures should exceed .70 and should be interpreted like a Cronbach's coefficient. All ICR and AVE values meet the recommended threshold values. Table 2 summarises the measurement model results.

Discriminant validity indicates the extent to which a given construct is different from other constructs. The measures of the constructs should be distinct and the indicators should load on the appropriate construct. One criterion for adequate discriminant validity is that the construct should share more variance with its measures than with other constructs in the model (Barclay et al., 1995). To evaluate Discriminant validity, the AVE may be compared with the square of the correlations among the latent variables (Chin, 1998). The diagonal of Table 2 contains the square root of the AVE. All AVEs are greater than the off-diagonal elements in the corresponding rows and columns, demonstrating discriminant validity.

In our analysis of convergent validity, in Table 2, we have seen that all of the indicators (questions) load on their own latent constructs (key ratios) with a value that exceeds 0.50, which is the threshold recommended by Trochim (2006). In addition, each question load higher on their own latent constructs than on the others. The analysis of convergent validity shown that each indicator is well correlated with the construct it is connected to. The bootstrap procedure provides an estimate of the standard error for each salience in all latent variables.

If the ratio of a salience to its standard error is greater than two, the salience can be regarded as reliable. The bootstrap estimates serve to assess the contribution of each data point to the latent variable structure. The estimates of the standard errors are usually stable after 100 resampling according to DeVellis (2003). A resampling technique was used, based on bootstrapping (150 resamples). The examination of the t-values was based on a two-tail test with statistically significant levels of 0.01. The results are shown in Figure 6. As we see all calculated t-value for all indicators are upper than tabling t on 0.01 significant level. See Table 3.

We conclude that the measurement model is robust and reliable as was suggested by Enskog (2006). Moreover the validity of the measurement model is strengthened through these results as the number of respondents of the survey has increased dramatically since the previous results were presented.

6.2 Structural model

To assess the relationships of the constructs (classes of challenges) in the structural model we used the coefficient of determination, R^2 as well as the path coefficients, inner model t-value, and their corresponding significance score, which were retrieved from a t-table. We calculated the results of R^2 for the dependant constructs business micro environment challenges, and technical challenges, As well as path coefficients between the constructs, business micro environment challenges, business micro environment challenges, and technical challenges. See Table 1.

Table 1 Test of structural model

	Technical challenges			*Business micro environment challenges*		
	beta	*R^2*	*t-value*	*beta*	*R^2*	*t-value*
Business macro environment challenges	0.17	0.93	1.52	0.94	0.88	57.41
Business micro environment challenges	0.80	0.93	7.05		-	-

Notes: Factor loadings (beta), t-test and R^2

Table 2 Spearman's rank order correlation analysis of survey questions

	1	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*	*11*	*12*	*13*	*14*	*15*	*16*	*17*	*18*
TRC	1.0	.63	.68	.78	.69	.67	.75	.69	.92	.74	.58	.76	.59	.55	.37	.60	.87	.82
MSF		1.0	.35	.31	.38	.36	.43	.32	.58	.45	.31	.51	.30	.56	.56	.41	.42	.32
MSP			1.0	.79	.68	.70	.70	.75	.78	.78	.72	.70	.86	.79	.54	.56	.87	.78
COM				1.0	.75	.78	.81	.83	.78	.93	.77	.70	.77	.84	.68	.63	.81	.89
LM					1.0	.93	.81	.76	.77	.72	.47	.61	.68	.72	.46	.90	.70	.77
OFLX						1.0	.68	.69	.68	.69	.59	.55	.65	.77	.38	.92	.72	.78
MscB							1.0	.77	.89	.80	.50	.69	.76	.70	.41	.57	.69	.78
SoT								1.0	.71	.90	.63	.74	.69	.72	.42	.64	.72	.85
PrM									1.0	.74	.51	.73	.75	.65	.38	.58	.86	.81
EnI										1.0	.72	.73	.72	.76	.32	.58	.76	.89
BPI											1.0	.59	.54	.65	.09	.44	.68	.72
CandC												1.0	.69	.48	.50	.49	.67	.67
SCR													1.0	.82	.19	.46	.74	.72
BtOtGLo														1.0	.32	.63	.78	.84
EoGL															1.0	.52	.35	.51
Dand																1.0	.64	.67
AppL																	1.0	.87
EXT																		1.0

The results from the analysis of the structural model, conclude that the process model is strong, indicating that the constructs; business macro environment challenges, and business micro environment challenges are good determinants of technical challenges. and business macro environment challenges are good determinants business micro environment challenges.

The independent constructs business macro environment challenges, and business micro environment challenges explain 0.931% of the variance of technical challenges. And the independent construct business macro environment challenges explain 0.884% of the variance of business micro environment challenges. This confirms the results presented by Enskog (2006), which reported a value of 76%. We conclude that there is consistency in the structural model and that the model is reliable.

We can also see that business micro environment challenges are a strong determinant of technical challenges with a path coefficient of 0.801 tested by calculated t-value of 7.05, and business macro environment challenges are a weak determinant of technical challenges with a path coefficient of 0.173 tested by calculated t-value of 1.52, and we can also see that business macro environment challenges are a strong determinant of business micro environment challenges with a path coefficient of 0.940 tested by calculated t-value of 57.41, Which they indicating significance at the 0.01 level (see Table 1). This result indicates that key ratio business micro environment challenges, business macro environment challenges, and technical challenges do in fact belong in the process model.

Table 3 Test of convergent validity

	Technical challenges		*Business macro environment challenges*		*Business micro environment challenges*	
	beta	*t-value*	*beta*	*t-value*	*beta*	*t-value*
AppLtotal	0.95	25.28				
BPItotal			0.66	9.41		
BtOtGLototal			0.85	15.35		
COMtotal					0.93	46.96
CandCtotal			0.88	27.30		
DandItotal	0.88	120.25				
EXTtotal	0.97	156.25				
EnItotal					0.91	53.92
EoGLototal			0.67	5.19		
LMtotal					0.92	50.85
MSFtotal					0.62	5.27
MSPtotal					0.92	37.82
MscBtotal					0.90	27.52
OFLXtotal					0.92	32.30
PrMtotal					0.94	38.91
SCRtotal			0.93	52.95		
SoTtotal					0.92	56.09
TRCtotal					0.85	13.88

Notes: Factor loadings (beta) and t-value

7 Hypothesis testing

The theoretical model and hypothesised relationships were estimated using 200 iterations of the bootstrapping technique in SmartPLS (Chin et al., 1996). To examine the specific hypotheses, we assessed the t-statistics for the standardised path coefficients and calculated p-values based on a two-tail test with a significance level of (0.01). Table 3 presents the results of the PLS analysis used to test the model.

7.1 Business micro environment challenges hypothesis (measurement model)

We test how every challenges of business micro environment related to its class using convergent validity and t-value at significant 0.01 level. In our analysis of the convergent validity and t-test we have seen that all indicators challenges load on their business micro environment challenges latent construct with a values (beta) that are exceeds 0.50, and with calculated t-values, which are the threshold recommended by Trochim (2006). And with these results, we conclude that the all indicators are well correlated with the business micro environment challenges. See Table 3.

7.2 Business macro environment challenges hypothesis (measurement model)

We test how every challenges of business macro environment related to its class using the convergent validity and t-value at significant 0.01 level. In our analysis of the convergent validity and t-test we have seen that all indicators challenges load on their business macro environment challenges latent construct with a values (beta) that are exceeds 0.50, and with calculated t-values, which are the threshold recommended by Trochim (2006). And with these results, we conclude that the all indicators are well correlated with the business macro environment challenges. See Table 3.

7.3 Technical challenges hypothesis (measurement model)

We test how every challenges of technical challenges related to its class using the convergent validity and t-value at significant 0.01 level. In our analysis of the convergent validity and t-test we have seen that all indicators challenges load on their technical challenges latent construct with a values (beta) that are exceeds 0.50, and with calculated t-values, which are the threshold recommended by Trochim (2006). And with these results, we conclude that the all indicators are well correlated with the technical challenges. See Table 3.

7.4 Relation between challenges (constructs) hypothesis (structural model)

To assess the relationship between business macro environment challenges and the business micro environment challenges constructs, we calculate path coefficient (beta) 0.94 which is describe the linear relationship between the two constructs (retrieved from t-table). To assess how much of the variance two variable shares we calculate coefficient of determination R^2, it can be used to say that the business macro environment challenges are to explain 0.884% of business micro environment challenges. To see if we can indicate how much one can rely on the results obtained we calculated t-value using SmartPLS which it equal 57.41 at a significance 0.01 level. See Table 1.

This result confirms the results presented by Enskog (2006). Which was reported a value of 76%. We can conclude that there is consistency and reliability in the relation and we can describe it as a strong one.

To assess the relationship between business macro environment challenges and the technical challenges constructs, we calculate path coefficient (beta) 0.173 which is describe the linear relationship between the two constructs (retrieved from t-table). To assess how much of the variance two variable shares we calculate coefficient of determination R^2, it can be used to say that the business macro environment challenges are to explain 0.931% of technical challenges. To see if we can indicate how much one can rely on the results obtained we calculated t-value using SmartPLS which it equal 1.52 at a significance 0.01 level.

This result confirms the results presented by Enskog (2006). Which was reported a value of 76%. We can conclude that there is consistency and reliability in the relation and we can describe it as a weak one, which mean that we reject the hypothesis.

To assess the relationship between business micro environment challenges and the technical challenges constructs, we calculate path coefficient (beta) 0.801 which is describe the linear relationship between the two constructs (retrieved from t-table). To assess how much of the variance two variable shares we calculate coefficient of determination R^2, it can be used to say that the business micro environment challenges are to explain 0.931% of technical challenges. To see if we can indicate how much one can rely on the results obtained we calculated t-value using SmartPLS which it equal 7.05 at a significance 0.01 level.

This result confirms the results presented by Enskog (2006). Which was reported a value of 76%. We can conclude that there is consistency and reliability in the relation and we can describe it as a strong one.

8 Discussion

There are a number of ways that the set of statistical methods presented in this research which can be beneficially used by researches and organisations. We can see the need to incorporate statistical analysis of the challenges in order to strengthen the statistical validity and quality of SC integration challenges model.

The first practical contribution of this study is the potential of generalising the result of grouping all challenges that mentioned in other related literatures in one model. Using the result of statistical methods suggested in this research in the future ensures the validity of the results from SC integration challenges model.

The business micro environment challenges of the SC integration, include transaction cost, strategic flexibility management, strategic planning management, customer order management, logistic management, operation flexibility, measure of SC benefits, standard of trade, procurement management, and the enterprise integration challenges. The business macro environment challenges of the SC integration include business process integration, culture and change, supplier competence requirement, business transformation oriented to globalisation, and the effect of globalisation challenges. The technical challenges of the SC integration include data and information integration, application integration, and the extranet adoption challenges (Hussain and Mohammad, 2010b). This classification supported by statistical measurements that every sub-

challenge (factor) related to its class or group. According to the PLS results, we see that the beta results in the measurement model represent the hypothesis of the research. We statistically prove that all sub-challenges under the business micro environment as categorised by (Hussain and Mohammad, 2010b) are related to this class, this had been proved statistically through the path coefficient (beta result) of this class. Path coefficient summarised the results of the survey answered for section one of the questionnaire, these results harmonies with the opinions of Morten (2003), Mohammady (2004), Hewlett-Packard (2004), Steve (2007), Lesley (2007), McGuffog and Wadsley (1999), Jaffer and Khatib (2004). As a result of what we extracted from the literatures and from the statistical test of path coefficient, we see that the hypothesis of business micro environment challenges are proved. Which mean that all of these challenges related to the class statistically.

And we see that the beta results in the measurement model represent the hypothesis of research. We statistically prove that all sub-challenges under the business macro environment as categorised by Hussain and Mohammad (2010b) are related to this class, this had been proved statistically through the path coefficient (beta result) of this class. Path coefficient summarised the results of the survey answered of section two of the questionnaire, these results are harmonies with the opinions of Hewlett-Packard (2004), Lee and Whang (2001) and Jaffer and Khatib (2004). As a result of what we extracted from the literatures and from the statistical test of path coefficient, we see that the hypothesis of business macro environment challenges are proved. Which mean that all of these challenges related to the class statistically. Finally, we see that the beta results in the measurement model represent the hypothesis of research. We statistically prove that all sub-challenges under the technical challenges as categorised by Hussain and Mohammad (2010b) are related to this class, this had been proved statistically through the path coefficient (beta result) of this class. Path coefficient summarised the results of the survey answered of section three of the questionnaire; these results are harmonies with the opinions (Pender, 2001; Peter, 2000; Lee and Whang 2001). As a result of what we extracted from the literatures and from the statistical test of path coefficient, we see that the hypothesis of technical challenges are proved. It means that all of these challenges related to the class statistically.

The second contribution of the study is that we proved the relation between the three classes of challenges through the results of measurements that we used in the PLS regression analysis. We see through developing the model that there is a relation between the three challenges classes, which are supported statistically by the results of measurement extracted through SmartPLS. Path coefficient results show though beta that the business macro environment has an impact on the business micro environment challenges in percentage 0.94 of beta value, this result could clear that the firm who face a business macro-environment challenges has a 94% possibility to face the business micro-environment challenges.

Also we reject the impact of business macro environment challenges on the technical challenges because it was not supported statistically through the result of path coefficient in percentage 0.173 of beta value and t-value 1.52.

Also there is a relation between business micro environment challenges and technical challenges supported statically by the path coefficient 0.881 of beta value, this result could clear that the firm who face a business micro-environment challenges has an 88% possibility to face the technical challenges.

9 Conclusions

Our empirical investigation using PLS path modelling we contributed to the supply chain integration literature by two things; first, we prove the validity of Hussain and Mohammad (2010b) classification to the supply chain integration challenges. Second, we extracted an immediate relationship between the three classes of challenges; these relationships are: first, the existence of business macro-environment challenges guarantees the existence of business micro-environment challenges. Second, the existence of business micro-environment challenges guarantees the existence of the technical challenges.

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