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**DETERMINANTS OF INFORMAL COORDINATION IN
NETWORKED SUPPLY CHAINS**

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DETERMINANTS OF INFORMAL COORDINATION IN NETWORKED SUPPLY CHAINS

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Determinants of Informal Coordination in Networked Supply Chains

Abstract:

Purpose – Provide insight into the determinants or constructs that enable informally networked supply chains to operate in order to achieve improved operational performance.

Design/methodology/approach – The research is based on a wide literature review, focused on the identification of dimensions of informal networking in supply chains along network connectivity, supply chain relationship alignment, informally networked supply chain, and operational performance. These determinants or constructs of informal networking were statistically validated for validity and reliability, using a sample of 231 supply chain professionals.

Findings – Four determinant of informal networking were derived: capability connectivity, describing the ability of supply chain partners to rapidly and informally integrate capabilities to service an ad hoc market requirement; relationship alignment or the ability to informally integrate resources across supply chain partners in the context of highly dynamic market situations; the informally networked supply chain itself, measuring the ability of supply chain partners to respond to transient opportunities in the context of highly dynamic markets; and finally operational performance which measures the effect informal networking has on company performance.

Research limitations/implications – Future research may investigate the effects of informally networked supply chains on a broader array of measures of company performance, and additional measures of operational performance.

Practical implications – These newly developed constructs or determinants give managers further insight into which dimensions need to be fostered to enable informally networked supply chains to operate, and what operational gains may be potentially realised as a result of informal networking.

Originality/value – This paper contributes to enhancing the understanding of the newly emerging phenomenon of informal networking in supply chains and how it may yield operational efficiency and effectiveness gains.

Keywords: construct development, coordination, informal networking, supply chain

JEL Code: D73, H1, H77

1. Introduction

Nowadays collaboration between firms is a powerful source of competitive advantage, calling for effective management of relationships in the supply chain, which includes the development and maintenance of capabilities to ensure an effective operating system. An operating system is said to be superior to that of a competitor if it responds better to the holistic structure of market opportunities, and as such secures the long-term viability of the firm. This paper develops new constructs to be used in a conceptual model for analysing how informal connection of capabilities in networked supply chains can increase the operational effectiveness of a firm in highly dynamic markets. Highly dynamic markets are characterised by short lead-time requirements and a large variety of product and service components, thus posing unique requirements for operations and logistics.

The proposition is made that the dynamics in short-term relationships are significantly different from the ones in long-term relationships. Supply chain partners typically build relationship traits such as commitment, trust, joint objectives, communication and the exchange of information over time. It is argued that in highly dynamic situations, supply chain partners have only limited time to get and work together to respond to a market opportunity. The key question is whether partners within a supply chain are connected and synchronized properly to grasp the networking opportunities. Most companies do not have the abilities to see and capability to measure their business as a sum of their extended value network.

This paper introduces the concept of the “informally networked supply chain” (iNSC) to discuss collaborative, short-term relationships where partners coordinate their mutual capabilities to address a transitory, but important, business opportunity in order to achieve collectively beneficial outcomes.

In such a context, supply chain management concerns the timely coordination of capabilities, i.e. technologies, processes, and other resources related to the flow of material, information and funds within a company, but also externally between companies. The reason for better coordination of supply chain activity, and to obtain access to capabilities, is the improvement of overall operational performance of one company and the total supply chain (Kemppainen and Vepsäläinen, 2003, Stank et al., 1999). Traditionally, improvement initiatives involved the pursuit of operational improvement within one company, i.e. improvement of functional and procedural aspects to achieve cost reductions and better asset utilisation. However, as markets and customer demands evolve, supply chain managers are prompted to integrate processes and technology across supply chain partners. While evidence for the benefit of technology and process integration across businesses has been produced through supply chain research (Kemppainen and Vepsäläinen, 2003), the role of relationships in such collaboration networks has been less well researched. It appears that existing supply chain concepts do not sufficiently address the simultaneous effects that informal connectivity (collaboration standards, technology standards and regulatory and industry rules) and relationship alignment (e.g. trust, power and knowledge sharing) have on dynamic coordination in networked supply chains. As a result, opportunities to use the supply chain as a resource to achieve quick response and operational effectiveness may be lost.

We turn next to a review of the literature to ground the constructs that underpin supply chain management in highly dynamic markets, followed by a statistical validation of the constructs using a sample of 231 supply chain professionals generated from the Dun & Bradstreet’s database. Final validated constructs and their respective measurement items are listed, and ongoing research is being conducted on structural model items that interrelates capability leverage, supply chain relationship

alignment, and degree of informal supply chain networking to gains in operational effectiveness. In developing scales, care was given to the specification of the constructs and to the items generated in order to minimise measurement errors and the effect on findings. A framework based on (Churchill Jr, 1979) was used to guide scale development. Firstly, the construct was mapped to relevant supply chain and management disciplines. The purpose was to ensure that relevant existing field research contributions were identified. Secondly, defined and tested scales were selected from previous research contributions, some of which are described next. For research items where no matching scales were found, existing scales were adapted to fit the research question, or they were created based on the literature and/or findings from the exploratory interviews with experts.

The scales were tested through a pilot study and, based on the results, the measures were refined and finalised for data collection. Finally, their reliability and validity were tested. Because of space limitations, only the general logic with some selected outcomes are reported.

2. Literature Review

The main body of the literature reports how supply chain entities' formal coordination (collaboration) influences SC performance, most studies emphasizing the influences of a single format of collaboration (Kampstra et al. (2006)). However, the existence of informal relations (connectivity) is also an effective indicator of SC performance.

The definition of coordination is broad, and the most common definition applicable in a supply chain context by Malone et al. (1999) is used, who suggests that "Coordination is managing dependencies between activities". The question then arises as to which activities are representative in informal coordination settings? For effective management of the supply chain we can consider five main activities to be connected, namely: information, demand creation, demand fulfillment, demand evaluation, and governance (see Figure 1).

Figure 1: Connectivity dimensions & capability connectivity measures

Except for the information system that could be formally connected, all other dimensions are subject to an informal practice. In what follows we will focus on informal connections and its impact on coordination, measures of relationship alignment in informal relationships, the concept of the informally networked supply chain, and measures of operational performance.

This subsequently culminates in the development of four constructs of informal coordination. Firstly, *capability connectivity* in supply chains describes the degree to which technologies, processes, rules, and regulations enable the integration of multiple supply chain partners' information flows, which in turn facilitate the related financial and physical flows in an environment of rapid decision-making (Malhotra et al., 2005; Davenport, 2005; Morash, 2001). Capability connectivity relates to enabling structures for informal coordination of supply chain capabilities (Xu and Beamon, 2006). These enablers are assumed to be beyond the short-term control of supply chain partners, but may be important for achieving effectiveness gains.

Secondly, *relationship alignment* in the supply chain defines the relational factors that are necessary to achieve mutual access and utilisation of capabilities in networked supply chains. The variable relationship alignment describes coordination processes relating to coordinating capabilities for responding to short-lived demand requirements. It includes variables such as trust, power, knowledge, and risk as key factors to enable rapid and informal decision-making for the coordination of capabilities in a network of supply chain partners in pursuit of a joint objective (Patnayakuni et al., 2006).

Thirdly, the *informally networked supply chain* describes the activities and decision processes required to access and execute capabilities in the context of highly dynamic time and informal business relationships (Bowersox et al., 2002; Håkansson and Ford, 2002; Harland et al., 2004). It is proposed that the greater the speed and informality with which supply chain partners can access and assemble mutual supply chain capabilities, the more value they may be able to capture from time-sensitive opportunities.

Finally, *operational performance* is defined as performing similar activities better than rivals perform them and is an outcome measure for using input resources within a company, and in the context of this research, across the supply chain (Rokkan and Haugland, 2002; Lambe and Spekman, 1997; Sydow and Staber, 2002). Operational performance provides outcome measures for value delivery to customers, i.e. time and cost of products and services, as well as in relation to competitive advantage, i.e. relative increase of revenue and profit to competitors.

2.1 Capability Connectivity

Supply chain profitability depends on its collective capabilities, which usually are limited by some constraints in the chain. For large supply chains, these constraints are significantly influenced by the interactions among entities in different parts of the chain. When a supply chain's critical path capability is limited by a constraint, the supply chain gets stressed, and the need to coordinate capabilities becomes very important in order to improve the transfer capability on the constrained path. Therefore, capability connectivity in supply chains describes the degree to which technologies, processes, rules, and regulations enable the integration of relevant supply chain partners' physical, information, and financial flows, in order to lift such constraints. Capability connectivity in supply chains typically fits into a particular "governance" format, which can be classified into three forms of collaboration: (a) informal (voluntary) collaboration, (b) formal collaboration, (c) hybrid. The earlier is the focus of this study. Capability connectivity is also measured by the degree to which relevant technical standards are recognised and used by supply chain partners (Helfat and Eisenhardt, 2004, Yusuf et al., 2004). Technical standards enable the partners in a supply chain to exchange data, information, and knowledge in an effective and timely manner. It also considers the degree to which relevant process standards and methods are recognised and used by supply chain partners (Park, 2003, Saeed et al., 2005). Through process standards, partners in a networked supply chain can access shared resources at different points within a process in a more timely fashion. Connectivity also takes into account the degree to which relevant industry rules and regulations are harmonised, recognised, and considered in the decision processes of all supply chain partners. Increasingly, the large number of regulatory regimes at industry, state, national, and international

level can lead to supply chain constraints, and hence delay relevant decision-making (Elias, 2003, DOTARS, 2002). This is even more the case, if these regulations conflict with one another.

Capability connectivity thus enables capabilities in a supply chain to be treated by networked partners as if they belong to one ‘virtual’ resource pool.

In order to assess the importance of technology, process, rules, and regulations for supply chain networks, the literature reports a number of measurement scales. Van Hoek (van Hoek et al., 2001) presents measures for the external usage of information and communication technologies (measures of upstream integration with suppliers and downstream integration with logistics service providers and customers) through a survey of 80 managers of manufacturers involved in international markets (importing and exporting) such as electronics, automotive, food, and clothing. He applied an eight-point Likert-scale from (0) ‘not applicable at all’ to (7) ‘very much applicable’. The survey asked questions about the application of information and communication technology (ICT) in relation to suppliers, and the application of ICT in relation to logistics service suppliers.

The first dimension of capability connectivity provides scales for technology standards, which is proposed by (Williams et al., 1998). They have used it in various industries (i.e. the degree of standardisation for EDI documents, the degree of standardisation of product identification schemes; the degree to which proprietary formats are being used; and the degree to which industry-wide EDI standard formats are being used). They applied the scales in the context of supply chain research in interviews with 275 Council of Logistics Management (CLM) members in the US in 1997. They use a seven-point Likert-scale from (1) strongly disagree to (7) strongly agree.

The question and corresponding measures were adapted to determine the importance of the technology aspects of capability connectivity, and was stated as (on a scale from 1 to 7, where ‘Not important’ = 1 and ‘Very important’ = 7): “How important are the following abilities for successfully coordinating supply chain activities between two or more companies?”., with the following response categories:

- Standard procedures for information exchange
- Access to shared IT applications across companies
- Access to Internet-based applications.

Process standards represent the second dimension of the set variables for capability connectivity. (Daugherty et al., 1999) apply measurement scales to study information compatibility issues (e.g. formatting and ease of connectivity) in the exchange of information between supply chain partners in

replenishment programs such as collaborative planning, forecasting and replenishment (CPFR) and vendor managed inventory (VMI). Respondents were asked to assess their company's information systems capabilities with respect to those systems being 'formatted to facilitate usage' or whether they were being 'formatted on an exception basis. Furthermore, they were asked to self-assess the internal connectivity and compatibility of systems, as well as the external connectivity and compatibility of their systems. The questions were asked on a seven-point Likert scale from (1) 'Not capable' to (7) 'Highly capable'.

It is proposed that, the greater the degree of process connectivity between supply chain partners, the more informally the coordination of supply chain activity can be achieved. Using the same question and a seven-point Likert scale as above, corresponding measures for process connectivity were adapted to determine the importance of process aspects of capability connectivity.

A third dimension of capability connectivity relates to regulation and industry rules. Kessides and Willig (Kessides and Willig, 1995) offer a measurement approach for the impact regulation can have on the performance of companies in logistics. They contend that measurement must follow principles that determine the adequacy of revenues, such as the company's overall rate of return. According to the authors, the rate of return should be at least equal to the returns currently earned by the company by engaging in projects with similar risks.

Fawcett et.al (Fawcett et al., 2000) present information on a study that addresses the impact of technology, processes, and regulations on performance. They explore the cross-functional development of quality and cost in an international production-sharing setting. Using the seven-point Likert scale from (1) 'Very poorly' to (7) 'Very well', 31 senior managers directly responsible for their strategic business units' Mexican production-sharing operations were interviewed about the ability of their information systems to provide useful information for cross-national resource availability; currency convertibility; domestic content laws; foreign ownership laws; global technology developments; global transportation rates logistics costs and tax issues.

2.2 Relationship alignment

Research suggests that alignment of informal relationships towards joint objectives depends on relationship variables, such as trust, power, knowledge, and risk, as well as related attributes such as commitment, information sharing, communication, and the management of intellectual property (Rokkan and Haugland, 2002, Grossman, 2004, Morgan and Hunt, 1994, Kampstra et al., 2006).

Most of the studies on collaboration relationship configuration have discussed the importance of factors such as trust, power, communication and information exchange (Kampstra et al., 2006). A study by (Myhr and Spekman, 2005) contained relevant scales for these factors. More specific scales were found in (Blois, 1999), (Daugherty et al., 1999) who provide tested measurement scales for trust and their influence on exchange activities in the context of electronically supported exchange relationships.

Maloni and Benton (Maloni and Benton, 2000) measured different dimensions of power in the supply chain by surveying 180 CEOs, presidents, and vice-presidents of large suppliers of the Chrysler Corporation and Honda of America. The authors used a seven-point Likert scale and developed questions to test coercive power (ability of one company to influence the intentions and actions of another company because of superior commercial standing); expert power (ability of one company to influence the intentions and actions of another company because of superior knowledge and expertise about the business issue at hand); legal legitimate power (ability of one company to influence the intentions and actions of another company because of a judiciary right); and referent power (ability of one company to influence the intentions and actions of another company because the target values certain marketing and sales assets of the company).

The following general measurement scales were adapted based on research by (Hult et al., 2004). Questions about knowledge acquisition activities were mainly adapted from [18] Questions about information distribution activities were adapted from (Jaworski and Kohli, 1993). Shared meaning and subjective cycle time measures were adapted from (Hult et al., 2004).

2.3 Informally networked supply chains

The informally networked supply chain is a construct consisting of two well established factors (1) time to access supply chain capabilities and (2) degree of formality in coordinating supply chain capability across organisational boundaries. A definition for 'time to access capabilities' is the time it takes the entire supply chain to coordinate interrelated capabilities and execute those to achieve a desired result (Lummus et al., 2003). The definition and corresponding model proposed by the authors specifies several important characteristics that are required within and between players in the supply chain to improve supply chain responsiveness, agility, and flexibility.

Scales for measuring supply chain flexibility, agility, and responsiveness were derived from the above study. Using a five-point Likert scale (endpoints of slow and fast), the respondents were asked to indicate the speed (or degree of responsiveness) with which their businesses can engage in various

operational activities. The following questions were also derived from the study and extended by findings from exploratory research:

In the following situations, how important is quick and informal access to resources of other companies for your ability to respond to the following market situations? (On a scale from 1 to 7, where 'Not important' = 1 and 'Very important' = 7):

- An important customer wants to expedite a sales order.
- An important customer places an order with unusually complex product/service requirements.
- An opportunity to break into a new market arises unexpectedly.
- Only for a short and limited time, you have the opportunity to purchase a key input material or service.
- You have to quickly identify an alternative source for a key product because your normal suppliers can not deliver.
- For a short and limited time you have a sales opportunity that requires 3rd party manufacturing capability.
- For a short and limited time you have a sales opportunity that requires 3rd party logistics capabilities.

Beamon (Beamon, 1998) measured formalisation of supply chain relationships (i.e. existence of formal agreements and the extent to which they limit dealers' managerial choices) by studying 115 store owners or managers from a random sample of audio/video retail stores. Each owner/manager was asked to choose one brand of Hi-fi speaker and evaluate the manufacturer-dealer relationship in relation to sales of that brand.

The following research question resulted:

Different types of commercial arrangements govern relationships between supply chain partners. How important are the following commercial arrangements for your ability to respond to unexpected market opportunities and threats? (On a scale from 1 to 7, where 'Not important' = 1 and 'Very important' = 7)

- Formal relationships (i.e. on the basis of existing contracts) with existing business partners.
- Informal relationships (i.e. no contracts) with existing business partners.
- Formal relationships (i.e. on a contract basis) with new business partners.
- Informal relationships (i.e. no contracts) with new business partners.
- Other, please specify below:

2.4 Operational performance

In the context of this research, the last construct describes operational performance improvements as a result of informal networking in supply chains. Firstly, it is proposed that company-level operational performance is a measure that captures aspect of revenue enhancement, and service improvement of effective supply chain practices (Ramdas and Spekman, 2000), better strategic focus (Gunasekaran et al., 2004) and give access to knowledge and expertise (Chapman et al., 2003).

Secondly, it is proposed that process coordination of capabilities across organisational boundaries can contribute to cost-savings (Hewitt, 1994), standardisation of services (Davenport, 2005), and faster total supply chain response times (Sydow and Staber, 2002). This is in line with findings in Gunasekaran (2001). Operational performance is affected by product cost, quality, speed and reliability of delivery, and flexibility (Stank et al., 2001). As it is a primary determinant of customer satisfaction, measuring and improving delivery is always desirable to increase competitiveness. Delivery by its very nature takes place in a dynamic and ever-changing environment, making the study and subsequent improvement of a distribution system difficult. It should be noted that it is not easy to anticipate how changes to one of the major elements within a distribution structure will affect the system as a whole (Stock et al., 2000).

The performance of informally networked supply chain activity on the supply chain level may be measured by the collective capability to provide products/services that meet the individual demands of customers. Measures include, for example, flexibility in time and product delivery and are based on traditional metrics such as machine/tool set up time, economies of scope and number of inventory turns. Lummus et.al (Lummus et al., 2003) argues that the degree to which an organisation can adjust its supply chain speed, destinations, and volumes are key determinants for its performance. The authors add that customers expect such a performance at the supply chain level without the addition of significant total costs.

The efficiency of a supply chain can be assessed using the total logistics cost which is a financial measure. It is necessary to assess the financial impact of broad strategies and practices that contribute to the flow of products in a supply chain. Since logistics cut across functional boundaries, care must be taken to assess the impact of actions to influence costs in one area in terms of their impact on costs associated with other areas (Coyle et al., 2003). For example, a change in capacity has a major effect on cost associated with inventory and order processing.

Information processing cost includes costs associated with order entry, order follow/updating, discounts, and invoicing. Based on survey results from various industries, Johnson et.al. (Johnson

and Seungjin, 2002) identified information processing as the largest contributor to total logistics cost. The role of information technology is shifting from a general passive management enabler through databases, to a highly advanced process controller that can monitor activities and decide upon an appropriate route for information. Modern information technology, through its power to provide timely, accurate, and reliable information, has led to a greater integration of modern supply chains than has been possible by any other means.

A satisfied customer is of the highest importance. In a supply chain, customers can reside next door or across the globe, and in either case they must be well served. Without a contented customer, the supply chain strategy cannot be deemed effective. Van Hoek et.al (van Hoek et al., 2001) emphasised that in order to assess supply chain performance, supply chain metrics must centre on customer satisfaction.

Customer query time relates to the time it takes for a firm to respond to a customer query with the required information. It is not unusual for a customer to enquire about the status of an order, potential problems in stock availability, or delivery. A fast and accurate response to those requests is essential in keeping customers satisfied. Our research eventually extracted two factors of operational performance along dimensions of operational efficiency and operational effectiveness. These, and other relevant constructs, are further modeled and tested as discussed below.

3. Statistical Validation

Item reliabilities (i.e. the extent to which a scale produces internally consistent measures for multi-item scales) were measured via Cronbach's coefficient alpha. Cronbach's alpha can be seen as an average correlation of every combination of one question to the other questions in the group. As such, a construct requires three or more items to produce a valid result (Mentzer and Flint, 1997). The threshold value recommended by Nunnally (Nunnally, 1978) and Flynn (Flynn et al., 1990) is .60. Constructs that did not achieve a satisfactory Cronbach alpha, or did not have three or more items with a factor loadings of .50 or more, were eliminated from further analysis.

Unidimensionality is the degree to which a set of items represent one and only one underlying latent construct (Garver and Mentzer, 1999). As suggested by Narasimhan and Jayaram [26], an exploratory factor analysis (EFA) for each construct was conducted to ensure unidimensionality of the scales. The indicator items are deleted if they load on more than two factors, or their factor loadings are smaller than 0.5. Moreover, items that don't load on the factor they intend to measure, but instead on factors they didn't intend to measure, are also to be deleted (Chen and Paulraj, 2004).

Validity of a measurement scale is the extent to which the scale fully captures all aspects of the construct to be measured (Tabachnick and Fidell, 2001), and consists of content validity, convergent validity, and discriminant validity.

Content validity is defined as the extent to which the content of a measurement scale appears to include all relevant aspects of the construct it measures (Tabachnick and Fidell, 2001). Content validity of the scales was established by grounding their origins in the literature, and for newly developed items through an exploratory study, and by thorough testing with a relatively large panel of experts.

Convergent validity was assessed by conducting a Confirmatory factor analysis (CFA). Convergent validity refers to the degree to which multiple attempts to measure the same concept produce the same result. Convergent validity is assessed by the extent to which the latent construct correlates to items designed to measure that same latent construct. Structural equation modeling was used to estimate models in which each item was linked to its corresponding construct, and the covariances among those constructs were freely estimated. Generally, a construct with either loadings of indicators of at least 0.5, a significant t-value ($t > 2.0$), or both, is considered to be convergent valid (Chau, 1997). In our model, all factor loadings are greater than 0.50 and the t-values are all greater than 2.0. Therefore, convergent validity is achieved. Furthermore, a construct is considered to have convergent validity if its eigenvalue exceeds 1.0 in EFA (Hair et al., 1998). In addition, all the factor loadings must exceed the minimum value of 0.50.

Models in which each item was linked to its corresponding construct were produced, and the covariances among those constructs were freely estimated, generating goodness-of-fit measures in AMOS.

Ongoing debates about the superiority, or even the appropriateness, of one index over another makes the issue of selecting fit measures difficult (Byrne, 1998). For instance, (Hu and Bentler, 1998) advise against using GFI and AGFI because they are significantly influenced by sample size and are insufficiently sensitive to model mis-specification. Most fit indices are influenced by sample size and should not be interpreted independently of sample size (Hu and Bentler, 1998). Therefore, no consistent criteria (i.e. cut-offs) are defined to apply in all instances (Shah and Goldstein, 2006).

In response to this ambiguity, multiple measures of fit are reported to evaluate the fit of the data to the model. Fit was assessed by the ratio of the Chi-squared to its degrees of freedom (df). The Tucker-Lewis Index (TLI), the Comparative Fit Index (CFI), the Goodness-of-Fit Index (GFI), and the Adjusted-Goodness-of-Fit-Index (AGFI) are reported. The Standardised Root Mean Square Residual (SRMR) and the Root-Mean-Square Error of Approximation (RMSEA), two measures that reflect the residual differences between the input and implied (reproduced) matrices, indicate how

well matrix covariance terms are predicted by the tested model. SRMR in particular performs well under many conditions (Hu and Bentler, 1998). Where required a summary of standardised (correlation) residuals was computed as well, because when most or all are ‘quite small’ relative to correlations in the tested sample, they indicate good model fit (Bentler and Yuan, 1999).

Discriminant validity measures the extent to which the items representing a latent construct discriminate that construct from other items representing other latent constructs (Li et al., 2005). Confirmatory Factor Analysis (CFA) was used to estimate discriminant validity. Large correlations between latent constructs (greater than .80) suggest a lack of discriminant validity. Poor discriminant validity is present if the correlation between two factors is (or is very close to) 1 or -1 (Tabachnick and Fidell, 2001). The correlations between the factors were between 0.189 and 0.491, therefore establishing discriminant validity for the various constructs.

The above listed methodology was used to established construct validity and reliability. Given the page limitation, no detailed intermediate numerical analyses are reported, except for a summary of results in Table 1. The resulting items that stood up to the required validity and reliability tests to operationalize constructs used in informally networked supply chains, are reported below:

TABLE 1
Summary Results of Construct Development

Construct	Value	Cronbach Alpha	Number of items per factor	Factor cor-relations	Chi-Square	df	Normed Chi Square	SRMR	RMR	RMSEA	GFI	AGFI	TLI	CFI
	Description						<3	<0.05		<0.08	>.9	>.9	>.9	>.9
CAPABILITY CONNECTIVITY (CC)				0.19	52.562	19	2.766	0.051	0.066	0.078	0.948	0.901	0.912	0.994
CC_CONN	Effect of process and IT connectivity	0.658	4											
CC_REGUL	Effect of rules and regulations	0.852	4											
RELATIONSHIP ALIGNMENT (RA)				-	2.770	2	1.385	0.029	0.066	0.041	0.994	0.970	0.988	0.996
RA_RES_LNK	Ability to link resources	0.736	4											
INFORMALLY NETWORKED SUPPLY CHAIN (INSC)				0.491	37.933	13	2.918	0.049	0.079	0.082	0.953	0.908	0.904	0.941
INSC_MRKT	Market-related rapid response	0.758	4											
INSC_SUPPL	Supplier-related rapid response	0.725	3											
OPERATIONAL PERFORMANCE (OP)				0.431	40.035	13	3.080	0.044	0.066	0.048	0.969	0.921	0.923	0.950
EFFIC	Increase efficiencies	0.721	4											
EFFECT	Increase effectiveness	0.802	3											

1. Capability connectivity (CC), consisted of two factors and describes the ability of supply chain partners' to rapidly and informally integrate capabilities to service an ad hoc market requirement. The first factor measures the access to collaborative processes and IT capabilities, collectively referred to as capability connectivity (CC_CONN). The second factor (REGUL) measures the effect of rules and regulation on the propensity of supply chain partners to coordinate their activities informally.
 - a. CC_CON – The construct relates to the importance of information technology and cross-company processes for the coordination of activities in highly dynamic markets, and is measured by four items:
 - i. Access to supply chain partners' non-confidential information (non_confid (Q2_3)),
 - ii. Access to supply chain partners' confidential information (confid (Q2_4)),
 - iii. Access to shared IT (shared_IT (Q2_7)), and
 - iv. Use of Internet-based supply chain systems and applications for coordination between supply chain partners (www_appl (Q2_8)).
 - b. CC_REGUL – The factor relates to the effect regulatory regimes have for the coordination of activities in highly dynamic marketsand, and is measured by four measures:
 - i. Effect of government regulation on establishing new collaborative arrangements rapidly with existing partners in a timely manner (exist_partn (Q4_1)).
 - ii. Effect of government regulation on establishing new collaborative arrangements rapidly with new partners in a timely manner (new_partn (Q4_2)).
 - iii. Effect of government regulators' lack of understanding of supply chain requirements (regul_no_underst (Q4_3)).
 - iv. Effect of government regulators' negative effect on investments (regul_no_invest (Q4_8)).
2. The single-factor relationship alignment (RA_RES_LNK) describes the ability to informally integrate resources across supply chain partners in the context of highly dynamic market situations, and is represented by four variables.
 - i. Trust being a prerequisite for informal relationships (trust_sc (Q3_1)).

- ii. Ability to rapidly integrate the resources of new partners (rapid _res_int (Q3_6)).
 - iii. Timeliness of communication between supply chain partners (rapid _comm (Q3_8)).
 - iv. Knowledge sharing amongst supply chain partners (share_kx (Q3_10)).
- 3. The construct 'Informally networked supply chain (INSC)' consists of two factors and measures the ability of supply chain partners to respond to transient opportunities in the context of highly dynamic markets.
 - a. The first factor INSC_MRKT measures market-orientated informal networking, and consists of four items.
 - i. Propensity of supply chain partners to informally coordinate their capabilities to expedite a customer order (inf_expedite (Q6_1)),
 - ii. Ability of supply chain partners to rapidly respond to complex customer requirements relating to order configuration (cmplx_cust (Q6_2)),
 - iii. Propensity of supply chain partners to informally work together to enter into new markets (inf_new_market(Q6_3)), and
 - iv. Access of supply chainpartners to sourcing alternatives in their supply chain networks, should unanticipated market needs so require (sourcg_opp (Q6_4)).
 - b. The second factor INSC_SUPPL measures supply-related informal networking, and consists of three items.
 - i. Rapid access to alternative sources for supplies (inf_altern_source (Q6_5)),
 - ii. Rapid access to contract manufacturing capacity (inf_opp_contmfg (Q6_7)), and
 - iii. Rapid access 3rd party logistics services (inf_opp_3PL(Q6_6)).
- 4. The construct Operational Performance (OP) relates to the effect informal networking has on company performance, and consists of two factors.
 - a. The first factor 'efficiency (EFFIC)' consists of four items that measure the operational efficiencies achieved by informally networking in the context of highly dynamic markets.
 - i. Reduce operational cost (red_cost (Q1_1)),
 - ii. Access to knowledge of supply chain partners (gain_kx (Q1_6)),

- iii. Opportunities for standardising supply chain service provision (std_service (Q61_11)), and
 - iv. Increase the responsiveness of the total supply chain (Q1_14)).
- b. The second factor ‘effectiveness (EFFECT)’ consists of three items
 - i. improve productivity (imp_prod (Q1_4)),
 - ii. reduce response times (red_resp_time (Q1_5)), and
 - iii. increase the ability to focus on core business (foc_core (Q1_2)) by informally networking in the supply chain.

As reported earlier, all constructs and their respective items achieved satisfactory unidimensionality, reliability, validity, and goodness-of-fit.

4. Conclusions and areas for future research

This paper contributes to enhancing the understanding of the newly emerging phenomenon of informal networking in supply chains and how it may yield operational efficiency and effectiveness gains. Four determinant of informal networking were derived: capability connectivity, describing the ability of supply chain partners to rapidly and informally integrate capabilities to service an ad hoc market requirement; relationship alignment or the ability to informally integrate resources across supply chain partners in the context of highly dynamic market situations; the informally networked supply chain itself, measuring the ability of supply chain partners to respond to transient opportunities in the context of highly dynamic markets; and finally operational performance which measures the effect informal networking has on company performance.

Results of this study could be implemented in areas like service- and knowledge management-businesses that could help other organizations deal with informal supply chain coordination, allowing different entities to focus on their core competencies. These firms could provide basic information about the developing network connectivities, using databases such as email repositories or other communication means, techniques such as text mining, graph /network theory, and advise parties where in the network informal coordination is forming and how to deal with the formation of informal networks or clusters. Such neutral third parties may further promote additional coordination of capabilities. The identification of such informal SC coordination could be beneficial not only to companies sourcing globally, but also for companies with limited capacity.

While this research contributes to a better understanding of informal networking, it has its limitations. Future research may investigate the effects of informally networked supply chains on a

broader array of measures of company performance, and additional measures of operational performance.

Currently, based on the constructs developed in this paper, structural models are being tested to interrelate connectivity, regulation, industry rules, and relationship alignment to the propensity of supply chain partners to informally coordinate their capabilities, expressed by the informally networked supply chain construct, in order to achieve operational performance gains in market conditions that are interimistic.

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