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Viewing supply chain integration through information-related elements

ABSTRACT

Although the concept of supply chain integration (SCI) is familiar to most researchers and decision-makers especially in the field of supply chain management (SCM), the actual mechanism as well as measuring and management of SCI are blurred. The case studies with regard to SCI mostly represent process industry such as automotive industry with sequential interdependencies between the integrated activities. However, environmental dynamics call for greater SCI to capture the benefits of coordinated activities and therefore, SCI is more likely to occur in industries with rapid changes in demand, technology or competition. Thus, firms will use SCI as a mechanism to control external dynamics. In addition to the lack of research of SCI in dynamic project environment, the integrative elements such as trust, mutuality, information exchange, openness and communication are less studied due to their complexity. All these integrative elements are also more or less directly related to information and knowledge sharing.

In this paper we have considered the information-related elements of single companies in two project industry clusters in the context of supply chain integration. The considered clusters are shipbuilding and construction both representing dynamic project industry with significant environmental turbulence and irregularity. The aim was to view the possibilities of single companies to integrate in each network considering both similarities and differences in information and knowledge sharing between the two clusters.

The viewpoint in this paper is based on a conceptual framework of integration elements building on the idea that SCI is an expression of collaboration and common goals to meet the objectives of a supply chain or a network. Therefore, three perspectives should be considered when managing companies towards SCI: the common goals perspective, the information and knowledge sharing perspective and the trust and commitment perspective. Here we focus on the elements related to information and knowledge sharing because of their central role also in defining common goals as well as building trust and commitment between the companies. After bringing out the conceptual model for SCI we then introduce the information-related statements to be empirically tested in two dynamic project clusters. The information-related statements are based on the conceptual framework and are grouped as follows: i) statements related to information technology, ii) statements related to information exploitation and iii) statements related to information flows. The focal differences and similarities between the two clusters will be identified based on this grouping. As a result, the opportunities and difficulties (i.e. possibilities) of integration in project business context in relation to information and knowledge sharing are expected to be identified.

The findings of our study reveal that information and knowledge sharing of the companies in a wittingly developed cluster, i.e. shipbuilding network, differs from a more heterogeneous construction industry network. However, both clusters call for radical SCM improvements in relation to information and knowledge sharing and utilizing ICT. Our study also shows that information-related drivers to improve or drivers impairing the company’s integration possibilities in a supply chain or network can be defined and detected.

Keywords: Information and knowledge sharing, supply chain integration, supply network

INTRODUCTION

Supply chain management (SCM) seeks to enhance competitive performance by integrating the internal functions within a company and effectively linking them with the external operations of suppliers, customers and other supply chain members. Supply chain integration (SCI) for one has been defined as "the degree to which a manufacturer (focal company) strategically collaborates with its supply chain partners and collaboratively manages intra- and inter-organizational processes, in order to achieve effective and efficient flows of products and services, information, money and decisions, to provide maximum value to the customer" (Flynn, Huo and Zhao, 2010). Also Pagell and Wu (2006) consider SCI as a process of interaction and collaboration in which companies work together in a cooperative manner to arrive at mutually acceptable outcomes. As previous definitions imply, SCI has been found to offer benefits such as reduced cost, superior customer service levels and improved responsiveness to changes in the marketplace (e.g. Jahre and Fabbe-Costes, 2005; Power, 2005). The role of SCI is important also in a dynamic environment. As Van Donk and van der Vaart (2005) among others point out, a high level of environmental uncertainty is a focal driving force aiming at more integrative practices. In other words, the level of integration needed depends largely on the amount of uncertainty and dynamics within the supply chain or network and to manage and diminish supply chain dynamics or the effects of it, a more thoroughly managed integration process is needed. (cf. Stonebraker and Liao, 2004)

However, the process of integration is not a simple one, as Cousins and Menguc (2006) state. Integration of supply chain activities requires dyadic involvement, i.e. consistent involvement of both the buyer and the supplier, and investing in socialization which is critical to integration success. Socialization implies the level of interaction and communication between various actors within and between the firms. (Cousins and Menguc, 2006) Furthermore, SCI is especially problematic in a dynamic business environment, such as one-off projects (c.f. Gosling and Naim, 2009). These supply chains are usually associated with large, complex projects varying in frequency, scope and scale. Accordingly, the phenomenon of SCI in its present state is not a foregone conclusion. For example Barrat (2004) talks about collaborative (or integrative) culture, cultural elements being trust, mutuality, information exchange, openness and communication which all are critical elements of integration. Barrat (2004) also stresses that these elements have been to a large extent ignored due to their complexity and therefore, deserve significant attention in research. Furthermore, all these cultural elements are more or less directly related to information and knowledge sharing.

With this research we intend to rise to the challenge of examining the integrative culture mentioned by Barrat (2004) and especially the elements related to information and knowledge sharing. The basic idea is to explore the information and knowledge sharing part of integration process in a project business environment and the opportunities and difficulties connected with it considering these formerly often ignored information-related elements.

Thereby, the aim of this study is to test the measures related to information and knowledge sharing in the context of SCI and to empirically consider the integration possibilities of companies in two dynamic clusters and thereby highlight the differences between these clusters. First we bring out a conceptual integration model including information and knowledge sharing elements as one part. Next we introduce the statements to empirically test the state of information and knowledge sharing in two dynamic project clusters. The statements are based on the above-mentioned framework for integration elements and are grouped as follows: i) statements related to information technology, ii) statements related to information exploitation and iii) statements related to information flows. The focal differences and similarities between the two clusters will be identified based on this grouping. As a result, the opportunities and difficulties (i.e. possibilities) of SCI in project business context in relation to information and knowledge sharing are expected to be identified.

INTEGRATION ELEMENTS RELATED TO INFORMATION SHARING

Alter (1999) divides integration into five levels (common culture, common standards, information sharing, coordination and collaboration) whereas Spekman et al. (1998) divide the three concepts of cooperation, coordination and collaboration into three distinct "levels of intensity" among actors. Cooperation is seen as a threshold level of interaction being a starting point for SCM. The next level of intensity is coordination, including mechanisms such as EDI, and the last level is termed collaboration. Collaboration requires high levels of trust, commitment and information sharing among supply chain partners and they also need to share a common view of the future. On the basis of this idea, a conceptual model of focal SCI elements is presented (Figure 1).

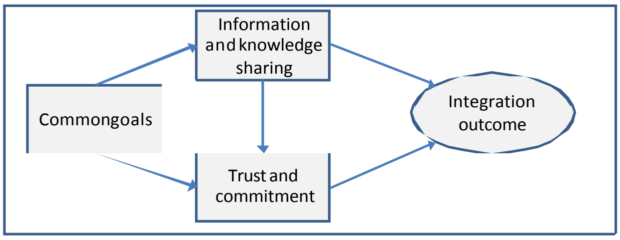

Figure 1 Conceptual model

Closer coordination is argued to help eliminate many non-value adding activities from internal and external production processes. In other words, better coordination translates directly into reduced variability, which leads to greater efficiency along with faster delivery of finished goods (Frohlich and Westbrook, 2001). Coordination among functions is a critical precondition for effective supply chain integration and, together with shared information, improves the ability of supply chains to react to sudden changes in volatile demand environments (cf. Fawcett and Magnan, 2002; Lee, So and Tang, 2000). Thus, coordination or collaboration with the right media, regarded as a critical element of integration, contributes to these performance improvements. (Breite and Koskinen, 2010) Benefits are expected to emerge when partners are willing to work together, understand each other's viewpoints, share information and resources and achieve collective goals. The flexibility and output performance of supply chains can also be improved by emphasizing integration and information sharing (Sezen, 2008) and coordination becomes possible when information is transparently shared among supply chain partners (Bagchi and Skjoett-Larsen, 2002; Bagchi, Chun Ha, Skjoett-Larsen and Soerensen 2005).

According to Bagchi et al. (2005) generating trust is easier among the partners in an integrated supply chain. Trust can be defined in the activities inherent in high-trust relationships, such as communication, informal agreement, absence of surveillance, and task-coordination (Currall and Judge, 1995). It promotes collaboration, decision realignment and reduces irrational behavior. According to Weick and Roberts (1993), co-operation is imperative for the development of the mindset, and trust is imperative for co-operation. According to Nonaka and Takeuchi (1995), building trust requires the use of face-to-face dialogue that provides reassurance on points of doubt and leads to willingness to respect the others' sincerity.

We can suggest that the success for individual company depends largely on the openness and extent of sharing of the outcomes of supply chain relationships. Thus we conclude that trust has an indirect effect on the options in the process of supply chain integration and especially in dynamic business environment, such as project business, the development of trust is in an essential role. We also suppose that the development of trust needs information and knowledge sharing, therefore the estimation of information sharing is important also in the context of trust.

Hereby we summarize that the main functions in SCI are interaction, collaboration, information sharing, trust, managing integrated chains of processes and cooperation to achieve the collective objectives. In our conceptual model, information and knowledge sharing is one of the focal SCI elements. Next, an operationalization of the elements was made in order to obtain information-related statements to be tested empirically. The statements are presented in Appendix 1.

Three types of information sharing activities are included in the survey questions: i) the flow of information in electric form, ii) the general flow of information and iii) the company's capability to manage and exploit information and communication technology (ICT). The element of electronic flow of information defines how well information flows in the supply chain in electronic form. The element of electronic flow of information can be divided into the following statements: *a) information is transferred electronically to the customer, b) information is transferred electronically from the customer, c) information is transferred electronically to the supplier, d) information is transferred electronically from the supplier, e) information is transferred electronically to the customer's customer, f) information is transferred electronically from the customer's customer, g) information is transferred electronically to the supplier's supplier and h) information is transferred electronically from the supplier's supplier.* The general flow of information defines how well information flows in the supply chain in general and how well the relationships function in the supply chain. The general flow of information can be divided into the following statements: a) *information flows well internally, b) information flows well towards the customers, c) information flows well towards the suppliers, d) the company exploits the interaction in internal relations as well as in customer and supplier relations and e) the company utilizes interaction in achieving SC goals.* The company's capability to manage information and communication technology (ICT) defines how well the company utilizes ICT in its supply chain management. This element can be divided into the following statements*: a) we manage well ICT, b) we exploit IT internally*, *c) we exploit IT on SC level, d) all the members of supply chain have access to the electronic databank and e) IT supports the company's goal achievement*.

RESEARCH DESIGN

The research adopted an empirical approach to explore the information-related elements of the companies in shipbuilding and construction industry. A sample of 392 organizations from the Finnish shipbuilding cluster database and a sample of 500 organizations from the Finnish construction industry database were surveyed. An Internet-based survey was administered. In shipbuilding cluster a total of 48 complete responses were received of which 1 was deemed unusable due to the nature of the organization (not a company). The effective response rate was thus 12.0 percent (47/392). Of the responding firms, 49 percent were in the maritime industry, 15 percent were engineering workshops, 2 percent information technology companies, 6 percent port service, shipping and construction industry both 2 percent and 24 percent were in industries classified “other”. The response by position held within the supply chain was subcontractor (43 percent), turnkey supplier (43 percent), materials supplier (8 percent) and components supplier (6 percent). The response by position held within the firm was owner/entrepreneur/senior management (48 percent), middle management (22 percent), specialist (20 percent) and clerical staff (6 percent). Four percent of respondents were in positions classified as “other”. 72 percent of respondents had more than 26 years’ experience in the industry. All respondents had more than 11 years’ experience in the industry.

In construction cluster a total of 71 complete responses were received. The effective response rate was thus 14.0 percent (71/500). Of the responding firms a majority (54 percent) was in the new construction industry and 27 percent were in renovation. A total of 20 percent of the respondents did not either answer to this question or did not give a complete answer. The response by position held within the supply chain was main contractor (82 percent) and subcontractor (1 percent). 17 percent of the respondents did not give a complete answer to this question. The response by position held within the firm was owner/entrepreneur/senior management (39 percent), middle management (41 percent), specialist (4 percent) and clerical staff (8 percent). A total of 7 percent of respondents were in positions classified as “other” or did not give a complete answer to this question. 56 percent of respondents had more than 26 years’ experience in the industry. All respondents had more than 5 years’ experience in the industry. The respondents both in shipbuilding and in construction cluster are expected to be the contact persons between the focal company and the cluster. Thereby, the respondents are supposed to have a sufficient view of their own company and its position in relation to the whole network.

As Bagchi et al. (2007 and 2005) state, SCM and SCI cover a wide range of management activities and functional areas leading to difficulty finding respondents with a comprehensive knowledge of the whole area. This fact might have influenced the response rate somewhat. However, both response rates (12.0 % and 14.0 %) are considered acceptable considering the length (68 statements in total) and complexity of the questionnaire of which this paper reports only the part connected to information and knowledge sharing.

The survey included demographic questions on age, gender, education, working experience and job status. The items were measured on a sliding scale ranging from strongly disagree to strongly agree. There was also a possibility to choose a response “neither agree nor disagree” to every statement. Tests for non-response bias were conducted by comparing early respondents (responses received during the first two weeks) and later respondents (responses received during the third week). An independent-samples t-test of difference was conducted on firm size (number of employees and revenue). No statistically significant differences were identified at $p<0.05$. This indicates that the study does not suffer from a serious non-response bias.

RESULTS

In determining the measurement properties of the constructs used in the analysis, the reliability and construct validity of the variables were assessed. Reliability, i.e. estimating the internal consistency of the items, is estimated through Cronbach´s coefficient alpha (Cronbach, 1951) (Table 1 for both clusters). A high level of Cronbach´s coefficient alpha indicates better reliability of the scale; with an alpha score higher than 0.7 is generally considered acceptable. Reliability analyses in Table 1 shows a high degree of internal consistency among research variables. In Table 1 “Managing ICT” refers to Table 4

“Company’s capability to manage ICT” and “General flow of information” refers to Table 3 “General flow of information” respectively.

Table 1 Cronbach´s alpha for reliability in construction and shipbuilding clusters

Constructioncluster= CC Shipbuildingcluster= SC	Cronbachs Alpha
ManagingICT	CC 0.79 SC 0.85
Generalflow of information	CC 0.87 SC 0.79

Electric flow of information

As previously mentioned information and knowledge sharing in both clusters was examined by using the following elements: the electric flow of information, the general flow of information and the company’s capability to manage information. The electric flow of information defines how a company shares information in electric form in extended supply chain, that is, to its supplier, supplier’s supplier, customer and customer’s customer and vice versa. The alternative answers for these statements were either “Yes” or “No”. As Table 2 reveals, in the construction cluster (CC) 55 percent (36/66) of the companies share information to their customer in electronic form and in the shipbuilding cluster (SC) correspondingly 96 percent (45/47). 55 percent (36/66) of the companies in CC and 87 percent (41/47) of the companies in SC receive information from their customers in electronic form. Information sharing by suppliers to focal companies in electronic form was 53 percent (35/66) in CC and 70 percent (33/47) in SC. 56 percent (37/66) of the companies in CC and 72 percent (34/47) of the companies in SC have electronically shared information to their suppliers. (cf. Table 2)

When the electronic flow of information between the companies and their suppliers’ suppliers and customers’ customers was examined the following results were received: In CC the sharing of information to customer’s customers in electronic form was 12 percent (8/66) and 36 percent (17/47) in SC. In CC, 9 percent (6/66) of the companies and in SC, 17 percent (8/47) of the companies have electronically shared their information to supplier’s suppliers. Correspondingly in CC 9 percent (6/66) of customer’s customers and in SC 30 percent (14/47) of customer’s customers have electronically shared their information to focal companies (i.e. their suppliers). In CC 11 percent (7/66) of supplier’s suppliers and in SC 17 percent (8/47) of supplier’s suppliers have electronically shared information to focal companies (i.e. their customer). (cf. Table 2)

Table 2. Flow of information in electronic form

Company's information flow to customer

Construction cluster (CC) Shipbuilding cluster (SC)		Inf. flow to customer: Yes	Inf. flow to customer: No	Total
CC	Count	36	30	66
	% within	44 %	94 %	58 %
SC	Count	45	2	47
	% within	56 %	6 %	42 %
Total	Count	81	32	113
	% within	100 %	100 %	100 %

Customer's information flow to company

Construction cluster (CC) Shipbuilding cluster (SC)		Inf. flow to company: Yes	Inf. flow to company: No	Total
CC	Count	36	30	66
	% within	47 %	83 %	58 %
SC	Count	41	6	47
	% within	53 %	17 %	42 %
Total	Count	77	36	113
	% within	100 %	100 %	100 %

Company's information flow to supplier

Construction cluster (CC) Shipbuilding cluster (SC)		inf. flow to supplier: Yes	inf. flow to supplier: No	Total
CC	Count	37	29	66
	% within	52 %	69 %	58 %
SC	Count	34	13	47
	% within	48 %	31 %	42 %
Total	Count	71	42	113
	% within	100 %	100 %	100 %

Supplier's information flow to company

Construction cluster (CC) Shipbuilding cluster (SC)		Inf. flow to comapny: Yes	Inf. flow to comapny: No	Total
CC	Count	35	31	66
	% within	51 %	69 %	58 %
SC	Count	33	14	47
	% within	49 %	31 %	42 %
Total	Count	68	45	113
	% within	100 %	100 %	100 %

Company's information flow to customer's customer

Construction cluster (CC) Shipbuilding cluster (SC)		to customer´s customer: Yes	to customer´s customer: No	Total
CC	Count	8	58	66
	% within	32 %	66 %	58 %
SC	Count	17	30	47
	% within	68 %	34 %	42 %
Total	Count	25	88	113
	% within	100 %	100 %	100 %

Customer's customers' information flow to company

Construction cluster (CC) Shipbuilding cluster (SC)		to company: Yes	to company: No	Total
CC	Count	6	60	66
	% within	30 %	65 %	58 %
SC	Count	14	33	47
	% within	70 %	35 %	42 %
Total	Count	20	93	113
	% within	100 %	100 %	100 %

Company's information flow to supplier's supplier

Construction cluster (CC) Shipbuilding cluster (SC)		to supplier's supplier: Yes	to supplier's supplier: No	Total
CC	Count	6	60	66
	% within	43 %	61 %	58 %
SC	Count	8	39	47
	% within	57 %	39 %	42 %
Total	Count	14	99	113
	% within	100 %	100 %	100 %

Supplier's supplier's information flow to company

Construction cluster (CC) Shipbuilding cluster (SC)		to company: Yes	to company: No	Total
CC	Count	7	59	66
	% within	47 %	60 %	58 %
SC	Count	8	39	47
	% within	53 %	40 %	42 %
Total	Count	15	98	113
	% within	100 %	100 %	100 %

General information flow

As previously mentioned, the general information flow contains the statements as follows: *information flows well internally, information flows well towards the customers, information flows well towards the suppliers, the company exploits the interaction in internal relations as well as in customer and supplier relations and the company utilizes interaction in achieving SC goals* (see Table 3). These statements were measured on a sliding scale ranging from "strongly disagree" to "strongly agree" the scale rating from 0 to 100. The independent samples' test (t-test) revealed that there are no significant differences in the mean values between the clusters. (See Appendix 2) The standard deviation in every value was quite large (approximately 20) and the mean values varied from 56 to 78. The mean values of "Internal information flow" were 69 in both clusters and the mean values of "Information flow to customer" were 67 in CC and 69 in SC. Correspondingly, the mean values of "Information flow to supplier" were 64 in CC and 56 in SC, the mean values of "Utilization of relationship" were 75 in CC and 78 in SC, and the mean values of "Utilization of relationship in supply chain management" were 62 in CC and 60 in SC.

Table 3 General flow of information

Construction cluster = CC, Shipbuilding cluster = SC		N	Mean	Std. Deviation	Std. Error Mean
Internal information flow	CC	39	68,6923	23,21881	3,71799
	SC	47	69,3617	21,44906	3,12867
Information flow to customer	CC	39	66,7179	20,12193	3,22209
	SC	47	69,2553	20,23929	2,95220
Information flow to supplier	CC	39	64,1026	20,05361	3,21115
	SC	47	56,1277	29,03043	4,23452
Utilization of relationship	CC	39	74,6923	22,94519	3,67417
	SC	47	78,2340	18,10262	2,64054
Utilization of relationship in SCM	CC	39	61,5897	24,21909	3,87816
	SC	47	60,0000	24,59056	3,58690

Company's capability to manage ICT

A company's capability to manage ICT contains the statements as follows: *we manage well ICT, we exploit IT internally, we exploit IT on SC level, all the members of supply chain have access to the electronic databank and IT supports the company's goal achievement* (see Table 4). These statements were also measured on a sliding scale ranging from "strongly disagree" to "strongly agree" the scale rating from 0 to 100. The independent samples' test (t-test) revealed that there are no significant differences in mean values between the clusters except for the statement of "IT supports company's goals", where the value of the significance level was 0.02, (if the significance value is < 0.05 then the value is statistically significant.) (See Appendix 2) The standard deviation in every value was quite large (ranging from 20 to 36) and the mean values varied from 38 to 70. The mean values of "Managing ICT" were 56 in CC and 64 in SC and the mean values of "Utilization of IT in internal activities" were 63 in CC and 70 in SC. In addition, the mean values of "Utilization of IT in SCM" were 51 in CC and 59 in SC, the mean values of "Members of supply chain have access to data bases" were 44 in CC and 38 in SC and the mean values of "IT supports company's goals" were 55 in CC and 70 in SC.

Table 4 Company's capability to manage ICT

Construction cluster = CC, Shipbuilding cluster = SC		N	Mean	Std. Deviation	Std. Error Mean
Managing ICT	CC	39	55,8205	24,27135	3,88653
	SC	47	64,0213	24,60337	3,58877
Utilization of IT in internal activities	CC	39	63,3077	21,15252	3,38711
	SC	47	69,7447	25,36213	3,69945
Utilization of IT in SCM	CC	39	51,4615	18,48164	2,95943
	SC	47	59,0638	28,59645	4,17122
Members of supply chain have access to data bases	CC	39	43,8462	29,24267	4,68257
	SC	47	37,7447	36,24462	5,28682
IT supports company's goals	CC	39	54,5385	28,46775	4,55849
	SC	47	69,5745	30,13502	4,39564

CONCLUSIONS AND DISCUSSION

The idea of this paper was to test the measures related to information and knowledge sharing to empirically explore the integration possibilities of companies in two dynamic and different networks thereby highlighting the differences and similarities of integration potential and possibilities between these clusters. Information and knowledge sharing was examined by using the following classification: the electric flow of information, the general flow of information and a company's capability to exploit and manage information.

The results concerning the electric flow of information indicate that in the shipbuilding cluster, the electric flow of information from the companies to the customer and supplier is much better than in the construction cluster. In the construction cluster 55 % of the companies share information to their customer in electronic form, in the shipbuilding cluster correspondingly 96 %. 56 % of the companies in the construction cluster and 72 % of the companies in the shipbuilding cluster have electronically shared information to their suppliers. Also the electric flow of information from the customer and supplier to focal companies is much better in the shipbuilding cluster than in the construction cluster. 55 % of the companies get information from their customers in electronic form in the construction cluster and correspondingly 87 % of the companies in the shipbuilding cluster. Information was shared by suppliers to focal companies in electronic form in 53 % of the companies in the construction cluster and in 70 % of the companies in the shipbuilding cluster. We can state that in the construction cluster, companies' information systems and their utilization have not been fully developed. Furthermore, there also seems to be requirement to improve the efficiency of information flow in both clusters.

The consideration also reveals that companies in both clusters have loose information flow couplings to their customers' customers and suppliers' suppliers which are in line with the findings of Stanley and Gregory (2002). Information was shared to customer's customer in electronic form only in 12 % of the companies in the construction cluster and in 36 % of the companies in the shipbuilding cluster. Only 9 % of the companies in construction cluster and 17 % of the companies in the shipbuilding cluster have electronically shared information to supplier's suppliers. Correspondingly, only 9 % of customer's customers in the construction cluster and 30 % of customer's customers in the shipbuilding cluster have electronically shared information to focal companies. Only 11 % of supplier's suppliers in the construction cluster and 17 % of supplier's suppliers in the shipbuilding cluster have electronically shared information to focal companies. We can conclude that in both clusters there is a call for radical supply chain management improvements, especially from the viewpoint of information and knowledge sharing.

As mentioned above, the general flow of information in both the clusters was estimated by using the drivers as follows: "Internal information flow", "Information flow to customer", "Information flow to supplier", "Utilization of relationship" and "Utilization of relationship in SCM". The independent samples' test (t-test) revealed that there are no significant differences in the mean values between the clusters. Standard deviation in every value was quite large (about 20) and the mean values varied from 56 to 78. We can thereby state that the companies in both clusters manage information generally quite similarly.

The mean values of "Internal information flow" were 69 in the both cluster and the mean values of "Information flow to customer" were 67 in the construction cluster and 69 in the shipbuilding cluster. These mean values indicate that generally, the internal information flow and information flow to the customers are quite well managed. Correspondingly, the mean values of “Information flow to supplier” (64 in the construction cluster and 56 in the shipbuilding cluster) indicate somewhat poorer information management with suppliers. The mean values of “Utilization of relationship” (75 in the construction cluster and 78 in the shipbuilding cluster) represent quite good relationship management in both the clusters. However, the mean values of “Utilization of relationship in supply chain management” (62 in the construction cluster and 60 in the shipbuilding cluster) manifest the lack of supply chain management in both clusters.

A single company’s capability to manage ICT was defined using the drivers as follows: “Managing ICT”, “Utilization of IT internal activities”, “Utilization of IT in SCM”, “Members of supply chain have access to data bases” and “IT supports company’s goals”. The independent samples’ test (t-test) revealed that there are no significant differences in the mean values between the clusters except for the statement of IT supporting company’s goals, where the value of the significance level was 0.02. Standard deviation in every value was quite large (ranging from 20 to 36) and the mean values varied from 38 to 70. These deviations clearly manifest that both clusters contain heterogeneous groups of companies whose capabilities to manage and exploit ICT differ strongly.

The mean values of “Managing ICT” (56 in the construction cluster and 64 in the shipbuilding cluster) represent somewhat good general ICT management in the clusters. Also the mean values of “Utilization of IT in internal activities” (63 in the construction cluster and 70 in the shipbuilding cluster) indicate that companies utilize IT in their internal activities quite well. However, in the companies’ supply chain management, the utilization of IT is clearly poorly managed. The mean values of “Utilization of IT in SCM” were 51 in the construction cluster and 59 in the shipbuilding cluster and especially the mean values of “Members of supply chain have access to data bases” (44 in the construction cluster and 38 in the shipbuilding cluster) highlight that supply chain integration has not been fully realized with ICT.

The results seem to support the mindset that in a dynamic project environment the chances for supply chain integration are hard to achieve. Although we focused only on information and knowledge sharing part of SCI in the selected clusters, we can still contend that the conceptual framework of supply chain integration is fruitful in further research when a single company’s integration potential in a network is examined in more detail. For managers, the framework proffers a practical and new way to estimate a company’s position and competence in a network.

There are surely a few limitations in interpreting the findings of our study. First, we have a limited database and therefore we consider these to be initial results on this complex issue of SCI in dynamic project environment. Second, the data comes from a diverse set of firms. Thus we have got an overview of the situation in Finnish shipbuilding and construction clusters, neither a detailed analysis of certain companies´ situation nor an analysis of particular supply chains. Third, we had to develop new information-related measures for integration potential. The fit criteria indicate that we have put together a valid set of items. That is, this paper provides information and knowledge management measures to empirically explore the phenomenon of integration potential and possibility in a dynamic project business environment.

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APPENDIX 1

Information-related research statements
We manage well information technology
We exploit information technology inside our company
We exploit information technology on the supply chain level
I am familiar with our co-partners´ information systems
All the members in the supply chain have access to electronic databank/information needed
Information technology supports my company´s goal achievement
Information flows well inside our company
Information flows well towards our customers
Information flows well towards our suppliers
I regularly exploit the interaction in company´s internal relations
We regularly exploit the interaction in customer relationships
We regularly exploit the interaction in supplier relationships
We regularly exploit the interaction in achieving the supply chain goals
Information is transferred electronically towards the customer/from the customer/towards the supplier/from the supplier/towards the customer´s customer/from the customer´s customer/towards the supplier´s supplier/from the supplier´s supplier

APPENDIX 2

Independent Samples Test in the Case of General Flow of Information

		Equality of Variances		t-test for Equality of Means						
									Interval of the	
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
Internal information flow	Equal variances assumed	,626	,431	-,139	84	,890	-,66939	4,82316	-10,26077	8,92198
	Equal variances not assumed			-,138	78,397	,891	-,66939	4,85922	-10,34258	9,00379
Information flow to customer	Equal variances assumed	,129	,721	-,580	84	,563	-2,53737	4,37245	-11,23246	6,15772
	Equal variances not assumed			-,581	81,269	,563	-2,53737	4,37005	-11,23197	6,15723
Information flow to supplier	Equal variances assumed	4,298	,041	1,451	84	,150	7,97490	5,49442	-2,95134	18,90115
	Equal variances not assumed			1,501	81,494	,137	7,97490	5,31438	-2,59808	18,54789
Utilization of relationship	Equal variances assumed	,591	,444	-,800	84	,426	-3,54173	4,42652	-12,34436	5,26089
	Equal variances not assumed			-,783	71,610	,436	-3,54173	4,52460	-12,56219	5,47872
Utilization of relationship in SCM	Equal variances assumed	,131	,718	,301	84	,765	1,58974	5,29018	-8,93037	12,10985
	Equal variances not assumed			,301	81,533	,764	1,58974	5,28261	-8,91995	12,09944

Independent Samples Test in the Case of Managing ICT

		Levene's Test for Equality of Variances		t-test for Equality of Means						
									95% Confidence Interval of the Difference	
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
Managing ICT	Equal variances assumed	,462	,498	-1,548	84	,125	-8,20076	5,29679	-18,73402	2,33249
	Equal variances not assumed			-1,550	81,488	,125	-8,20076	5,29002	-18,72530	2,32377
Utilization of ICT in internal activities	Equal variances assumed	1,051	,308	-1,262	84	,211	-6,43699	5,10130	-16,58147	3,70750
	Equal variances not assumed			-1,283	83,996	,203	-6,43699	5,01582	-16,41150	3,53753
Utilization of ICT in SCM	Equal variances assumed	12,199	,001	-1,430	84	,156	-7,60229	5,31604	-18,17383	2,96925
	Equal variances not assumed			-1,486	79,562	,141	-7,60229	5,11442	-17,78117	2,57659
Members of supply chain have access to data bases	Equal variances assumed	10,184	,002	,847	84	,399	6,10147	7,20431	-8,22509	20,42803
	Equal variances not assumed			,864	83,945	,390	6,10147	7,06236	-7,94295	20,14589
ICT supports company's goals	Equal variances assumed	,060	,806	-2,362	84	,021	-15,03601	6,36655	-27,69660	-2,37541
	Equal variances not assumed			-2,374	82,557	,020	-15,03601	6,33258	-27,63224	-2,43977