Communications of the IIMA

Volume 12 | Issue 2 Article 4

2012

Perception of Information Technology Enablers for Effective Supply Chain Management

Fedor Brookman
HU University of Applied Sciences Utrecht

Jakobus Smit
HU University of Applied Sciences Utrecht

A.J. Gilbert Silvius
HU University of Applied Sciences Utrecht

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Fedor Brookman
HU University of Applied Sciences Utrecht
fedor.brookman@student.hu.nl

Jakobus Smit
HU University of Applied Sciences Utrecht
kobus.smit@hu.nl

A. J. Gilbert Silvius
HU University of Applied Sciences Utrecht
gilbert.silvius@hu.nl

ABSTRACT

This paper reports a study on the importance of enablers in order for IT to support effective supply chain management, as perceived defined by different positions in the supply chain. In the study, a significant difference for the enabler "Funds for IT enablement" is found between the supplier position and other positions. Furthermore relations between the enablers are examined and research is done into why certain factors are being perceived more important than others.

Keywords: Supply chain management, information technology, IT management, IT integration.

INTRODUCTION AND BACKGROUND

Research into supply chain management (SCM) and information technology (IT) have been around for several decades (Cooper, Lambert, & Pagh, 1997). What we have learnt from this, amongst other things, is that competition is no longer only between businesses. Instead whole supply chains are competing against each other to deliver the best result to the customer (Cox, 1999; Kumar, 2001; Lambert & Cooper, 2000). Different scholars also emphasize that supply chains are becoming more demand driven: must produce more customized goods, have shorter lead times, and are required to offer cheaper products (Cooper et al., 1997; Pereira, 2009; Subramani, 2004). This asks for a more agile and flexible supply chain (Christopher & Towill, 2000; Faisal, Banwet, & Shankar, 2006, 2007).

In order to meet these demands organizations are trying to make their supply chains more agile and form virtual enterprises (Gunasekaran & Ngai, 2004). In the supply chain management field it therefore becomes ever more important to collaborate and integrate with business partners in order to deliver the best possible end product to the customer (Cooper et al., 1997; Pereira, 2009; Subramani, 2004). It is not surprising therefore that information sharing is one of four key

concepts for coordination among the supply chain according to Simatupang, Wright and Sridharan (2002). The exchange of information is the foundation of collaboration.

Since SCM is about collaboration and integration, this also includes the integration of processes and functions in the supply chain (Cooper et al., 1997; Li, Yang, Sun, & Sohal, 2009). Considering the high demands for integration and collaboration it is logical that IT has become increasingly important in the various positions in the supply chain. Interest in research has therefore also shifted towards the role of IT in SCM; and by implication also some focus on the conditions that make it possible for IT to support SCM. Jharkharia & Shankar (2004) use in this regard the term enablers since the question focuses on things that make it possible for IT to support SCM.

A more specific area of interest within this line of enquiry is the focus on the role of IT in the different positions in the supply chain. Iskandar, Kurokawa, and LeBlanc (2001) for instance studied electronic data interchange (EDI) adoption differences in first and second tier automotive suppliers and found significant differences between the two tiers, signaling the possibility that different levels of importance are ascribed to IT enablers in different positions in the supply chain. According to Jharkharia & Shankar (2004) consensus among the partners is of great importance for an effective supply chain. In this context consensus among partners should be reached about what enablers are important in order for IT to be able to support the supply chain and strive for enhancement of integration and collaboration. An interesting question therefore is: *How does the perceived importance of certain IT-enablers differ in each position of the supply chain?*

This paper reports a study that aimed to identify the importance that each position in the supply chain ascribes to different IT enablers. This research builds on and contributes to existing research in the topics but also makes a contribution to practice by highlighting these different perspectives and providing some concrete aspects that may need to be addressed to foster integration and collaboration in supply chains. Although not the focus of this paper, the findings may then be used to inform further research on how to strategize for successful supply chain management.

The following section provides a review of recent research on the topic, This is followed by a description of the research method, a discussion of the findings and finally the concluding section.

LITERATURE REVIEW

According to Chopra & Meindl (2007) the objective for every supply chain should be to maximize the overall value generated. Effective supply chain management and an efficient supply chain involve the management of supply chain assets, products, information and funds in order to maximize profitability. Chopra & Meindl (2007) identified different positions in the supply chain: supplier, manufacturer, distributor, retailer and customer. In this chain and between the positions each supply chain exists of a material flow downstream and an information flow upstream (Naylor, Naim, & Perry, 1999).

Some research has been done on the role of IT in optimizing the supply chain needs. It has become clear that IT has had a substantial impact on the development of SCM (Lee & Whang, 2000) and that information sharing across partners is a basic enabler for effective SCM (Jharkharia & Shankar, 2004). Lee, Padmanabhan, and Whang (1997), for example, conclude that distortions or delayed information cause the bullwhip effect in the supply chain. Barratt (2004) states that the exchange of information is the foundation of collaboration in the supply chain. And with the increase of new practices, such as vendor managed inventory, information sharing is becoming even more important (Chu & Lee, 2006). Subramani (2004) defines the role of IT in a supply chain as reducing costs, provide decision making support and improve customer service. The need for increased flexibility is also mentioned (Zhang, Vonderembse, & Lim, 2005).

Studies in SCM show that IT contributed to supply chain performance and integration, however, seems to be no consensus on *how* IT delivers the best results and on the value of IT. Several studies identified differences in perception between supply chain positions, or have been looking for differences (Choi & Rungtusanatham, 1999; Iskandar et al., 2001). Another indication for differences is companies who reside at a specific supply chain position might have different needs or strategies.

Gunasekaran & Ngai (2004) reported an extensive literature review from articles published since 1994 and proposed a classification scheme for the role of IT in SCM. In this scheme the researcher identified six major categories that focus on developing an IT-enabled SCM. Based on the classification scheme the researcher then proposed a model for IT-enabled SCM. The model consists of the six defined categories: Strategic Planning, Virtual Enterprise, Infrastructure, Knowledge and IT Management, Implementation of IT.

Jharkharia & Shankar (2004) elaborated on this study and specified the domains into enablers. In their study they identified ten enablers and measured the what extent an enabler is a driver for IT enabled SCM. In this way, they ranked the enablers on order of importance for enabling an IT-enabled supply chain. This results in shown in table 1.

Rank	*Enabler*	*Mean*	*STDV*
1	Supply-chain wide IT strategy	3.64	1.03
2	Profit sharing due to IT enablement	3.29	1.16
3	High level of supply chain integration	3.05	1.32
4	Top management commitment	2.91	1.18
5	Security of online information	2.81	1.27
6	Trust in supply chain linkages	2.73	1.19
7	Collaborative planning	2.71	1.26
8	Reliable IT infrastructure	2.63	1.14
9	Funds for IT enablement	2.53	1.37
10	Awareness about use of IT in supply chains	2.47	1.24

Table 1. Identified Enablers of an IT-enabled Supply Chain (Jharkharia & Shankar, 2004).

In our study we adopted this framework of enablers of an IT-enabled SCM to study the main research question. We explored the ranking of these enablers on different positions of the supply chain: Supplier, Manufacturer, Distributor, Wholesaler/Retailer (as identified by Chopra & Meindl, 2007). The next section reports the methodology of the study.

METHODOLOGY

In our study, the ranking of factors enabling an IT supported SCM, as reported by Jharkharia & Shankar (2004) were tested on different positions in the supply chain. The study is both deductive and descriptive in nature due to the testing of the theory formed by Jharkharia & Shankar (2004 & 2005) and the testing of the indications of differences in supply chain positions. In this study exploratory research was conducted by searching for relations and comparing the results of groups of respondents. This was done according to the procedures as proposed by (Bryman & Bell, 2007; Pallant, 2007)

Survey

In the study, a structured survey was used, that allowed quantitative analysis of the results. Because of the domain of the study, respondents were selected from positions in the logistics and IT fields. For example: supply chain managers, business logistics managers, information managers and IT-managers. The factors that are used in this study have a rather high level of abstraction, therefore only respondents with an overview of the supply chain and insight in all the factors were approached. Asking employees on lower levels in the organization would have involved the risk of unqualified responses. Data collection was done with the use of an online survey tool: Surveygizmo.

The questionnaire provided first an introduction to the respondent on why and how this research is conducted. Also confidentiality issues were mentioned. In the following section, the respondents had to answer some general questions in order to be able to classify the respondent: Where do they reside in the supply chain, are they a business or IT representative, in which supply chain they act and organizational size in terms of FTE's (full time equivalents). Respondents were then asked to rank each of the IT factors on a five point Likert scale ranging from very unimportant to very important (LS-Likert Scale). The same scale as used by Jharkharia & Shankar (2004). Respondents had to offer a short explanation to why they ranked the factor as they did. Only the enablers are tested, this also generates some insight on the barriers as they are the exact opposite of the enablers.

In order to get the respondents to rank the factors in relation to each other they had also to rank the factors from one to ten in another questions (RQ – ranking question). This question was used to verify the scores given in the section. As described, the tested IT-factors originate from other studies. In the expectation that respondents may find that another factor is more important/relevant an open question was added in which extra factors could be mentioned.

Furthermore respondents were asked about their perception of IT integration and collaboration with their respective supply chain partners. When asking this question it was made clear that by

integration the technical integration of IT systems was meant and by collaboration the partnership with the supply chain partner. This provided data through which a relationship between the ranking of certain factors end the perceived partnership with partners could be established. Together with company size this information might be leveraged to provide insights on power issues in the supply chain. In this particular question respondents were specifically asked about the predecessor and successor in the supply chain, these question are generated based on where the respondent resides in the supply chain.

Sampling

Respondents were chosen by taking a non-probability sample, the sample was chosen by using a convenience sampling method. All the respondents were approached through personal and business networks from the researcher. The researcher asked people in IT or logistics to fill out the survey. Other people in the personal network of the researcher were asked to provide the names and addresses of more people who may be willing to respond. Due to the fact that it was needed for some respondents to act in the same supply chain it was impossible to utilize a random sample method. Another reason for using a non-probability sample is that the respondents are restricted to be active in a multi-source supplier / buyer company, otherwise companies which are dictated by others would generate different results.

A total of 45 people were invited to participate and finally 28 respondents filled out the complete questionnaires and five respondents partially filled out a questionnaire that can be used with some analyses. This yielded a response rate of useful questionnaires of 73 percent. And a response rate for complete questionnaires of 60 percent. Responses were from different industries. All people that responded are employed in the Netherlands.

ANALYSIS

Each variable of the survey is classified into one of the following types (interval / ratio, ordinal, nominal, dichotomous) as proposed by (Bryman & Bell, 2007). This is done in order to be able to conduct the appropriate analysis. The answers to the Likert scale question were classified as a continuous variable, in the same manner as Jharkharia & Shankar (2004) did.

In order to be able to classify the open ended answers first all given answers were reviewed and the researcher observed reoccurring words and sentences. Based on this review raw categories were determined, these categories were also maintained in the codebook as proposed by (Pallant, 2007). This resulted in 31 categories. During this process four explanations were deleted as they did not provide any extra explanation. In order to classify the answers these were mapped onto the (Gunasekaran & Ngai, 2004) framework. This provides insight into which domains respondents provided the explanations.

Due to the fact that the data is not normally distributed and the sample is not random chosen non-parametric tests are used (Bryman & Bell, 2007; Pallant, 2007). In order to determine the level of internal consistency and to determine whether the same concept is measured (validity) a Cronbach's Alpha test is conducted for the likert scale questions. This test gives an indication

about the reliability of the data. This results in a Cronbach alpha score of .552 based on the ten variables. The value of .552 is somewhat low, the general assumption is that a value of .7 shows a high enough level of internal consistency (Bland & Altman, 1997).

If "Profit sharing due to IT enablement" would not be taken into account this would result in a Cronbach's Alpha from .684, which is satisfactory. However, in order to be able to compare the results to Jharkharia & Shankar (2004) all the ten enablers are used for analysis.

FINDINGS

Ranking Overall

Table 2 presents the mean scores for the perceived importance of the enablers of an IT-enabled SCM for all respondents. These results show that the respondents score the "reliable IT infrastructure" factor highest. They score "High level of Supply Chain integration" second highest. "Profit sharing due to IT enablement" is scored lowest. The analysis of the whole sample however reveals differences in ranking when compared to the results of Jharkharia & Shankar (2004). The most notable difference is that in Jharkharia & Shankar's research "Profit Sharing" ranked second with a mean score 3.29 and in this study the enabler was perceived least important for the IT-enablement of supply chain with a mean score 2.45.

Enabler	Rank	N	Range	Min.	Max.	Mean	STDV
LS: Reliable IT infrastructure	1	33	2	3	5	4,45	,711
LS: High level of supply chain integration	2	33	3	2	5	4,27	,801
LS: Top management commitment	3	33	2	3	5	4,21	,696
LS: Trust in supply chain linkages	4	33	4	1	5	4,00	,935
LS: Security of online information	5	33	3	2	5	4,00	1,118
LS: Supply-chain wide IT strategy	6	33	3	2	5	3,88	,893
LS: Awareness about use of IT in supply chains.	7	33	3	2	5	3,82	,727
LS: Collaborative planning	8	33	4	1	5	3,73	,876
LS: Funds for IT enablement	9	33	4	1	5	3,67	,957
LS: Profit sharing due to IT enablement	10	33	4	1	5	2,45	1,121
Valid N (listwise)		33					

Table 2. Perceived Importance of Enablers for an IT-enabled Supply Chain.

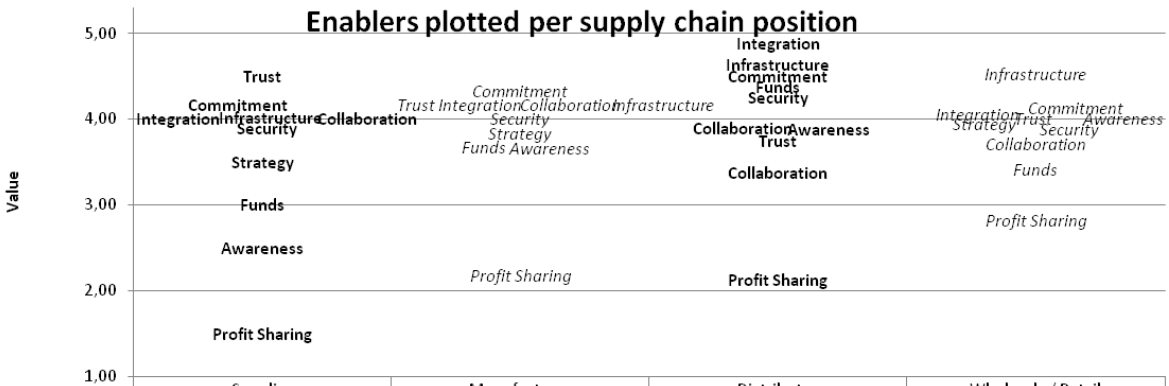
Analyzing the ranking question shows that the results look consistent with the responses to the Likert scale questions. Only small differences in ranking are found these are not due to the fact that less respondents answered this question, because when these respondents are excluded from the Likert scale question the same ranking is found. One of the differences for example is the sequence between "Top Management Commitment" and "High level of supply chain Integration" which have switched places in both questions. We can conclude that both questions

are answered approximately the same, this validates the results of both questions. In section 6.3, were relationships between the variables is explored, additional information about the consistency between these variables will be addressed.

Ranking by Position in the Supply Chain

Figure 1 shows how each enabler was ranked for each different supply chain position. In this figure, the enablers are plotted onto the grid according to their mean score. For example, "Trust" has an overall mean value of 4.50 at the position of the supplier, therefore "Trust" is plotted above the supplier position on a value of 4.5 on the Y-axis.

Figure 1 shows the differences in ranking of the enablers between different positions in the supply chain. In order to be precise enablers are printed bold and italic to emphasize the difference between each supply chain position (Supplier, Manufacturer, Distributor, Wholesaler/Retailer). It is important to be aware that the plotting of some enablers distorts a little bit due to a shortage of space when enablers had the same score. However, the scores in the table at the bottom of the figure are accurate.



	Supplier	Manufacturer	Distributor	Wholesale / Retail
Trust	4,50	4,17	3,75	4,00
Infrastructure	4,00	4,17	4,63	4,53
Security	4,00	4,00	4,25	3,88
Integration	4,00	4,17	4,88	4,06
Collaboration	4,00	4,17	3,38	3,71
Commitment	4,00	4,33	4,50	4,06
Strategy	3,50	3,83	3,88	3,94
Funds	3,00	3,67	4,38	3,41
Awareness	2,50	3,67	3,88	4,00
Profit Sharing	1,50	2,17	2,13	2,82

Figure 1. :Enablers Plotted Per Supply Chain Position.

By looking at the results it is obvious that "Profit Sharing" is ranked lowest among all different supply chain positions. Furthermore it can be noted that most values are around four points. It seems that the distributor gave the highest scores and by looking at the average of all the mean values this is confirmed. The distributor has an overall average score of 3.97 points, which is highest average of all the different supply chain positions.

A Kruskal-Wallis test conducted over all respondents divided by supply chain position reveals that only for the factor "Funds for IT enablement" a statistically significant difference exists between supply chain positions (Gp1, n = 2: Supplier, Gp2, n = 6: Manufacturer, Gp3, n = 8: Distributor, Gp4, n = 17: Wholesale / Retail), p = .04. The difference is significant when p < .05. The supplier recorded a median score of 3 points. The other 3 groups recorded a score of 4 points. The factor "High level of supply chain integration" almost has a significant difference with a score of .07. Other factors show no significant differences between supply chain positions.

Correlations

In order to explore the data further and to test whether relations exists between the identified enablers, correlations were tested. Non-parametric tests were used to analyze the data, Exploratory research for relations was done by conducting the Spearman's Rank Order Correlation (Rho) test (Pallant, 2007). No causality tests or tests for determining the direction of the relationships were conducted.

A strong positive significant correlation (r=.508) exists between "Top Management Commitment" and "Funds for IT enablement" at the .01 level with a Sig. 2 tailed of .003. This implies that when one of the factors is scored high the other most likely will also get a high score. Other notable positive significant relationships exist between "Supply chain wide IT strategy" and "Security of online information" with a significant correlation of .449 at the .01 level. "Top management Commitment" and "Reliable IT Infrastructure" also have a significant positive correlation. "Reliable IT Infrastructure" also has a significant positive correlation with "Security of online information." Between "Security of online information" and "Profit sharing due to IT enablement" exists a significant negative correlation of medium strength (r=-.364). This implies that when one of these factors receives a high score the other variable will record a low score. "Profit sharing" has nine negative correlation values, This can be explained because profit sharing is almost always ranked low, as described in section 7a. This ensures the identified negative correlations, although not significant but one.

It is also notable that for some variables almost no relationships exist, for example between the variables "Funds for IT-enablement" and "High level of supply chain integration" a correlation coefficient of .005 exists which indicates almost no relation at all.

In order to get more confidence in the data and to explore for further relations between variables the variables 11 to 20 (Likert Scale answers) and variables 31 to 40 (Ranking question answers) were tested on each other for correlations. This is also achieved by conducting the Spearman's Rho test, the test is conducted among 30 respondents.

Based on the test it can be concluded that for several IT-enablers correlations with other enablers exists when the enablers are tested by the respondent in two different questions. It is important to notice that negative correlations are expected to be found in this correlation matrix, for example between "LS: Security of Online information" and "RQ: Security of Online information". This occurs because the ranking question (RQ) is formulated negatively. A low number means that this respondent rated it as the most important factor. In the Likert scale question a high number indicates importance, therefore it was expected to find negative correlations between the LS and

RQ enablers. Conducting the Spearman's Rho test results in the fact that for 9 out of 10 enablers negative correlations were found. It was expected to find negative correlations between these variables. The only enabler that had a very little positive correlation was "Supply-chain wide IT strategy" with a score of r = .003. This is likely because this enabler was ranked 6th when comparing the Likert scale means and 4th by only reviewing the ranking question. The enabler ranked in the middle and because respondents are required to rank the enablers in the RQ questions small positive correlations can occur. These results provide confidence in the date and both questions validate each other by this test.

An interesting explorative topic is whether a relation exists between the perception of integration and collaboration and the IT-enablers. In order to determine whether this relationship exists, a Spearman's Rho test was conducted. Based on the mean values presented in previous tables it was expected to find correlations between the scores for integration and collaboration because the means of the two variables score close to each other. Conducting the Spearman's Rho test revealed three significant correlations. As expected strong correlations between Collaboration Predecessor and Integration predecessor exist with p = .721. A stronger correlation was found between Collaboration and Integration with the successor in the supply chain, p = .823. More interesting is the third correlation that was identified, this is a correlation between the likert scale enabler "High level of supply chain integration" and integration with the predecessor. A significant correlation of medium strength is identified with a value of p = .496. This means that when respondents rank their integration with their predecessor higher they also rank "High level of supply chain integration" higher. This could be due to a possible bias: when the personal belief of the respondent is that integration is important, he tends to score his own integration with his predecessors higher. No causality is proven by this correlation.

CONCLUSION

Because IT is a key enabler of effective SCM, and literature shows indications that different supply chain position have different needs or strategies regarding IT, this study explored the importance of the enablers of a IT-enabled SCM as perceived in the different supply chain positions.

It was expected to find the same ranking of importance for the IT factors as the study conducted by (Jharkharia & Shankar, 2004). However, this study resulted in another ranking based on Likert scales. The outcome of perceived overall importance is presented in table 2. The enablers are compared to the ranking of enablers as Jharkharia & Shankar (2004) identified them. The most notable difference is that "Profit Sharing" and "Reliable Infrastructure" score entirely different in the two studies. "Profit Sharing" is perceived most important in the study conducted by Jharkharia & Shankar (2004) and is perceived least important in our study. In the study by Jharkharia & Shankar, "Reliable infrastructure" was perceived less important (ranking of 8) and this was perceived most important in our study.

When looking at specific differences among supply chain positions, it was expected to find differences between positions because each position has different need. In this research differences based on mean score have been identified. The supplier, manufacturer, distributor

and wholesale / retailer, respectively perceived these factors most important "Trust in supply chain linkages" mean = 4.5, "Top management commitment" mean = 4.33, "Reliable IT infrastructure" mean = 4.63 and "Reliable IT infrastructure" mean 4.53. It is interesting to note that it that the supplier rates business enablers higher and at the end of the supply chain the IT infrastructure enabler is perceived as more important.

All positions perceived "profit sharing" to be the least important factor. All the mean scores can be found in the results section of this research. In order not to judge only on mean scores but to determine whether significant differences exists in perception between the different supply chain positions a Kruskal-Wallis test was conducted. This test showed that only for the IT enabler "Funds for IT enablement" a significant lower score was found for the supplier position. The supplier gave this enabler a median score of 3 points, while the other positions rated this enabler 4 points. Under the given circumstances we can conclude that the supplier is of the opinion that "Funds for IT enablement" are less important than the other positions.

Testing the answers for perceived importance the Likert scale question showed that for five relations between enablers medium to strong correlations has been identified. The correlation with the largest strength is the positive significant relation that is revealed between "Top Management Commitment" and "Funds for IT-enablement". We can conclude that when one of these factors score high the other most likely will also receive a high score. One of these five correlations is a negative correlation. A significant negative correlation exists between "reliable infrastructure" and "security of online information" which means that if one of these factors is being perceived more important the other will be perceived less important. These correlations are identified based on the Likert scale ratings given by respondents.

By testing for correlations between the two questions that were asked about the perceived importance lots of significant correlations were found, this is what was expected. This increases the confidence in the data as this indicates that the respondents answered these two questions synchronized with each other. An interesting positive correlation exists between the scores for integration with the predecessor and the enabler "High Level of Supply Chain Integration". When the enabler "High Level of Supply Chain Integration" is ranked important the score for integration with the predecessor will also most likely be higher.

In order to determine through which domains the IT-enablers and barriers relate to the business side of the supply chain it is expected of respondents to offer explanations to their given scores on enablers. By analyzing why certain factors are being perceived as important and the given explanations, we can conclude that most reasons for perceiving a factors as important can be found on the dividing line between "processes and collaboration" and "benefits and collaboration".

The research reported in this paper was aimed at clarifying perceptions of the importance of IT-enablers. This aim was achieved. However, further research is required and it is suggested that the focus for future research rests on two aspects. Firstly it is necessary to repeat this study in other industry contexts with bigger samples in order to provide further validation for the findings here. Secondly the findings of this investigation can be applied in a follow-up study aimed at

exploring the implications that these perceptions may have for implementation strategies for effective supply chain management.

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