

Supply chain management framework: dimensions and development stages

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Abstract

In the last decade the strategic role of operations has increased, which led to fast improvements in management and methodology. In parallel, two basic principles have been strengthened. One of the principles is the idea to concentrate on processes instead of organizational function based task orientation. The other principle is the extension of coordination and integration of value creating processes. Changes did not stop at the border of companies, the nature of inter-company relations has also changed according to the principles above. On the basis of these dimensions of supply chain management we hypothesized that companies go through three development stages: 1) transaction dominated companies, 2) internally integrated companies, 3) externally integrated companies. We assumed that these models are the results of historical development with increasing performance levels. We tested the hypotheses by IMSS data. The empirical analysis confirmed the existence of three very different and stable groups of companies along the dimensions.

Key words: SCM, IMSS data, general framework

Introduction

Supply chain management (SCM) is one of the most cited and analyzed concepts recently in logistics and operations management. Several researchers deal with SCM from research areas such as logistics, transportation, strategy, marketing, organizational behavior, economics etc. (Croom et. al. (2001)) analyzing various aspects of the phenomenon. It is also a fashionable term today in business circles. However, both managers and researchers are confused since very different things are discussed under this umbrella. There is no common and widely accepted definition for it.

That is why we started to develop a framework, collecting and using knowledge from related literature. Although the elements of the framework are not new, their combination and the identification of developmental stages, we believe, contributes to the SCM theory.

The purpose of this paper is to (i) support empirically the existence of three level of development stages in SCM, (ii) look at the different characteristics of these phases of SCM and (iii) investigate the operational and financial

consequences of staying at a particular development level.

The paper is set up as follows. After looking at the dimensions of SCM and other models on development stages our framework is described in detail. Then we test the framework by using IMSS survey data. Finally some conclusions are drawn.

Dimensions of supply chain management

The development of SCM concept is a consequence of a long-standing and ongoing development, taking place in the management of material flows and the transformation process itself (let us call it operations further on in the paper). The development in this field aims to leverage strategic positioning over competitors mainly through improved operational efficiency. We believe that *supply chain* can be seen as a given structure of collaborating companies working together in satisfying customer demand, and *SCM* is a conscious development and guidance of these relationships in order to gain competitive advantage for the collaborating chain

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members over other industry players (Bowersox et al, 2002; Harland et. al, 2001; Mentzer et. al, 2001 and others).

When collecting the most important dimensions of a successful SCM inevitably the first is the increasing strategic role and, in parallel, the increasing **strategic orientation** of operations (Stock and Lambert, 2001; Rudberg and Olhager, 2003). The final goal is to increase the competitiveness of companies and make operations to be able to contribute to the execution of firms' strategies (Hayes and Wheelwright, 1979). This can be accomplished through various programs and techniques, which appear within the company (e.g. ERP, new organizational forms) and along the supply chain both on the supplier side (e.g. vendor-managed inventories) and on the distribution side (e.g. efficient customer response, quick response, e-commerce or DRP). Although these programs and techniques can be very different they all recognize that operational efficiency is directly affected by uncertainties originated from (1) the uncertain demand that materials management faces and (2) the material flows that take place in the chain when satisfying this demand.

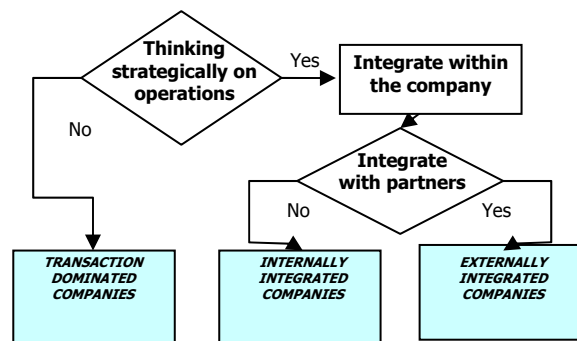
Uncertainties stemming from the demand side are strongly connected with the traditional anticipatory business practice and can be reduced by response based operation (Bowersox et. al, 2002). Response based business operation builds on accurate and timely deployment of concrete consumer demand data instead of traditional sales forecasts. The deployment process mainly can be supported by closer **coordination and integration** within the firm and between collaborating companies. Among the different coordination means (Lambert and Cooper (2000); Simatupang et. al, 2002) we think that the development of the planning and the strongly connected with it the development of information sharing processes has outstanding importance.

The second type of uncertainties originates from the materials processes, from the uncertainty of lead times. Reducing this increases the accuracy and the reliability of value creating business processes and consequently raises both their effectiveness and efficiency. Improving the performance of business processes (shorter lead time) and their accuracy

(more reliable lead time) necessitate a systematic approach focusing more on how to develop and connect business processes. Better performing business processes lead to a better fit between the actual demand and the amount of products inventoried and streamed along the logistics pipeline. The **process view** is one of the basic characteristics of today's operations management (Lambert and Cooper, 2000).

Finally a fourth important element of successful SCM is the type of **relations between collaborating partners** (Christopher and Jüttner, 2000). This determines the way companies cooperate with each other within a given chain. The changes taking place during the last two decade in partner relationships show a continuous advance between collaborating firms, with an increase in building long term relationships. The increased dedication to build long term partner relationships goes together with the increasing level of relation specific investments (Bensaou, 1999). Bensaou point out that the level of relation specific investment made by either partner significantly correlates with practices commonly associated with strategic partnership.

Figure1: Description of development stages in our model



Models on development stages in SCM

There are some researchers who gave typologies concerning the different development stages of operations and logistics management. The conceptual framework of **Ballou et al (2000)** builds a three stage model with following stages:

1. *Intrafunctional* coordination (administration of the activities and processes *within* the logistics function of the firm);
2. Coordination of *interfunctional* activities, such as between finance, logistics and production, logistics and marketing as they take place *among* the functional areas of the firm.
3. Coordination of *inter-organizational* supply chain activities that take place between legally separate firms within the product-flow channel, such as *between* firms and their suppliers.

The separating point between the stages is the *extent (scope) where companies try to manage processes*. Managing processes means the degree of control a product-flow manager has to *coordinate* the process. The model does not identify additional important operational characteristics, like strategic orientation, process view and partnerships management. Moreover, it is problematic to distinguish between intrafunctional and interfunctional levels, since materials/logistics management by definition connect functional areas (like marketing, finance, production).

Another classification is that of **Mentzer et al (2000)**. They suggest a continuum of *strategic, operational and transactional partnering* based upon the following aspects:

- 1) The orientation of the partners,
- 2) The degree of implementation of partnering between two independent firms.

Strategic partnering is a relationship designed to achieve long-term strategic objective and thus dramatically improve competitive positions of the collaborating firm. This can be achieved through for example common development of new technology or products. Operational partnering views the partner as a close associate, who tries to increase supply chain performance in the short term. Strategic initiatives are not shared with operational partners, but considerable operational coordination still occurs. Transactional buyer-seller relationship is treated on a purchase-by-purchase basis. The relationship between the buyer and the seller does not look beyond the scope of the individual purchase and, thus, does not address the level of operational coordination of operational partnering or strategic coordination. In this model the

type of relationships is the basic distinguishing factor. And relationship does happen through *coordination*.

Model description

On the basis of the literature we have raised four dimensions that are common in today's SCM. These are as follows:

1. *Increasing strategic role* of operations and operations management.
2. *Increasing level of coordination and integration* of material processes.
3. *Process view* getting more and more accepted and applied.
4. Building stronger *relationships* between collaborating partners.

Although the increase in the mentioned dimensions takes place usually by small steps, some milestones can be found along their development process. We conceptualize these milestones on the basis of two aspects: (1) Whether companies **realize the strategic importance** of operations or not? (2) Does the operations management have **an inside or an outside orientation**? Companies with an inside orientation make decisions on a company focus, while companies with an outside orientation take into account inter-company factors during decision making.

According to these two aspects we differentiate among three basic operating models, which represent different development phases in the field of operations and materials management. The three operating models outlined and investigated in this paper are:

1. *Transaction dominated companies* representing a starting point from which development has been started.
2. *Internally integrated companies* having recognized the strategic importance of the field and having a company-focused orientation while managing it.
3. *Externally integrated companies* realizing the strategic importance of materials management and operations and extending their management efforts beyond company's borders.

For **transaction dominated companies** the strategic importance of materials management and operations is low and as a consequence they do not stress those development aspects that are suitable for increasing competitiveness of this field. These companies do not invest in coordinating an integrating material processes, manage activities instead of company-wide processes and do not strive for building closer connections with collaborating companies.

Internally integrated companies can be characterized with the recognition of strategic importance of operations and with an effort to manage them in order to gain competitive advantage. This means that companies start to apply different coordination and integration techniques, among them heavily invest in developing planning procedures and information technology. They can be characterized with a process focus. Most of their improvement efforts focus on their own operation. Although they

start to build long-term relations with some partners, this is not accompanied by intensive use of relation specific investments. This operational model is very close to the model of integrated logistics management (Ballou, 1987; Magee et. al, 1985).

The basic difference between the internally and the externally integrated operating models lies in the dimension of managing partner relationships. Both model stress the strategic importance of operations, improve their coordination and integration with a process focus. The **externally oriented companies** spread this improvement efforts and management attitude beyond the company and improve operation and collaboration with partners significantly. This can be achieved only by investing heavily in important relationships and build strategic alliances. This operating model contains the basic elements of the SCM concept.

The short description of the three stages along the four dimensions are summarized in Table 1.

Table 1: The framework

Types	Transaction dominated companies	Internally integrated companies	Externally integrated companies
Dimensions			
<i>Strategic role of operations</i>	No	On company level	Both company and inter-company level
<i>Level of coordination and integration</i>	Low	On company level	Both company and inter-company level
<i>Process view</i>	No	On company level	Both company and inter-company level
<i>Partner relationship</i>	Short-term	Long-term	Strategic alliances

In order to see the difference between others' and our classification we summarized the main distinguishing features in Table 2.

Table 2: Comparison of different classifications in the literature and in this paper

	<i>Ballou et. al (2000)</i>	<i>Mentzer et. al (2000)</i>	<i>This paper</i>
Discussed dimensions	<ul style="list-style-type: none"> ▪ Level of coordination 	<ul style="list-style-type: none"> ▪ Level of coordination ▪ Type of relationships 	<ul style="list-style-type: none"> ▪ Strategic orientation ▪ Level of coordination ▪ Process view ▪ Type of relationship
Discussed scope of operations	<ul style="list-style-type: none"> ▪ Intrafunctional ▪ Interfunctional (equals to intracompany) ▪ Intercompany 	<ul style="list-style-type: none"> ▪ Intercompany 	<ul style="list-style-type: none"> ▪ Intracompany ▪ Intercompany

The survey

Our analysis is based on the IMSS-III survey (International Manufacturing Strategy Survey) conducted in 2001. Data collection was made by individual researchers who were responsible for their own countries. There was a suggested method of collecting data (phone call for invitation, mailing the questionnaire, reminding call) but researchers had the right to follow other paths. The survey is focused on the machinery sector with ISIC codes between 381-385 (metal production, machinery, electronic equipments, transportation equipments, measuring and controlling equipments, respectively). There are 382 companies with a size of 100 or above in the sample.

The steps of analysis

1. Our first objective was to *select variables* which can be used to analyze our framework. It is important to mention that the survey has been conducted for the time we created our framework. It means we had to make compromises at some points where we did not find the measure that we wanted to use. Although there were some questions in the questionnaire concerning various kinds of connection between the analyzed company and its customers, in this paper we concentrate our efforts only on the supplier side.
2. Second, *indexes were created* which represent the four dimensions (strategy, process focus, coordination and partnership). According to Babbie (1989) these indexes should contain variables which describe the dimensions from different aspects. Since these variables describe the same dimension they have to be correlated, but they should not be correlated too much, otherwise they do not add new information. After the indexes are created we have to test with a control variable if they really describe the given dimension. Also, we tested if there is correlation between the indexes. Since the indexes assumably represent the dimensions of SCM, the same arguments used at the variable level concerning the strength of correlation apply here.

3. Third, we used the indexes to *create clusters*. Since our framework contains three level of development (transactional, internally integrated and externally integrated companies) we used the k-means clustering method with a number of three. In order to see how reliable our clusters are we made alternative indexes which contained the control variables. It is important to mention here that we can not analyze development stages within one company. Rather, we assumed here that due to environmental, human, organizational etc. factors all the three development phases exist in practice.
4. Fourth, we characterized the clusters with some variables to see the main differences and to get more insight.

The results of the analysis

All the analysis were made with Statistica 5.0 program. We describe the results of the analysis in the order described.

Correlation between variables and creation of indexes

The selected variables and the correlations between variables can be seen in Table 3. On the basis of the results index 1, 3 and 4 seems to be well defined with the selected variables. The correlations are strong, sometimes extremely strong, but none of them can be considered as identical. There are problems with Index 2, since variables 21 and 22 do not correlate with 23. Also, there are some overlap between variables 23 and variables 31, 32 and 33, since all of them deals with ERP systems. Unfortunately, the questionnaire does not give too much opportunity to grid process focus. We selected the implementation of ERP programs, because the majority of such implementations require some BPR projects beforehand. We also thought to include the use of ISO 9000 programs in this variable (since ISO programs also requires at least to describe business processes) but since 83% of companies in the sample has the certification, this variable does not really differentiate companies. So irrespective of the bad

results in index 2 we decided to keep it as it is and see how it relates to the control variable.

After the correlation analysis indexes were created with taking the simple average of the included variable. For example, company X has the values of 4, 2 and 5 in variables 11, 12 and 13, respectively. Then index 1 for this company will be $(4+2+5)/3$, that is 3,67.

In the next step we analyzed the connection between the indexes on one hand, and between the indexes and the control variables on the other hand. We tried to choose variables which describe the given dimensions the most. All tested connections resulted in strong correlations which support our ideas.

Table 3: Correlations between variables*

Index 1: Strategy	11	12	13		
11 Existence of formal manufacturing strategy	1,00	0,26 ^a	0,20 ^a		
12 Influence of manufacturing on business strategy		1,00	0,14 ^b		
13 Actions to concentrate on your core activities and <u>outsourcing</u> support processes and activities			1,00		
Index 2: Process focus	21	22	23		
21 Goal to reduce manufacturing lead time	1,00	0,57 ^a	-0,03		
22 Goal to reduce procurement lead time		1,00	0,05		
23 Implementing ICT and/or ERP software			1,00		
Index 3: Coordination	31	32	33	34	35
31 Use of ERP in production planning and control	1,00	0,72 ^a	0,58 ^a	0,12 ^b	0,11 ^b
32 Use of ERP in purchasing and supply management		1,00	0,63 ^a	0,19 ^a	0,16 ^a
33 Use of ERP in sales and distribution management			1,00	0,20 ^a	0,14 ^a
34 Share information about inventory levels				1,00	0,49 ^a
35 Share information about production planning decisions and sales forecasts					1,00
Index 4: Partnership	41	42	43	44	
41 Investments in extranet/EDI systems	1,00	0,29 ^a	0,22 ^a	0,28 ^a	
42 Dedicated capacity, tools and equipment		1,00	0,54 ^a	0,54 ^a	
43 Dedicated storage and transportation			1,00	0,62 ^a	
44 Dedicated work force				1,00	

*casewise deletion of data within index variable correlations

Cluster analysis

Using the indexes we made cluster analysis (with case wise deletion of data in case of missing values, and with sorting distances and taking observations at constant intervals). The dimension values of the three clusters can be seen in Figure 2.

The clusters are significantly different in each dimension. The group of externally integrated companies contains 53 companies, the internally integrated group contains 89 companies, while there are 43 companies in the transaction dominated group. Other forms of initial clustering (choose observations

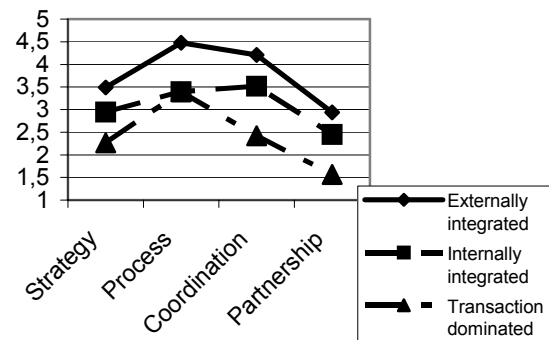


Figure 2: Dimension values of the three operating models

observations to maximize initial between cluster differences and choose the first N observations) produced very similar results; with several changes in the order of cases 90% of companies did belong to the same cluster). Also, the results of the control analysis, where the indexes includes the control variables produced very similar results (87,5% of companies have stayed in the same cluster).

Characteristics of stages

We can find fewer formal *strategies* inside **transaction oriented companies** and it results in inconsistency of decisions. For example, although they consider design and conformance quality as the most important competitive advantages, they have significantly lower level of preventive approach in maintenance and quality management, and when they select their suppliers, innovation ability of suppliers is among the lowest priorities. Also, their most important objective is to improve delivery reliability, quality is only on the second place. *Process focus* shows a bit better picture. The priority to reduce lead times, and the level of efforts to analyze processes are at the same level, than in the internally integrated group. Also, streamlining of production processes is relatively more usually used action than other ones. The methods of both internal and external *coordination* are old fashioned. Information systems are not integrated, the use of internet is almost not even started, and accordingly the share of information with partners can not be solved (they may be ready to share information but it usually does not exist). The level of dedicated and/or long term investments in *partnerships* (standards containers, co-location of plants) are low, which again shows a short term approach to business.

The **internally integrated group** is in the middle. They usually have some level of strategic planning, although they have a lag behind the externally integrated group. Interestingly there is no difference in *process index* between internally integrated and transaction dominated companies, although the signs of more efficient process focus in the internal integrated group can be seen in larger improvement in internal processing times. On the other hand, there is a large difference between internally and externally

integrated companies in this area. The level of using internal *coordination* tools, like ERP is significantly lower than in the best group and significantly higher than in the transaction dominated group. On the other hand, external coordination is just started, just as *relation* specific investments.

The **externally integrated group** has significantly better characteristics in the majority of fields. Their concentration on core activities, on rethinking supply strategy is significant. Their long term view come up in higher R&D investments and environmental consciousness. Process focus is among the highest priority both in actions and in goals. Process index have had the highest value for externally oriented companies among the four indexes, on the other the biggest difference between externally and internally oriented companies lies also in this dimension. Better performance on process dimensions (time and cost) seems to be a result of better strategy formulation and deployment: externally oriented companies think that their main performance dimensions with which they win order are time and, as a consequence, process related. Externally oriented companies put a significantly higher emphasis on long term performance dimensions of suppliers than the other two groups, like co-design ability of suppliers, supplier potential.

Concerning the *performance* of the three groups the results are not convincing. Neither ROS or ROI data are significantly different. The delivery reliability is also at the same level (around 12% of orders are late in all the three groups). There seems to be a difference, however in the dynamics of performance. In several areas the externally integrated group presents larger improvements.

Conclusions

The hypothesis on the existence of three development stages –transaction dominated, internally and externally integrated companies – is described in our framework using IMSS survey data. The analysis confirmed that the three stages differ from each other significantly. The signs of strategic thinking, as the most important theoretical differentiating factor, are really at a significantly lower level in transaction dominated firms. Also, the

external orientation, and long term view on partnership, as well as a very systematic process view can be detected in externally oriented companies. This latter may be explained by a higher emphasis on elements of time based competition that requires a very high dedication to process development. The relatively high level of process focus (as compared to other dimensions) in case of transaction oriented and internally integrated companies shows that developing internal business processes is a widely recognized and unavoidable mean of developing operations.

An important result is that companies seem to improve first on the operational level, by reorganizing their processes and implementing coordination tools. They are directed mainly by everyday decisions which force improvements in this field. Only then, they start to think strategically and try to prove that previous investments were not in vain. We think this should not be like that. On the other hand, it seems very logical, that long term partnerships go through the same process. We have to know and trust our partners before making long term investments.

All three development stages have shown similar financial performance levels, but there were slight differences in operational improvements, especially for the advantage of externally oriented companies. Since operational results are closer to measure efficiency in operations than financial ones, and also the multidimensional feature of financial performance measures can prevent to show the effect of the operational level, we think that different performance capabilities were partly confirmed. On the other hand, it is important to mention that - although there is a historical development path from transaction dominated to externally integrated companies - the three different models may be equally viable operating models in appropriate environment. It is normal, that less developed and isolated economies have less developed but very profitable companies. Also, smaller and second or third tier companies will never reach and never should reach the level of externally integrated companies, since the huge investments in information systems or in relations will never return. Thus we hypothesize that the position in the supply chain (part supplier, OEM, distributor) as

well as the economic environment leads to different development levels, but this requires further research.

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