Research paper

The development of a supply chain management process maturity model using the concepts of business process orientation

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Keywords

Supply chain management, Process management, Performance management, Modelling

Abstract

The concept of process maturity proposes that a process has a lifecycle that is assessed by the extent to which the process is explicitly defined, managed, measured and controlled. A maturity model assumes that progress towards goal achievement comes in stages. The supply chain maturity model presented in this paper is based on concepts developed by researchers over the past two decades. The Software Engineering Institute has also applied the concept of process maturity to the software development process in the form of the capability maturity model. This paper examines the relationship between supply chain management process maturity and performance, and provides a supply chain management process maturity model for enhanced supply chain performance.

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Introduction

Today's organizations are faced with increasing levels of global competition, demanding customers and employees, shrinking product lifecycles and decreasing acceptable response times. Competition in many industries has been based mainly on strategic assets (investments in scale, scope, brand equity) and on the ability to deploy these assets. However, competition is now based on capabilities, or "complex bundles of skills and accumulated knowledge, exercised through organizational processes" (Day, 1994). Corporations are also extending outside their legal boundaries as a normal way of organizing and forming competitive networks of companies. Thus, organizations need to develop strategically aligned capabilities not only within the company itself, but also among the organizations that are part of its value-adding networks.

Owing to this new business approach, many firms are now viewing processes as strategic assets. Under the new approach, organizations are no longer viewed as a collection of functional areas, but as a combination of highly integrated processes (Buxbaum, 1995; Hammer and Champy, 1993; Hammer, 1996, 1999). Additionally, processes are now viewed as assets requiring investment and development as they mature. Thus, the concept of process maturity is becoming increasingly important as firms adopt a process view of the organization. This concept proposes that a process has a lifecycle that is assessed by the extent to which the process is explicitly defined, managed, measured and controlled. The process maturity concept is analogous to that of a lifecycle, which occurs in developmental stages. This concept also implies growth in the areas of process capability, richness and consistency across the entire organization (Dorfman and Thayer, 1997).

The purpose of this paper is to present research findings that suggest a significant relationship between supply chain management maturity and performance. In addition, the paper provides a supply chain process maturity model that can be used to help facilitate enhanced supply chain performance. Contained in this paper is:

- a discussion on the concepts of business process orientation and process maturity;
- a discussion on the relationship between business process orientation, process maturity and supply chain management;
- the business process orientation maturity model;
- the supply chain management process maturity model;

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- statistical results relating supply chain management process maturity and performance; and
- conclusions regarding the relationship between supply chain process maturity and performance.

Business process orientation

The concept of business process orientation (BPO) is based upon the work of Deming (Walton, 1986), Porter (1985), Davenport and Short (1990), Hammer (1996, 1999), Hammer and Champy (1993), Grover *et al.* (1995) and Coombs and Hull (1996). This body of work suggests that firms can enhance their overall performance by adopting a "process view" of the organization. Although many firms have adopted the BPO concept, little to no empirical data exists to substantiate its effectiveness in facilitating improved business performance. McCormack and Johnson (2000) conducted an empirical study to explore the relationship between BPO and enhanced business performance. The research results showed that BPO is critical in reducing conflict and encouraging greater connectedness within an organization, while improving business performance. Moreover, companies with strong measures of BPO showed better overall business performance. The research also showed that high BPO levels within organizations led to a more positive corporate climate, illustrated through better organizational connectedness and less internal conflict. In addition, the study revealed the following key BPO elements:

- *process management and measurement* – measures that include aspects of the process such as output quality, cycle time, process cost and variability, as compared to the traditional accounting measures;
- *process jobs* – jobs that focus on processes as opposed to functions, and are cross-functional in responsibility; and
- *process view* – the cross-functional, horizontal picture of a business involving elements of structure, focus, measurement, ownership and customers.

Process maturity

The concept of process maturity proposes that a process has a lifecycle that is assessed by the extent to which the process is explicitly defined, managed, measured and controlled. It also implies growth in process capability, richness and consistency across the entire organization (Dorfman and Thayer, 1997). As an organization increases its process maturity, institutionalization takes place via policies, standards and organizational structures (Hammer, 1996).

The process maturity concept has been developed and tested relative to the software development process (Harter *et al.*, 2000) and the project management process (Ibbs and Kwak, 2000). However, there have been no published studies to date which examine the concept relative to supply chain management. In investigating the maturity concept relative to the software development process, the researchers used an assessment instrument developed by the Software Engineering Institute (SEI) (2002) along with outcome measurements (e.g. quality and cycle time) developed specifically for the study. The researchers found that the net effect of process maturity was a reduction in overall software development cycle time and software development effort.

In examining the process maturity concept relative to the project management process, Ibbs and Kwak (2000) used the basic concepts of the SEI model and developed specific questions from the Project Management Institute's Body of Knowledge. This maturity model represented five levels of project management maturity. The model was then used to examine the level of maturity across several industries. The relationship between maturity and performance was examined through interviews with participants. Although statistical relationships between maturity and performance were not examined, the interview results indicated a general acceptance that higher levels of project management maturity resulted in improved project performance.

As organizations increase their process maturity, institutionalization takes place via policies, standards and organizational structures (Hammer, 1996). Building an infrastructure and a culture that supports BPO methods, practices and procedures, enables process maturity to survive and endure long after those who have created it. Continuous process improvement, an important aspect of BPO, is based on many small evolutionary rather than revolutionary steps. Continuous process improvement serves as the energy that maintains and advances process maturity to new maturity levels. The proposed relationship between process maturity and BPO is shown in Figure 1.

As processes mature, they move from an internally-focused perspective to an externally-focused system perspective. A maturity level represents a threshold that, when reached, will institutionalize a total systems view necessary to achieve a set of process goals (Dorfman and Thayer, 1997). Achieving each level of maturity establishes a higher level of process capability for an organization. This capability, as shown in Figure 2, can be defined by:

Figure 1 Relationship between BPO and process maturity

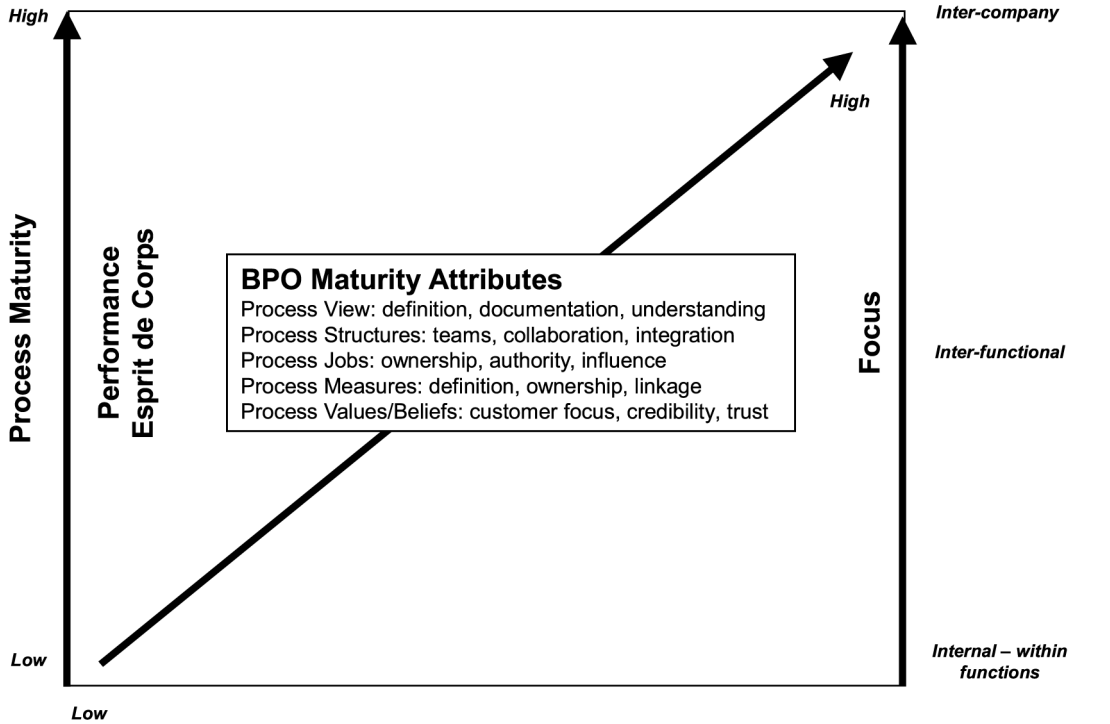
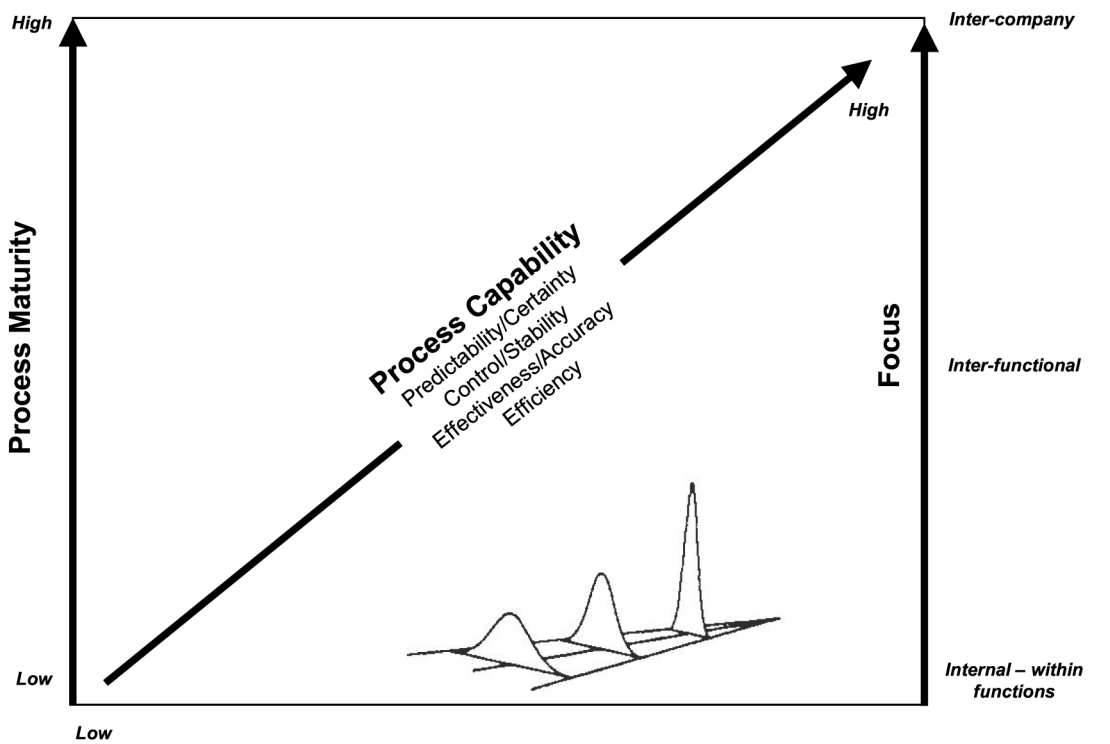


Figure 2 Relationship between process capability and maturity



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- *control* – defined as the difference between targets and actual results, noting the variation around these targets;
- *predictability* – measured by the variability in achieving cost and performance objectives; and
- *effectiveness* – the achievement of targeted results and the ability to raise targets.

The BPO maturity model

A BPO maturity model was developed based on the concepts of process maturity, BPO, and the capability and maturity model developed by the Software Engineering Institute at Carnegie Mellon University (SEI, 2002). The model and a description of each maturity level are shown in Figure 3.

It is important to note that trying to skip maturity levels is counter-productive, since each level builds a foundation from which to achieve the subsequent level. An organization must evolve through these levels to establish a culture of process excellence.

The SCM maturity model

Based on the BPO maturity model illustrated in Figure 3, discussions with supply chain experts and practitioners, and supply chain survey data organized by variables relating to different maturity levels, an SCM maturity model was developed as illustrated in Figure 4. The model conceptualizes how process maturity relates to the supply chain operations reference (SCOR) framework. The SCOR framework was chosen to conceptualize the supply chain management maturity model, owing to its process orientation and wide adoption by the supply chain academic and practitioner communities. The five stages of maturity show the progression of activities toward effective SCM and process maturity. Each level contains characteristics associated with process maturity such as predictability, capability, control, effectiveness and efficiency. The following is a brief description of each SCM maturity level:

- *Ad hoc* – The supply chain and its practices are unstructured and ill-defined. Process measures are not in place. Jobs and organizational structures are not based on horizontal supply chain processes. Process performance is unpredictable. Targets, if defined, are often missed. SCM costs are high. Customer satisfaction is low. Functional cooperation is also low.
- *Defined* – Basic SCM processes are defined and documented. Jobs and organization basically remain traditional. Process performance is more predictable. Targets are defined but still missed more often than not. Overcoming the functional silos takes considerable effort owing to boundary concerns and competing goals. SCM costs remain high. Customer satisfaction has improved, but is still low.

Figure 3 The BPO maturity model

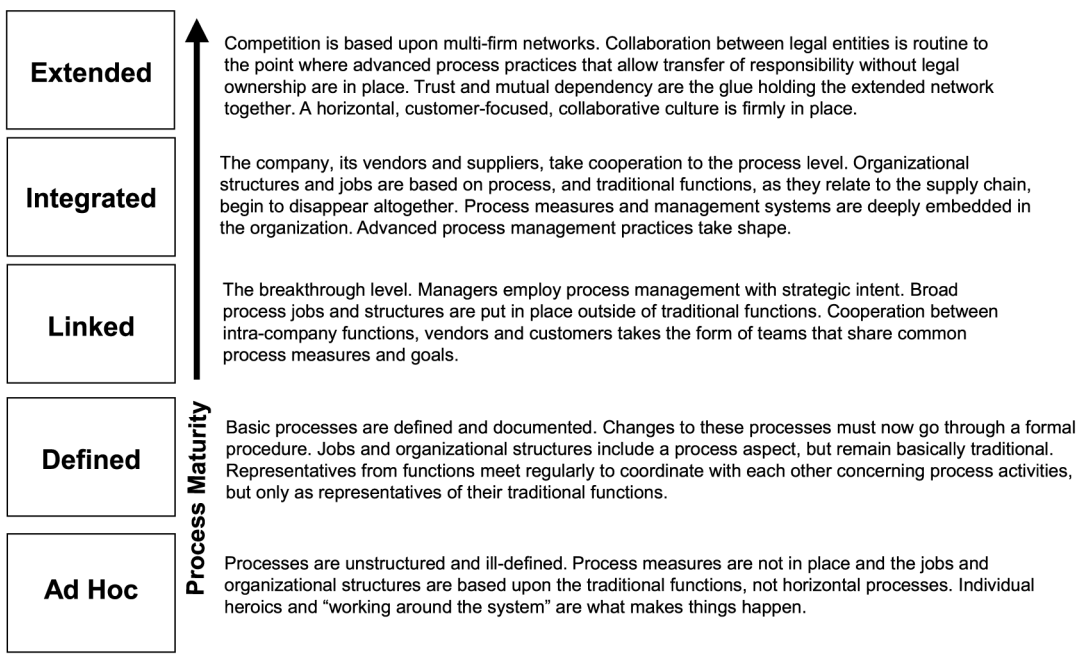

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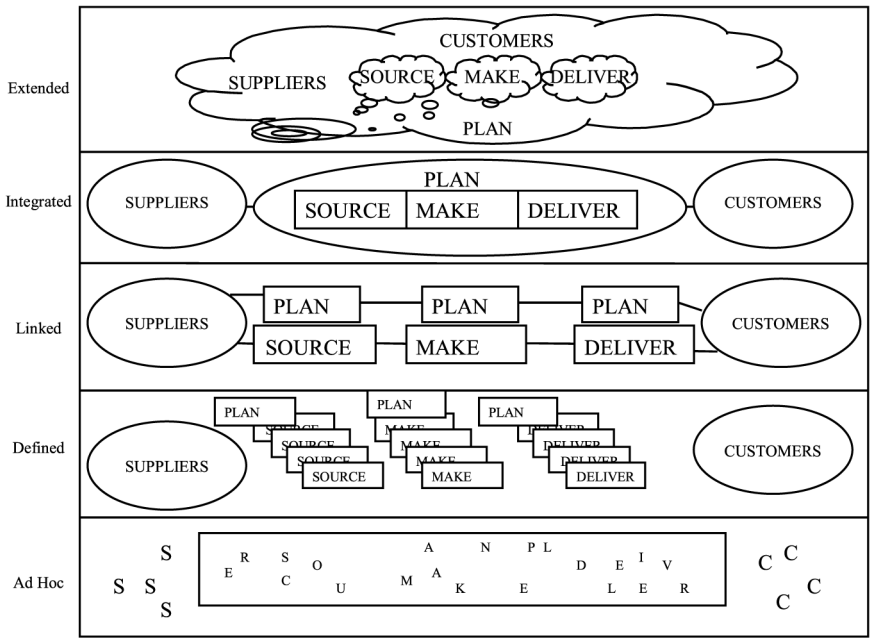
Figure 4 The supply chain management maturity model



- *Linked* – This represents the breakthrough level. Managers employ SCM with strategic intent and results. Broad SCM jobs and structures are put in place outside and on top of traditional functions. Cooperation between intra-company functions, vendors and customers takes the form of teams that share common SCM measures and goals that reach horizontally across the supply chain. Process performance becomes more predictable and targets are often achieved. Continuous improvement efforts take shape focused on root cause elimination and performance improvements. SCM costs begin decreasing and feelings of *esprit de corps* take the place of frustration. Customers are included in process improvement efforts and customer satisfaction begins to show marked improvement.
- *Integrated* – The company, its vendors and suppliers, take cooperation to the process level. Organizational structures and jobs are based on SCM procedures, and traditional functions, as they relate to the supply chain, begin to disappear altogether. SCM measures and management systems are deeply imbedded in the organization. Advanced SCM practices, such as collaborative forecasting and planning with customers and suppliers, take shape. Process performance becomes very predictable and targets are reliably achieved. Process improvement goals are set by the teams and achieved with confidence. SCM costs are dramatically reduced and customer satisfaction and *esprit de corps* become a competitive advantage.
- *Extended* – Competition is based on multi-firm supply chains. Collaboration between legal entities is routine to the point where advanced SCM practices that allow transfer of responsibility without legal ownership are in place. Multi-firm SCM teams with common processes, goals and broad authority take shape. Trust, mutual dependency and *esprit de corps* are the glue holding the extended supply chain together. A horizontal, customer-focused, collaborative culture is firmly in place. Process performance and reliability of the extended system are measured and joint investments in improving the system are shared, as are the returns.

SCM process maturity and performance

On constructing the SCM maturity model, a survey instrument was created to investigate the relationship between SCM process maturity and overall supply chain performance. Participants for the study were selected from the membership list of the Supply Chain Council. This list consisted of 523 key informants representing 90 firms. Participants were asked to rate their performance by each area of the SCOR model (i.e. "plan", "source", "make", "deliver") on a scale of 1 (poor) to 5 (excellent). The individual ratings were then summed to develop an overall performance score. The results are illustrated in Table I. In addition,

Table I Supply chain performance results (percentage of respondents)

	Rating				
	1 (Poor)	2 (Fair)	3 (Good)	4 (Very good)	5 (Excellent)
Please rate the overall performance of your business unit last year	0.0	11.8	39.2	41.2	7.8
Please rate the overall performance of your business unit last year relative to major competitors	4.1	10.2	26.5	46.9	12.2
Compared with your major competitors your overall days of supply (DOS) are:	10.0	32.0	24.0	22.0	12.0
Compared with your major competitors your overall cash-to-cash cycle times are:	8.9	20.0	42.2	20.0	8.9
Compared with your major competitors your delivery performance versus commit date is:	4.0	6.0	24.0	50.0	16.0
Compared with your major competitors your quoted order lead times are:	2.0	14.3	40.8	26.5	16.3

other overall performance questions were asked of the participants. The results for these questions are also presented in Table I. The distribution of the answer to the performance questions was acceptable, with no one grouping being over- or under-represented. The only exception was that the answers to the overall business performance question were slightly skewed, since no one rated their performance as being poor.

Next, a SCM process maturity measurement instrument was developed to collect data from the respondents used to analyze the relationship between SCM process maturity and the supply chain performance results exhibited in Table I. Regression analysis was used to identify statistically significant relationships between variables. Beta and R^2 coefficients were used as indicators of the strength and explanatory power of the relationships. In this analysis, R^2 indicates the fit of the linear relationship between the SCM maturity scores and the performance variable scores. R^2 also indicates the proportion of the variation in the dependent variable (performance) explained by SCM maturity (the independent variable). For example, as illustrated in Table II, 11 percent (0.111) of the variation in days of sales (DOS) inventory performance is explained by the SCM maturity scores. The statistical significance of each relationship is also shown in Table II. The minimum result used to decide if a relationship was significant was 0.1, or 90 percent. The relationships that met this hurdle are marked with an asterisk.

As illustrated in Table II, four relationships were found to be significant. "Basicpp", the sum of the individual SCOR area ratings, had the strongest correlation to SCM process maturity with a β of 0.825 and an R^2 of 0.68. RP3 (days of sales [DOS] versus competitors), RP5 (delivery performance versus commit date) and RP6 (order lead times versus competitors) were also significantly correlated with SCM process maturity. However, it is clear that performance measured by SCOR area (i.e. "plan", "source", "make" and "deliver") is the measurement of performance most related to SCM process maturity. An explanation for this result is that this measurement approach provides a clear process context as provided by the four areas of the SCOR model.

The other significant relationships are all process measures that clearly reflect process performance. There are very few factors outside of most SCM organizations that can impact the days of sales and order lead times process metrics. This may explain their relatively strong relationship with performance (β of 0.333 and 0.37, respectively) and relatively large R^2 (0.111 and

Table II Regression analysis results: SCM maturity versus performance variable

Performance variable	Description	β	R^2	Significance
Basicpp	Sum of individual SCOR ratings	0.825	0.680	0.000*
RP1	Overall business performance	0.182	0.033	0.202
RP2	Business performance versus competitors	0.157	0.025	0.282
RP3	DOS versus competitors	0.333	0.111	0.018*
RP4	Cash-to-cash cycle time versus competitors	0.044	0.002	0.775
RP5	Delivery versus commit date	0.237	0.056	0.097*
RP6	Order lead times versus competitors	0.370	0.137	0.009*

Note: *Significant at 0.1 or greater

0.137, respectively). In contrast, delivery performance versus commit date has a weak relationship. An explanation for this result is that many firms do not measure this, and there are other functions outside of the SCM organization that may impact this measure (e.g. sales and marketing).

It is interesting to note that overall business performance and business performance versus competitors were not significant. Perhaps this is too broad a measure for this analysis, since there are many factors that affect this variable, in addition to SCM. Cash-to-cash cycle times versus competitors was also not significant. An explanation for this result could be that this is outside of the responsibility of most SCM organizations. In many organizations, this activity is often under the control of the accounting department, which, in most firms, still remains outside the SCM process. Thus, performance in this area is not influenced by SCM process maturity.

Conclusions

This research illustrates the use of the SCM maturity model as a valuable analysis framework with a good theoretical basis. This research also suggests that SCM process performance collected by SCOR area is strongly related to SCM maturity. Additionally, the research indicates that direct process performance measures such as cycle times and inventory levels are also related to SCM maturity. These relationships suggest that the SCM maturity measurement instrument can be used for prescriptive purposes in SCM improvement efforts by indicating which maturity measurements are deficient, therefore focusing on continual improvement efforts.

Although the relationship between SCM maturity and overall business performance is not shown as significant in this research, a case can be made that process performance must impact overall business performance. Perhaps the method of measurement for overall business performance in this research is not specific enough and needs to be refined. Future research is needed in this area to investigate the relationship of SCM process maturity and specific supply chain-related financial measures such as SCM costs (order management, transportation, etc.). This may provide the specificity needed to uncover the relationships that are suggested by the relationship of SCM process maturity to process performance measures such as cycle time and inventory.

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