The Effect of
on Supply Chain Performance: An Empirical Study.

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ABSTRACT
The concept of process maturity proposes that a process has a lifecycle that is measured by the extent to which the process is explicitly defined, managed, measured, controlled and effective. A maturity model assumes that progress comes in stages, ultimately reaching an end goal. The supply chain maturity model is based upon concepts developed by Philip Crosby, who devised a maturity grid for the five stages companies go through in adopting quality practices. Based upon global research, this paper develops a usable SCM Process Maturity Model and identifies the relationship between SCM process maturity and performance.
Introduction – BPO, the foundation of process maturity

Today’s organizations are faced with increasing levels of global competition, demanding customers and employees, shrinking product life cycles, and decreasing acceptable response times. The old ways of conducting business are out: pursuing cost and quality tradeoffs in order to achieve the lowest possible price. A new paradigm is emerging with the integration of business partners and the focus on core processes, according to Bernard Teiling, Assistant Vice-president of Business Process Integration at Nestle S.A. Corporations are extending outside of their legal boundaries as a normal way of organizing. Thus, management needs to promote the right conditions not only within the company itself, but also within the organizations that are part of its value-adding network.

Many of the best companies—e.g. 3M, Cisco, Texas Instruments, and Dell--have embraced this new approach to business by becoming fast, flexible, and integrative, focusing on customers, competition, teams, time and process management. These organizations and those following their lead have been variously described as “horizontal”, “process centered” or “process oriented” (Byrne 1993, Brooks 1995, Buxbaum 1995, Hammer 1996 and 1999).

Due to this new business approach, firms are beginning to view processes as strategic assets. We maintain that companies competing in the new economy will need to reassess the strategic importance of their processes. Thus, organizations must no longer be viewed as just a collection of functional areas, but as a combination of highly integrated processes. In short, they will need to develop a business process orientation (McCormack 2000).

A business process orientation (BPO) is not simply a new business operations strategy. Rather, it emphasizes process as well as hierarchies with special emphasis on outcomes, particularly customer satisfaction. The key elements of Business process orientation elements are:

• **Process Management and Measurement** - measures that include aspects of the process like output quality, cycle time, process cost and variability compared to the traditional accounting measures.

• **Process Jobs** – jobs that focus on process not functions and are cross-functional in responsibility, e.g., “product development process owner" rather than "research manager".

• **Process View** - the cross-functional, horizontal picture of a business involving elements of structure, focus, measurement, ownership and customers.

We developed a business process orientation measurement tool (a survey questionnaire measuring the components of BPO) and applied it to one hundred domestic and international manufacturing companies. These firms represented a broad cross-section of industries, ranging in size from approximately $100 million to several billion in annual sales.
The results of our research 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. Our research also showed that high BPO led to a more positive corporate climate, including higher esprit de corps and connectedness and less internal conflict. Companies structured into broad process teams rather than narrow functional departments have less internal conflict and stronger team spirit.

**BPO and Supply Chain Management**

During the past several years, the concept of supply chain management or SCM has been maturing both in terms of theory and practice. Terms such as integrated supply chain management, supply chain optimization and supply chain collaboration have become the focus and goal of many organizations in the U.S. and around the world. Global supply chain management has also emerged as a key competitive strategy (Handfield 1999, Stank 1999, Bowersox 2000). Therefore, the following question guided our research efforts: To what extent is supply chain management influenced by a business process orientation?

The initial challenge we faced in our study was to develop a clear, simple definition of supply chain management. The definition used in this study was developed by first decomposing the phrase “supply chain management” into its constituent parts:

*Supply chain: The flow and transformation of raw materials into products from suppliers through production and distribution facilities to the ultimate consumer.*

*Management: The process of developing decisions and taking actions to direct the activities of people within an organization; planning, organizing, staffing, leading and controlling.*

The final definition used in this study combined these two statements as follows:

*Supply Chain Management:*

"*The process of developing decisions and taking actions to direct the activities of people within the supply chain toward common objectives.*"

Additionally, we had to develop detailed definitions and operational measures for the practice of supply chain management. To accomplish this, we conducted interviews and focus groups with supply chain experts and practitioners. Questions were organized generally around the elements of BPO, but slightly expanded (see Figure 1). The questions asked were supply chain management specific but were generally focused on the BPO components of SCM such as process view, process jobs, process structures, process values and beliefs, process management and measures, information technology support and supply chain specific best practices. The results of these focus groups and interviews were used to build an initial list of survey questions used in the study.
The definition of each BPO component of SCM is as follows.

**Process Measurement and Management Systems.** This includes process measurement systems, rewards for process improvement, outcome measurements, customer-driven and team-driven measures and rewards.

**Process Documentation.** Documentation of process steps, activities and tasks, in both visual and written formats, that allows people in different job functions and companies to communicate using the same vocabulary. This includes broad understanding of the processes across the organization, not just documentation.

**Process Jobs.** These jobs include horizontal (cross-functional) rather than vertical responsibility. People participate and take ownership of the whole process. Titles such as “Supply Chain Team Member”, “Plan Process Owner”, and “Global Supply Chain Manager” are examples.

**Process Structure.** This is the framework that defines the supply chain management team and breaks down the old functional "compartments," such as sales and manufacturing, which inhibit enterprise-wide process thinking. Without it, "supply chain managers" can't do their jobs. These structures included horizontal teams, partnerships, shared responsibility and shared ownership.
**Process Values and Beliefs.** These are the values and beliefs that energize an organization. For instance, they might include trust in the customer's sales forecasts and belief that fellow team members are completely committed to common goals and continuous process improvement.

**IT Support.** This is the perceived usefulness of the IT system in supporting SCM processes by the process owner and team members.

The sampling framework used in our study was constructed from the Supply Chain Council’s Supply Chain Operation Reference (SCOR) Model. Participants were selected from the membership list of the Supply Chain Council. The "user" or practitioner portion of the list was used for the final selection since this represented members whose firms were in the business of supplying a product, rather than a service, and were thought to be generally representative of supply chain practitioners rather than consultants. This list consisted of 523 key informants representing 90 firms.

In order to determine the specific impact of BPO on supply chain management, correlations were performed on the data. Responses to the specific survey questions grouped by BPO component categories were then correlated with overall supply chain management performance. For classification purposes we differentiated between strong and weak relationships. Correlations above 0.5 were considered strong while those below 0.5 were considered weak. Correlations for all components other than IT support were 0.5 or above in most areas. The results are provided in Table 1.

<table>
<thead>
<tr>
<th>COMPONENT</th>
<th>PLAN</th>
<th>SOURCE</th>
<th>MAKE</th>
<th>DELIVER</th>
</tr>
</thead>
<tbody>
<tr>
<td>Process Structure</td>
<td>0.7</td>
<td>0.6</td>
<td>0.5</td>
<td>0.6</td>
</tr>
<tr>
<td>Process documentation</td>
<td>0.6</td>
<td>0.7</td>
<td>0.5</td>
<td>0.5</td>
</tr>
<tr>
<td>Process Jobs</td>
<td>0.5</td>
<td>0.5</td>
<td>0.6</td>
<td>&lt;0.5</td>
</tr>
<tr>
<td>Process measures</td>
<td>0.5</td>
<td>0.7</td>
<td>&lt;0.5</td>
<td>0.6</td>
</tr>
<tr>
<td>Process Values and Beliefs</td>
<td>0.7</td>
<td>None</td>
<td>0.7</td>
<td>&lt;0.5</td>
</tr>
<tr>
<td>IT support</td>
<td>&lt;0.5</td>
<td>&lt;0.5</td>
<td>&lt;0.5</td>
<td>0.7</td>
</tr>
</tbody>
</table>

As illustrated in Table 1, the BPO components of *process structure, process documentation, process values and beliefs, process jobs, and process measures* are strongly correlated to supply chain management performance. Table 1 also shows that *IT support*, although strongly related to delivery process performance, is only marginally related to plan, source, and make process performance (<0.5).
BPO, SCM and Process Maturity

The concept of process maturity proposes that a process has a lifecycle that is measured 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 1997). As an organization increases its process maturity, institutionalization takes place via policies, standards and organizational structures (Hammer 1996). Building an infrastructure and a culture that supports the methods, practices and procedures enables process maturity to survive and endure long after those who have created it are gone. 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 relationship between process maturity and BPO is provided in Figure 2.

![Figure 2. Process Maturity and BPO](image)

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 1997). Achieving each level of maturity establishes a higher level of process capability for an organization. This capability, as shown in Figure 3, can be defined by:

Control – described as the difference between targets and actual results, noting the
variation (range) around these targets.

Predictability – measured by the variability in achieving cost and performance objectives.

Effectiveness – the achievement of targeted results and the ability to raise targets.

Figure 3. Process Capability and Maturity

We have developed a BPO maturity model based upon 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 4.

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 next level. An organization must evolve through these levels to establish a culture of process excellence.
Building the SCM Maturity Model

In order to build a SCM process maturity model that parallels the BPO model, SCM survey questions were organized into variables or concepts that related to the different maturity levels. The first step was to develop a definition of each level from a SCM perspective. In our discussions with SCM experts and practitioners, we were asked to draw a diagram matching each of the levels. Figure 5 represents our conceptualization of how process maturity relates to the SCOR Model.
The five stages of maturity show the progression of activities toward effective supply chain management 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 the SCM practices are unstructured and ill defined. Process measures are not in place and the jobs and organizational structures are based upon the traditional functions, not horizontal supply chain processes. Process performance is unpredictable and targets, if defined, are often missed. SCM costs are high both in dollars and emotional costs.

**Defined.** The basic SCM processes are defined and documented. Jobs and organizational structures include an SCM aspect, but remain basically traditional. Process performance is more predictable and targets are defined but still missed more often than not. Overcoming the functional silos takes considerable effort due to turf concerns and competing goals. SCM costs remain high, frustration is still present and customer satisfaction, although better defined, is still low.

**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.

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Figure 5. The SCM Maturity Model View
**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 embedded 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 upon 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. This is the beginning of a functioning supply chain network.

The next step in building the SCM maturity model was to identify which BPO components were related to which maturity levels. As we examined the data collected using the survey instrument, it became clear that certain components were focused on achieving the process goals for specific maturity levels and were only relevant for that level. Some components also appeared to just lay the foundation needed to get to the next maturity level. It also became clear that upper level performance could not be attempted until the lower maturity levels were well established. For example: Integrating your demand planning process with your customers’ if your process was not defined, capable or predictable would be a big mistake. The resulting customer interactions would be unpredictable and poorly focused resulting in poor performance of both processes and a dissatisfied customer. Therefore, this practice appears only in the Integrated and Extended levels, after a strong foundation of process interaction within the company has been established.
We located the placement of the BPO components by: (1) looking at the definition of each level; and (2) identifying the component and specific survey questions that related to that level of performance. This resulted in two distinct maturity levels: basic and advanced. Thus, some practices are needed to provide a foundation and stability for basic supply chain management performance while other practices leveraged this foundation and stability to provide advanced performance capabilities. For example, basic process documentation is needed before a benefit can be realized from documenting supplier and customer interactions, part of advanced process documentation. Also, a basic cross-functional team structure within a company must be in place before effective collaboration with suppliers and customers can be effective. Figure 6 shows the placement of components by maturity level with a high level description of the practices contained within them. The resulting SCM maturity framework shown in Figure provides a visual maturity scorecard that describes not only the maturity level but also the balance of the maturity components. The practices within these components must be present and institutionalized to realize sustainable performance for that maturity level and are required foundations for the levels above. Thus, the SCM maturity model is a framework that represents an approach for continual SCM improvement for SCM organizations seeking to increase their SCM process capability.

In addition, each component within the framework can be decomposed to a level of detail that can be used to provide specific actions and process recommendations. Using scaled survey questions indicating how often a specific practice is conducted (1 - never to 5 – always), the framework can also be used to measure the degree to which SCM practices are institutionalized, a critical aspect of process maturity. Institutionalization directly relates to the predictability aspect of process maturity. A practice that is a critical component of SCM at a certain maturity level must become institutionalized in order to provide enough stability to support advancement.
to the next level. Scores of 4 and 5 on the specific survey questions indicate the institutionalization of a particular SCM practice.

**SCM Maturity and Performance**

To investigate the relationship of SCM Process Maturity to overall supply chain and business performance, we selected six performance variables to be measured using self-assessment by the participants. Participants were asked to rate their performance by each area of the SCOR model on a scale of 1 to 5 (poor to excellent). These individual ratings were then summed to make an overall performance score. In addition, other overall performance questions were asked of the participants as shown in Table 5. For these questions, the performance distribution of the respondent companies is also shown in Table 5. The distribution of the answer to the performance questions was acceptable with no one grouping 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 a 1, poor.

Table 2. Overall Supply Chain Business Performance (% of respondents)

<table>
<thead>
<tr>
<th></th>
<th>Poor</th>
<th>Fair</th>
<th>Good</th>
<th>Very Good</th>
<th>Excellent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Please rate the overall performance of your business unit last year.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>0</td>
<td>11.8</td>
<td>39.2</td>
<td>41.2</td>
<td>7.8</td>
<td>7.8</td>
</tr>
<tr>
<td>Please rate the overall performance of your business unit last year relative to major competitors.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>4.1</td>
<td>10.2</td>
<td>26.5</td>
<td>46.9</td>
<td>12.2</td>
<td></td>
</tr>
<tr>
<td>Compared to your major competitors your overall inventory Days of Supply (DOS) are:</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>10.0</td>
<td>32.0</td>
<td>24.0</td>
<td>22.0</td>
<td>12.0</td>
<td></td>
</tr>
<tr>
<td>Compared to your major competitors your overall cash-to-cash cycle times are:</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>8.9</td>
<td>20.0</td>
<td>42.2</td>
<td>20.0</td>
<td>8.9</td>
<td></td>
</tr>
<tr>
<td>Compared to your major competitors your delivery performance vs. commit date is:</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>4.0</td>
<td>6.0</td>
<td>24.0</td>
<td>50.0</td>
<td>16.0</td>
<td></td>
</tr>
<tr>
<td>Compared to your major competitors your quoted order lead times are:</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>2.0</td>
<td>14.3</td>
<td>40.8</td>
<td>26.5</td>
<td>16.3</td>
<td></td>
</tr>
</tbody>
</table>
In the next step of the process of finding the relationships, we investigated the influence of the SCM process maturity on overall supply chain performance variables shown in table 5 and the overall performance score. SCM process maturity was measured as the numerical sum of all the SCM question scores. We then attempted to answer the following question:

Does SCM process maturity influence overall supply chain business performance?

In order to answer this question, we used linear regression analysis. This method identifies the statistically significant relationship between variables. Beta and $R^2$ coefficients were used as indicators of the strength and explanatory power of the relationship. $R^2$, or the coefficient of determination, is a number produced in the analysis that indicates the goodness of fit of a linear model. In this case it 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 explained by the model. For example, 11% (0.111) of the variation in Days of Sales (DOS) inventory performance is explained by the SCM maturity score. The Beta coefficient is also shown for each relationship. This number indicates the relative importance of the variable in the relationship.

Table 3. Regression Analysis Results – SCM Maturity v. Performance Variable

<table>
<thead>
<tr>
<th>Performance Variable</th>
<th>Description</th>
<th>Beta</th>
<th>$R^2$</th>
<th>Significance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Basicpp</td>
<td>Sum of individual SCOR ratings</td>
<td>0.825</td>
<td>0.68</td>
<td>0.000 *</td>
</tr>
<tr>
<td>RP1</td>
<td>Overall business performance</td>
<td>0.182</td>
<td>0.033</td>
<td>0.202</td>
</tr>
<tr>
<td>RP2</td>
<td>Business performance v. competitors</td>
<td>0.157</td>
<td>0.025</td>
<td>0.282</td>
</tr>
<tr>
<td>RP3</td>
<td>DOS v. competitors</td>
<td>0.333</td>
<td>0.111</td>
<td>0.018 *</td>
</tr>
<tr>
<td>RP4</td>
<td>Cash-to-cash cycle time v. competitors</td>
<td>0.044</td>
<td>0.002</td>
<td>0.775</td>
</tr>
<tr>
<td>RP5</td>
<td>Delivery v. commit date</td>
<td>0.237</td>
<td>0.056</td>
<td>0.097 *</td>
</tr>
<tr>
<td>RP6</td>
<td>Order lead times v. competitors</td>
<td>0.37</td>
<td>0.137</td>
<td>0.009 *</td>
</tr>
</tbody>
</table>

* Significant at 0.1 or higher

The statistical significance of each relationship is also shown in Table 3. The minimum result that we used to decide if a relationship was significant was 0.1 or 90%. The relationships that met this hurdle are marked with an asterisk.

As can be seen from the table, four relationships were significant, with Basicpp, the sum of the individual SCOR group ratings, being the strongest with a Beta of 0.825 and an $R^2$ of 0.68. RP3 (DOS v. competitors), RP5 (delivery performance v. commit date) and RP6 (order lead times v. competitors) were also significant. It is clear that performance measured by SCOR grouping (Plan, Source, Make and Deliver) is the measurement of performance most related to SCM maturity. This could be that this measurement approach provides a granular and focused measurement by asking the performance question within a clear process context.
The other significant relationships, RP3 (DOS v. competitors), RP5 (delivery performance v. commit date) and RP6 (order lead times v. competitors) are all process measures that clearly reflect process performance. DOS and order lead times are clean process measures. Meaning that they have very few factors outside of the SCM organization that can impact them. This may be the reason for the relatively strong relationship with performance (0.333 and 0.37 Beta) and relatively large $R^2$ (0.111 and 0.137). Delivery performance v. commit date has a weak relationship, possibly due to the fact that many firms do not measure this and there are other functions outside of the SCM organization that impact this measure (Sales and marketing).

It is interesting that overall business performance and business performance v. competitors were not significant. Perhaps this is too broad a measure for this analysis since there are many things that effect this variable, in addition to SCM.

Cash-to-cash cycle times v. competitors was also not significant. This could be that this is outside of the responsibility of most SCM organizations and is often under the control of the accounting departments, which in most firms still remains outside of the process and therefore not influenced by process maturity.

**Conclusions and Future Research**

This research suggests that supply chain management process performance, as measured by the self-assessment measure gathered in the context of each SCOR area, is very strongly related to SCM maturity. This research also indicates that direct process performance measures such as cycle times and inventory are also related to SCM maturity.

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.

**About the Authors**

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Dr. McCormack has over 25 years of business leadership, teaching and consulting experience in business strategy and leadership, supply chain management, business process engineering, change management, organizational design and information technology. His experience covers many national and international industry segments and a broad range of business processes. He is on the faculty of the University of Alabama at Birmingham School of Business teaching Information Systems and is also a judge in the Alabama Technology Network and Business Council's Manufacturer of the Year Competition.

Dr. McCormack holds Chemistry and Engineering degrees from Purdue University, an M.B.A. and a Doctorate of Business Administration. He is President of DRK Research (www.drkresearch.org) and the co-author of Business Process Orientation: Gaining the e-business competitive advantage, and the recently released book, Business Process Orientation and Supply Chain Networks: Advanced Strategies and Best Practices, both from CRC press (www.crcpress.com). He has also published numerous articles on supply chain management. He can be reached at kmccormack@business.uab.edu

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Dr. Lockamy served on the Board of Examiners for the Malcolm Baldrige National Quality Award via appointment by the United States Department of Commerce from 1997 through 2002. He also served as Vice President of the Board of Directors of the American Production and Inventory Control Society (APICS) Educational and Research Foundation. Dr. Lockamy is recognized as a Certified Fellow in Production and Inventory Management (CFPIM) by APICS, and is certified as an Academic Jonah by The Avraham Y. Goldratt Institute.

Dr. Lockamy earned a PhD in Operations Management from the University of Georgia, a masters in Business Administration from the Atlanta University Graduate School of Business, and a bachelors in Chemical Engineering from the Georgia Institute of Technology.
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