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The Supply Chain Process Management Maturity Model – SCPM3

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1. Introduction

In recent years, a growing amount of research, much of which is still preliminary, has been dedicated to investigating maturity models development for the strategic management of supply chains (Chan and Qi, 2003; Gunasekaran *et al.*, 2001; Coyle *et al.*, 2003).

The concept of process maturity derives from the understanding that processes have life cycles or developmental stages that can be clearly defined, managed, measured and controlled throughout time. A higher level of maturity, in any business process, results in: (1) better control of the results; (2) more accurate forecast of goals, costs and performance; (3) higher effectiveness in reaching defined goals and the management ability to propose new and higher targets for performance (Lockamy and McCormack, 2004; Poirier and Quinn, 2004; McCormack *et al.*, 2008).

In order to meet the performance levels desired by customers in terms of quantitative and qualitative flexibility of service in demand fulfillment, deadlines consistency and reduction of lead times related to fulfilling orders, firms have developed repertoires of abilities and knowledge that are used in their organizational process (Day, 1994 *apud* Lockamy and McCormack, 2004; Trkman, 2010). In two past decades, management of supply chain processes has evolved, also because of these new demands, from a departmental perspective, extremely functional and vertical, to an organic arrangement of integrated processes, horizontal and definitely oriented to providing value to intermediate and final costumers (Mentzer *et al.*, 2001). This new pattern of logistical process management had lead towards the development and application of different maturity models and performance metrics useful as support tools to help define a strategy and to face trade-offs, as well as to identify items that are considered critical to quality improvement of logistical services rendered to the client.

The purpose of this article is to explore the concept of maturity models and to answer an important question specifically directed to the management of supply chain processes. What best practices are fully matured and in use at what maturity level? This paper will more fully define the maturity levels based upon the capabilities of the company using statistical analysis of a global data set.

2. Theoretical framework

2.1 Maturity models and logistical processes management

The maturity model represents a methodology which applications are related to definition, measurement, management and business processes control that have been shown to be very similar management approaches concepts to BPR (Business Process Reengineering), attracting a growing interest not only of companies but also of researchers, directly involved in this area (Chan and Qi, 2003; Gunasekaran *et al.*, 2001). Although its origins are not directly linked to logistics, a growing number of reports has been seen in recent years that represent the use of maturity models based on KPI – Key Performance Indicators - to analyze the activities from logistical supply cycles to manufacturing and distribution support itself (Lahti *et al.*, 2009). Those exploratory experiments are expected to consolidate in order to define an agenda of research in the field of logistics, mainly the *supply chain management* (Chan and Qi, 2003; Gunasekaran *et al.*, 2001).

In the following section, the main maturity models currently used by companies to analyze the performance of their logistical processes will be presented. References will be shown about the SCOR measurements (Supply Chain Operations Reference Model), the CSC Framework model, developed by CSC – Computer Sciences Corporation – and the Business Process Orientation Maturity Model, developed by a group of researchers at DRK Research.

2.2 CSC framework

The CSC Framework was developed by CSC (Computer Sciences Corporation) and tested in 2003 for the first time, through a research involving 142 people in charge of supply chain management. Supply Chain Management Review readers and CSC clients composed this sample. Among the 142 components, 71 came from companies and independent consulting firms, while the other 71 came from groups, divisions, business strategic units or subsidiaries. The work's main objective was to identify the logistics function's development stage in the surveyed companies, considering their levels of excellence in the five maturity stages in supply chain, which are presented below (Poirier and Quinn, 2003; 2004).

At the model's first level, the company prioritizes the improvement of its functional processes. At this stage, internal efforts are made that aim at the integration of different functional areas of each company that integrates the supply chain. The SCOR model is used with a great effect in the initial stage, where the logistics and supply areas are more emphasized. The benefits normally include a drastic reduction in suppliers and logistics service providers, rationalization of the product mix and a greater volume of purchases. At level 1, the main inefficiencies faced by many companies concern the results of low inter-organization integration process, the barriers in businesses works, and the no-happening or no-expressive sharing between information systems and agents in the expanded value chain.

At the second level, attention is given to logistics gains, focusing more on the use of actives and the effectiveness of its physical distribution. Demand management becomes a critical factor, and the preciseness of predictions can be the main driving force for more acuity on the company's operations in the planning, programming and production control areas. Supply chain orientation gains more importance with a more strategic management of the organization's immediate supplier and client bases.

According to Poirier and Quinn (2004), the company's dominant "logistical culture" inhibits, many times, the progress of its actions towards superior excellence levels, given some premises shared by companies that find themselves in this development stage: (i) all good ideas need to be internally built; (ii) if external help is needed, it means that the internal

team is not doing its job. (iii) if external information can be used, we will do so but we will not be share it with anybody. The company can only expand its efficiency levels when its leadership, especially the one linked to the operation areas, decides to break with these premises and dissipate the restrictions that they impose.

At the third level, the company develops or redesigns its inter-organizational processes and starts to create a business network with few and carefully selected allies. During this stage, important suppliers are invited to participate in planning, operations, and sales sessions (S&OP – Sales and Operation Planning), bringing supply and demand closer to each other. Global relationships are established with logistical service suppliers, qualified in relation to transport functions, logistics and storage, and clients are encouraged to give feedback regarding current and desired products. Business allies, at this level, work together, using various tools and collaborative techniques to reduce, through mutual initiatives and shared results, cycle times, especially time-to-market, using their actives more efficiently.

The fourth level is characterized by collaborative initiatives. Companies start using methodologies such as Activity Based Costing (ABC) and the Balanced Score Card to transform the supply chain into a value network of partners, who work towards the same strategic goals. Information is shared electronically, and inter-company teams are formed to find solutions for specific client problems. E-commerce technologies are considered crucial for this level, guaranteeing real-time sharing of all relevant information at each point of the value chain. Development and using of models and methodologies for implementation in design, planning and collaborative replenishment are crucial at this stage of the inter-organizational relationship evolution.

The fifth and most advanced stage in the supply chain is the most difficult goal to achieve. It is a developmental stage characterized by a complete join between agents throughout the whole supply chain. According to Pourier and Quinn (2003; 2004), only a few organizations in a few sectors reach this stage. It is a stage of complete collaboration throughout the network and of strategic use of technology information to achieve position and status in the market. At this stage, companies usually reach extraordinary order prediction levels as well as a reduction in the cycle time throughout networks connected completely electronically.

2.3 The business process orientation maturity model

The concept of Business Process Orientation suggests that the companies may increase their overall performance by adopting a strategic view of their processes. According to Lockamy and McCormack (2004), companies with great guidance for their business processes reach greater levels of organizational performance and have a better work environment that is based on much more cooperation and less conflicts.

A very important aspect of this model is the use of SCOR to identify the processes' maturity (Lockamy and McCormack, 2004; SCC, 2003). The SCOR measurements were adopted by their process orientation characteristics and their growing use among professionals and academics who are directly involved in logistic matters. The five stages of the maturity model show a progress of activities when the supply chain is efficiently managed. Each level contains characteristics associated with factors such as predictability, capability, control, effectiveness and efficiency.

Ad Hoc, the model's first level, is characterized by poorly defined and bad structured practices. Process measurements are not applied and work and organizational structures are not based on the horizontal process of the supply chain. Performance is unpredictable and costs are high. Cross-functional cooperation and client satisfaction levels are low.

At the second level, **defined**, SCM's basic processes are defined and documented. There is neither work nor organizational structure alteration. However, performance is more predictable. In order to overcome company problems, considerable effort is required, and costs remain high. Client satisfaction levels improve but still remain low if compared to levels reached by competitors.

At the third level, **linked**, the application of SCM principles occurs (Supply Chain Management). The organizational structures become more horizontally prepared through the creation of authorities that overlooks functional units. Cooperation among intra-organizational functions, supply managers and clients transform into teams that share measures common with SCM, and into objectives with a horizontal scope in the supply chain. Efforts for continuous improvement are made aiming to stop problems early and thus achieve better performance improvement. Cost efficiency grows and clients starts to get involved directly in the improvement efforts of intra-organizational processes.

At the fourth level, **integrated**, the company, its suppliers, and clients strategically cooperate in the processes' levels. Organizational structures and activities are based on the SCM principles and traditional tasks, related to the expanded value chain processes, start to disappear. Performance measurements for the supply chain are used, with the advent of advanced practices, based on collaboration. The process improvement objectives are geared towards teams and well reached. Costs are drastically reduced, and client satisfaction, as well as team spirit, becomes a competitive advantage.

At the final level, **extended**, competition is based in multi-organizational supply chains. Multi-organizational SCM teams appear with expanded processes, recognized authority and objectives throughout the supply chain. Trust and auto-dependence build the support base of the extended supply chain. Process performance and trust in the extended system are measured. The supply chain is characterized by a client-focused horizontal culture. Investments in the system's improvement are shared, as well as the investment's return.

3. Building the Supply Chain Process Management Maturity model – SCPM3

However, while previously developed maturity models outline the general path towards achieving greater maturity the idea of our paper is to more clearly identify which particular areas are important in the quest for achieving greater maturity at which level. We answer the questions: What best practices are fully matured and in use at what maturity level? This will more fully define the maturity levels based upon the capabilities present within the assessed company.

From a database containing 90 process capabilities indicators of supply management processes, composed by respondents from 788 companies located in USA, Canada, United Kingdom, China and Brazil, an exploratory factorial analysis (EFA) was conducted. EFA using Maximum Likelihood aims to find models that could be used to represent the dataset organizing the variables in constructs, i.e. groupings. Dataset was composed by respondents whose functions were directly related to supply chain management processes. The sample deliberately included companies from different industries in order to get a cross industry perspective. The study participants were selected from two major sources:

Set 1 - The membership list of the Supply Chain Council. The "user" or practitioner portion of the list was used as the final selection, representing members whose firms supplied goods rather than services, and were thought to be generally representative of supply chain practitioners rather than consultants. An email solicitation recruiting participants

for a global research project on supply chain maturity was sent out to companies located in USA, Canada, United Kingdom and China. The responses represent 39.3% of the sample composition with 310 cases.

Set 2 - In Brazil, the companies were selected from a list of an important educational institution of logistics and supply chain management in the country. An electronic survey was done. From a total of 2,500 companies contacted, 534 surveys were received, thus yielding a response rate of 21.4 percent. After data preparation, 478 respondents were included in the sample, representing 60.7% of the total sample.

From the results, considering a cutting point of eigenvalues bigger than 1.0, 16 constructs were considered which were able to represent 64.3% of the overall data variance. The Kaiser-Meyer-Olkin measure of sampling adequacy, representing the proportion of the variables' variance that could be caused by the factors, got a very high result of 0.958, indicating that the results of the EFA can be useful for the dataset. Moreover, the Bartlett's Test of Sphericity was conducted resulting in a significance value lower than 0.0001 demonstrating a good relationship between the variables that would be considered to detect a possible structure or model. Additionally, the Goodness-of-Fit also demonstrated that those 16 groupings have an excellent adjustment for the dataset with a significance also lower than 0.0001.

Further, the 16 constructs previously detected by EFA were submitted to a content analysis, considering the meaning of each question used to compose the questionnaire used for data collection. Such procedure enables a refinement resulting in a new list of 13 groupings, leaner and objectively composed, that were used to subsidy the first version of the Supply Chain Process Management Maturity Model (SCPM3). The Cronbach's Alpha for each of the 13 groupings was calculated and all groupings got values superior to 0.6 showing a good scale reliability.

Additionally, by conducting a collaborative effort with a group of specialists in process management and supply chains, the 13 groupings were labeled considering the variables comprising them. A complete list of groupings and their respective variables can be found in the appendix of this paper.

In order to identify the hierarchical relationship between the groupings and also the key turning points (McCormack *et al.*, 2009) that could be used to classify them in different maturity models and its respective cutting points denoting a level change, a set of cluster analysis procedures was conducted. Cluster analysis, also denominated as "segmentation analysis" or "taxonomic analysis", aims to identify subgroups of homogeneous cases in a population. In this sense, the cluster analysis can identify a set of groups that minimizes the internal variation and maximizes the variation between groups (GARSON, 2009).

Aiming to prepare the dataset for the cluster analysis, based on the sum of scores of all variables from each grouping it was generated a new variable for each grouping. Later, a variable Maturity Score was generated by summing all new indicators generated for each grouping representing the maturity score for each one of the 788 cases of the sample.

Further, the TwoStep cluster analysis was then conducted, considering the maturity score as a continuous variable and taking a fixed number of 5 clusters - each representing one maturity level - aligned with the traditional classification of the existent maturity models that are composed by five different evolution levels. The TwoStep cluster analysis groups cases in pre-clusters that are treated as unique cases. As a second step, the hierarchical grouping is applied to the pre-clusters. The 788 cases in the sample were then classified considering its positions in each of the five clusters, i.e. in each of the five maturity levels identifying its respective turning points.

Considering each cluster as a distinct maturity level and taking the centroids identified for each cluster, the turning points for each level were established based on the minimum score for level 1¹ and the average between two centroids for the others, as can be illustrated in Figure 1.

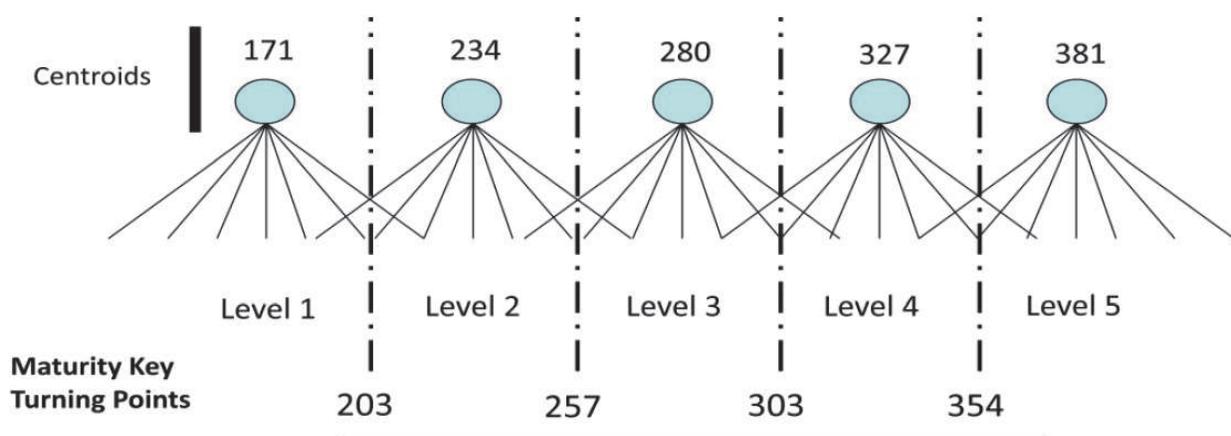


Fig. 1. Maturity Key Turning Points based in centroids scores. Source: Research Data

Taking the key turning points all the 788 cases were then reclassified regarding their maturity level and further identified in a new variable "LMaturity". In this sense, companies with maturity scores between 90 and 202 points were positioned at maturity level 1; between 203 and 256 points at level 2; ranging between 257 and 302 at level 3; between 303 and 353 at level 4; and above 354 points at maturity level 5. Such classification was based on a previous definition of the maturity levels as discussed by McCormack, Johnson and Walker (2003), with the turning points identified considering the data of this present research.

The internal turning points in each process grouping - i.e., the points that can be used to define a change in a maturity level for each group - were further identified by means of the cluster analysis with K-means algorithm. This method, by using the Euclidian distance, defines initially and randomly the centroids for each cluster and later initiates the interaction cycle. In each interaction the method groups the observed values taking the cluster average which the Euclidian distance is more close. In this sense, the algorithm aims to minimize the internal variance of each cluster and maximize the variance between clusters. The cluster centroids change in each interaction considering its new composition. The process continues until saturation is reached - with no more changes in centroids - or until the maximum limit of interactions is reached.

As conducted previously, the definition of the key turning points (McCormack *et al.*, 2009) were based at the centroids scores. For the first level the minimum score for each construct was taken and for the others, the centroids average of the previous level and the level itself was considered for each group.

Aiming to find evidence about the relationship of precedence between groups, the Euclidian distances correlation matrix was used as reference. This matrix was calculated based on a dissimilarity measure - i.e. the distance between the variables - based on the squared root of

¹Minimum score reachable by the *Maturity* variable, considering the sum of the 90 questions, each scored with a minimum value of 1.

the sum of the squared differences between the items. As discussed by Székely, Rizzo e Bakirov (2007) the correlation of the Euclidian distances can be considered as a new alternative to measure the dependence between variables. In this sense, by taking the scores from the proximities matrix as reference, the hierarchical analysis of the groups was conducted based on the Euclidian measure and the average link between groups. As result of this procedure a dendrogram was generated (Figure 2) representing the precedence between each group of indicators of capabilities in supply chain management processes.

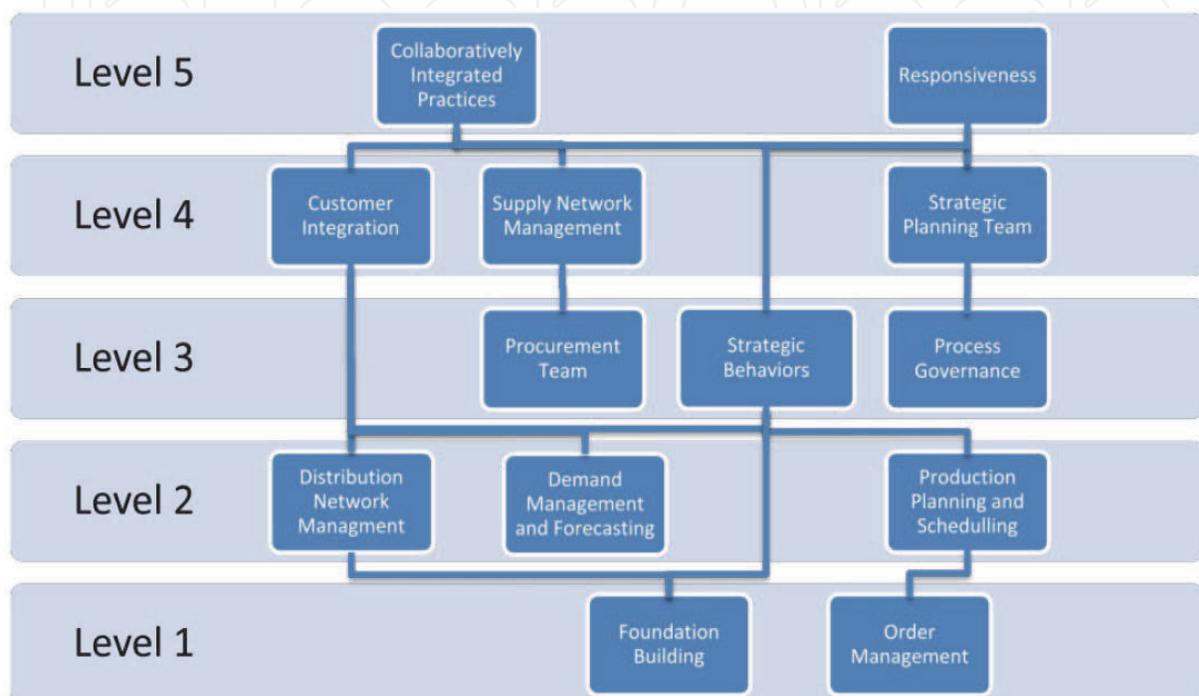


Fig. 2. Process groups organized by maturity level. Source: Research Data

To test the hierarchical relationships between groupings and the model composition and aiming to identify possible potential adjustments, path modeling and structural equation analysis was conducted. The tests were conducted relating the constructs of the maturity model with a performance variable (PSCOR), generated by summing the scores given by the respondents for the overall performance at the SCOR areas of Plan, Source, Make and Deliver. As a result, a new list of relationships between variables was generated indicating that, in case of change, it could improve the model adjustment reducing the scores of Chi-Square test. By using a cutting point of 200 points to determine which relationships could generate a significant improvement for the model adjustment, the constructs of *Strategic Behavior* and *Strategic Planning Team* were considered, if related, to improve the model adjustment. By understanding that the strategic behavior conditioned by firms developing teams to strategically plan their processes in supply chains, the relationship was considered valid. Additionally, looking at the composition of the construct *Strategic Behavior*, it is possible to notice that those indicators of capability in process refers, in general, to evidences about the existence of a strategic planning team working based on a wide view of the chain, considering the profitability of each customer and each product, working on the relationship with business partners, defining business priorities and evaluating the impact of the strategies on the business based on performance measures previously defined.

In addition, the relationship between groups was tested and all weights were calculated and validated considering a p-value < 0.001 , except the group *Strategic Planning Team*. Such group, when considered as a reflexive variable to *Responsiveness* and *Collaboratively Integrated Practices*, was rejected by the significance test. This results shows that it is not possible to assure that the estimated regression weight is different to zero, and, therefore, it is not possible to consider a direct relationship between those constructs. Considering those results, the construct of *Strategic Behavior* was repositioned at the model inverting the precedence relationship previously identified, positioning it as a successor of *Strategic Planning Team*. After adjustment the model considering the new structure, was resubmitted to the structural equation modeling and path analysis and a new table with the new regression weights was generated. All estimated regression weights for the new model, considering the relationships between groups, were considered significantly valid. Thus, the visual representation of the model was readjusted considering the new precedence relationships, as well as the turning points previously identified that can be used to determine the change of levels in a maturity scale for supply chain management processes. Finally, after the model and the relationship nature of the variables was discussed by specialists of the *BPM Team*² and some final adjustments were suggested to be implemented in the model and further validated by empirical research by connecting the construct of *Foundation Building* as a direct antecedent of *Demand Management and Forecasting*, *Production Planning and Scheduling* and *Supply Network Management*. Such suggestions were considered valid and adopted to be tested in future research by considering that the background generated by *Foundation Building* is a necessary condition for companies develop capabilities that enable an effective demand forecasting and demand management, generating important outcomes to be considered by the production planning and scheduling processes and also for the management of the suppliers network.

The final SCPM3 model emerging from the statistical analysis is presented in figure 3 and discussed below. The best practices present at each maturity level are show at the level where they become fully mature (the practices are additive as the company progresses).

Level 1 - Foundation - is characterized by building a basic structure, aiming to create a foundation for the processes to avoid ad hoc procedures and unorganized reactions, looking to stabilize and document processes. At this level, the critical business partners are identified and order management best practices are implemented considering restrictions of capacity and customer alignment.

Companies positioned at Foundation Level have the following characteristics:

- Process changes are hard to implement. Changes usually are energy consuming and hurt the relationships between those professionals involved. Changes are slow and need big planning efforts.
- There is always a sensation that customers are not satisfied with companies performance in delivery times. The commitments with the customers cannot be considered reliable and the company does not have an adequate control about what was ordered and not yet delivered.
- They are not prepared to generate deliveries to customers when some special treatment is requested. Processes are not flexible and, therefore, a lot of alternative resources are used to try to attend customers expectation generating unnecessary expenses for the organization.

² The Business Process Management Team is a global group of researchers lead by Prof. Kevin McCormack dedicated to investigate best practices and management models for process management.

- Inadequate demand forecasts and lack of internal processes integration generate problems caused by sellers promising more than companies have productive capacity to deliver and its inventory levels can support. Additionally, the company doesn't have control and not properly document shortfalls situations.
- Process of order placement, distribution and procurement are not properly documented.
- Companies information systems do not fully support all supply chain processes.
- Companies have not yet identified suppliers for product and services as strategic. Service levels with suppliers are not appropriately agreed, understood and documented.

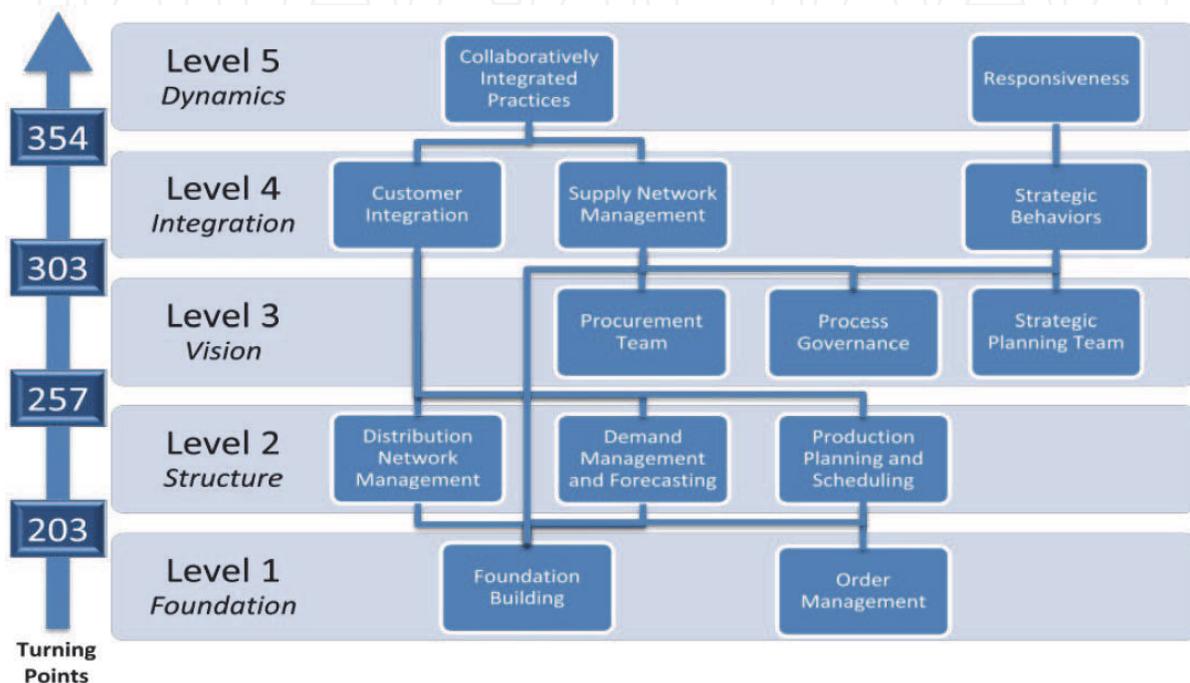


Fig. 3. SCPM3 final version. Source: Research data

At Level 2 – Structure – processes start to be structured in order to be further integrated. Control items are implemented in demand management processes, production planning and scheduling and for the distribution network management. Downstream, distribution network management practices are structured and the processes are defined. Demand starts to be evaluated in more detail. In other the direction, the processes of production planning and scheduling are structured taking the demand management and forecast as inputs.

Companies positioned at Structure Level have the following characteristics:

- Investments are made to document the flows of planning and scheduling, develop metrics to verify the adherence of planning by production scheduling and to the business needs.
- Plans start to be developed in more detail considering each item or service to be produced.
- Production plans start to integrate along company's divisions and the applied methodologies consider capacity constraints.
- Information systems start to support the operations and integrate with organizational processes.
- Demand is evaluated for each item/service considering historical data of orders and a process of demand management and forecasting implemented and formalized.

- Mathematical and statistical methods, together with customer information are used as baseline for distribution planning and demand forecasting.
- Forecasts are frequently updated and reliable. Forecasts are measured for accuracy and become the baseline for the development of plans and commitments with customers.
- Impact of future process changes is evaluated in detail before being implemented.
- Each node at the distribution chain has the measures and controls implemented. Automatic replenishment practices are in place in the distribution network.
- Distribution processes are measured and controlled and participants are rewarded based on those measures.

When organizations reach Level 3 – Vision – process owners are established and become responsible for its management and performance results. Procurement processes are evaluated by a team that looks strategically to the acquisitions in order to align the interests of the marketing and operations department. At this level, organization can be assumed to start to develop a strategic behavior considering a broader perspective of the supply chain.

Companies positioned at Vision level have the following characteristics:

- There is a procurement team formally designated and meeting periodically with other organizational functions such as marketing and operations.
- The process of order commitment has an owner that guarantees that commitments with customers are fulfilled. Similarly, the key processes of distribution, planning of the supply chain network, demand planning, procurement and operations have formal owners.
- Companies have a team responsible for the development of the operational strategic planning formally designated. The functions of sales, marketing, operations and logistics are represented on this team.
- The operational strategic planning team meets regularly and uses adequate tools for analysis to identify the impact of the changes before it is made.
- There is a planning process of operation strategy documented. When the team meets and make adjustments at the strategies, such adjustments are properly updated at the documents.

At Level 4 – Integration – companies seek to build a collaborative environment with their supply chain business partners. The organizational processes integrate with the processes of suppliers and customers in a collaborative platform. The forecasts are developed in detail, considering the demands of each customer individually. The relationship with upstream partners becomes more solid and integrated. The company, based on a set of concrete metrics and health data about the process flow, starts to use analytics and become more strategically driven with its supply chain partners.

Companies at Integration level have the following characteristics:

- Starts to develop, with its partners, the capability to respond to the demand signals working in a “pull” way.
- Functions of sales, operations and distribution collaborate with the process of production planning and scheduling.
- Information about customer planning starts to be considered as an input for the company’s planning. Forecasts are developed for each customer, individually.
- Changes in processes are implemented smoothly and guided by a documented process.
- The company aligns with its suppliers developing plans.
- Measures and controls are implemented to appraise the suppliers performance.

- Suppliers have access to inventory levels of the company and the information about production planning and scheduling are shared.
- Critical suppliers are considered partners and have broad access to company's information about production.
- The strategic planning team, established at the previous level, now continuously accesses the impact of its strategies based on supply chain performance measures.
- The strategic planning team is involved in the process to select new members and partners for the supply chain and actively participates in the relationships with suppliers and customers.
- The strategic planning team appraises the profits generated by each customer and each product individually and, based on such appraisal, defines specific priorities for each customer and product.

Level 5 - Dynamics - is characterized by a strategic integration of the chain, when processes support collaborative practices between partners and generate a baseline enabling the chain to be responsive to market changes. The chain starts, therefore, to behave dynamically, continually improving its processes considering its key performance indicators and reacting synchronized and fast to the changes in the competitive environment.

Companies positioned at the Dynamics level have the following characteristics:

- Functions of sales, marketing, distribution and planning collaborate between themselves to the process of order commitment and to develop forecasts.
- The order commitment process is integrated with the other supply chain processes.
- The demand management process and the production planning and scheduling are completely integrated.
- Companies establish a close relationship with customers and have control about demand and capacity constraints.
- Companies attend to the short term demands of customers and act in a responsive way.
- The supply times are considered critical for the production planning and are continuously revised and updated.
- Companies follow the orders and measure the percentage of orders delivered on time

4. Using the SCPM3 – A DRK methodological purpose

The following set of steps can be used as a guideline for managers and consultants as a roadmap for process improvement to maximize the return of the investment in supply chain management.

The bases of the application can be defined in three inter-related macro stages, as follows:

The Discovery stage involves the scope definition to be evaluated - i.e. the focus of the analysis - and aims to identify possible adjustments necessary to the basic indicators. (Appendix A), in order to collect information about specific points related to the defined scope and to proceed with data collection for the indicators of capabilities in supply chain management processes.

The Knowledge stage approach the communication of the results obtained in the previous stage: the contextualization of the results, the communication of the recommendations for improvement. At this stage also the knowledge unification in the organization happens about: a) What is a maturity model for supply chain process management?; b) Why access the indicators of capabilities of supply chain management processes?; c) How the maturity models can be applied?; and d) What can the organization learn from using the model?

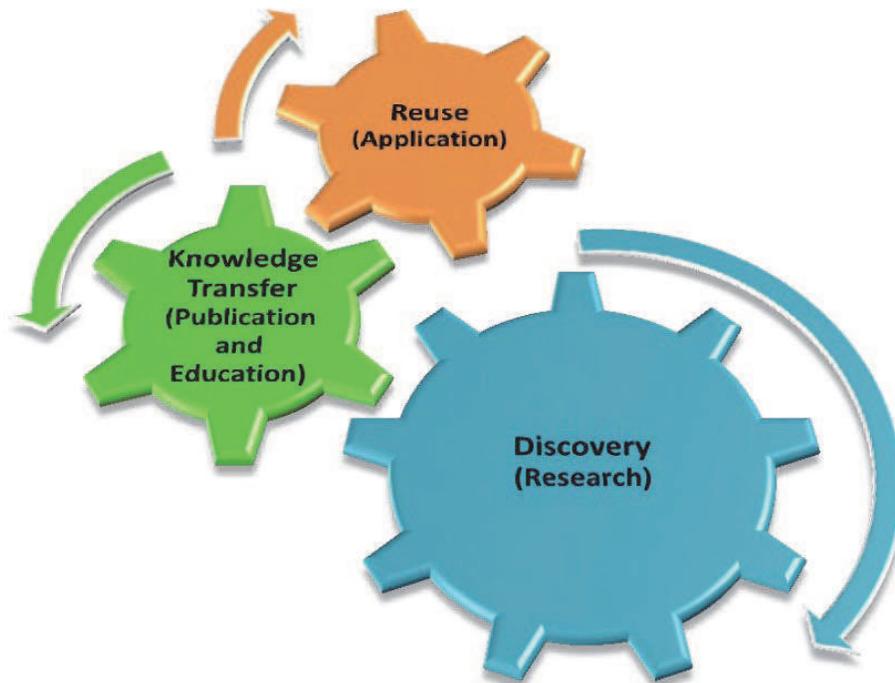


Fig. 4. Macro stages to apply the model. Source: Elaborated by the authors

At the Reuse stage, the application of the knowledge becomes operational by planning and implementing the recommendations and preparing the organization to restart the DRK cycle with a new stage of research.

The figure 6 illustrate the stages on a maturity cycle, that are further presented in more detail, aiming to provide guidelines to organizations looking to reach continuous improvement in their supply chain management processes:

At the Discovery phase, initial step to apply the SCPM3, it is defined the scope of the analysis considering the broad of the vision under different perspectives for supply chains (internal, dyad or external).

After the scope definition, it is necessary to identify the possible adjustments that would be necessary to the questionnaire (Appendix A), adding new complimentary questions aiming to gather information specific to the previously delimited scope. Such adjustments should be made with caution and followed by key professionals in the organization that have a strategic view about the supply chain processes.

The next step comprises of the data collection with 20 to 30 professionals with a broad view about the organization and its processes. After to proceed to the data collection and the preliminary data analysis, it would be recommended to apply deep interviews with some professionals in order to capture some business specificities on the scope.

The next step, Knowledge, aims to present the results of the research and the recommendations to the supply chain. It consists of four steps sequentially defined:

1. Alignment of the concepts about SCPM3;
2. Proceed to generate the preliminary results evaluation, based on the scores obtained on the indicators. What would be the maturity level of the organization and which would be the critical points to be developed and improved in order to reach a superior level;
3. Based on the data gathered, proceed with the evaluation of each group and identify the points that must be improved in each group of the model;

4. Compare each indicator with a benchmarking database for reference and present the results with recommendations for processes improvement and efforts prioritization. At the next step, an implementation plan for the recommendations must be elaborated and implemented. In the end, the organization must be prepared to restart a new cycle and revise its processes to continuously improve.

As a result for each cycle, the following deliverables are expected to be generated:

- Visual representation of the positioning of the organization at the SCPM3
- Scores by each group of the model
- Scores in each SCOR area (Plan, Source, Make and Deliver)
- Benchmarking of each score with the reference database, identifying the major gaps, weaknesses and strengths.
- A recommendation list and potential benefits for each recommendation, prioritizing each action and considering: cost reduction, inventory reduction, faster cycles and improvement of service levels delivered to company's customers.
- An executive report summarizing each cycle.

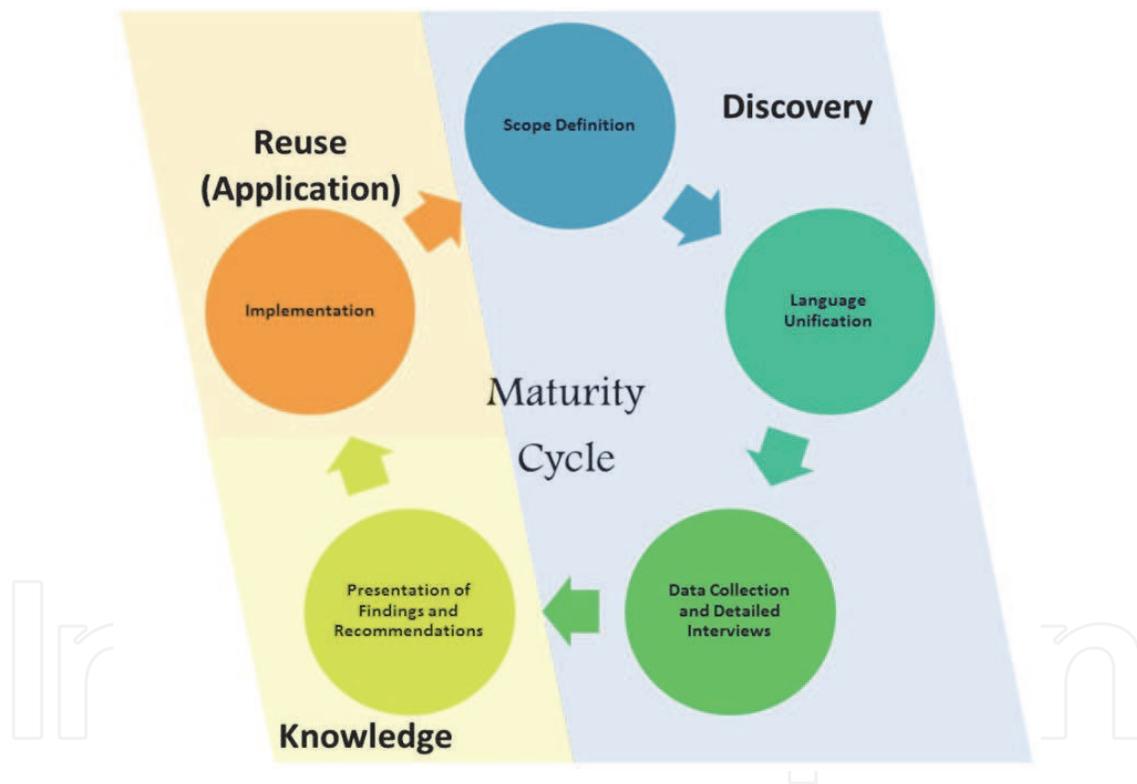


Fig. 5. SCPM3 Cycle. Source: Elaborated by authors

5. Conclusions and recommendations

In recent years, a growing amount of research has been dedicated to investigating ways to provide the right information for the right people in order to develop supply chain capabilities and resources to competitively bring products and services to the market. Key literature on the concept of business process management suggests both that organizations can enhance their overall performance by adopting a process view of business and that business-process orientation (BPO) has a positive impact on business performance.

The concept of process maturity derives from the understanding that processes have life cycles or developmental stages that can be clearly defined, managed, measured and controlled throughout time. A higher level of maturity, in any business process, results in: (1) better control of the results; (2) more accurate forecast of goals, costs and performance; (3) higher effectiveness in reaching defined goals and the management ability to propose new and higher targets for performance.

In order to meet the performance levels desired by customers in terms of quantitative and qualitative flexibility of service in demand fulfillment, deadline consistency and reduction of lead times related to fulfilling orders, firms have developed repertoires of abilities and knowledge that are used in their organizational process. In the two past decades, management of supply chain processes has evolved, also because of these new demands, from a departmental perspective, extremely functional and vertical, to an organic arrangement of integrated processes oriented to providing value to intermediate and final costumers. This new pattern of logistical process management had lead towards the development and application of different maturity models and performance metrics useful as support tools to help define a strategy and to face trade-offs, as well as to identify items that are considered critical to quality improvement of logistical services rendered to the client.

The SCPM3 model is the first SCM process maturity model the uses rigorous statistical analysis to define maturity levels and the best practices present at each level. This model is based upon a global data set of hundreds of companies across many industries. Therefore, the model will more closely represent what is really occurring rather than a preferred path to maturity represented by anecdotally developed models. This makes the SCPM3 broadly applicable as a benchmarking instrument. A company can complete the assessment using the indicators in Appendix A and use this score to place themselves on the maturity model. In this way, they can develop an action plan to improve process maturity incorporating best practices only as they are relevant to reaching the next maturity level, thus avoiding getting ahead of themselves and trying to implement best practices that do not have the precedence components in place. This will make the improvement efforts more effective and sustainable leading to less time needed to achieve each maturity level.

6. Appendix A - best practice measures

Construct Name	Question Text
Demand Management and Forecasting	Do your information systems currently support the Demand Management process?
	Do you analyze the variability of demand for your products?
	Do you have a documented demand forecasting process?
	Does this process use historical data in developing the forecast?
	Do you use mathematical methods (statistics) for demand forecasting?
	Does this process occur on a regular (scheduled) basis?
	Is a forecast developed for each product?
	Does your demand management process make use of customer information?
	Is the forecast updated weekly?
	Is the forecast credible or believable?
	Is the forecast used to develop plans and make commitments?
	Is forecast accuracy measured?

Construct Name	Question Text
Strategic Planning Team	Do you have an operations strategy planning team designated?
	Does the team use adequate analysis tools to examine the impact before a decision is made?
	Does this team have formal meetings?
	Are the major Supply Chain functions (Sales, Marketing, Manufacturing, Logistics, etc) represented on this team?
	Do you have a documented (written description, flow charts, etc) operations strategy planning process?
	When you meet, do you make adjustments in the strategy and document them?
Strategic Behaviors	Does the team look at the impact of their strategies on supply chain performance measures?
	Does the team have supply chain performance measures established?
	Is the team involved in the selection of supply chain management team members?
	Does this team look at customer profitability?
	Does this team look at product profitability?
	Does this team participate in customer and supplier relationships?
	Has the business defined customer priorities?
	Has the business defined product priorities?
Procurement Team	Is there a procurement process team designated?
	Does this team meet on a regular basis?
	Do other functions (manufacturing, sales, etc) work closely with the procurement process team members?
Supply Network Management	Do you "collaborate" with your suppliers to develop a plan?
	Do you measure and feedback supplier performance?
	Do suppliers manage "your" inventory of supplies?
	Do you have electronic ordering capabilities with your suppliers?
	Do you share planning and scheduling information with suppliers?
	Do key suppliers have employees on your site (s)?
Production Planning and Scheduling	Do you have a documented (written description, flow charts, etc) production planning and scheduling process?
	Do you measure "adherence to plan"?
	Does your current process adequately address the needs of the business?
	Are plans developed at the "item" level of detail?
	Are your planning processes integrated and coordinated across divisions?
	Do you have weekly planning cycles?
	Are you using constraint-based planning methodologies?
	Is shop floor scheduling integrated with the overall scheduling process?
Do your information systems currently support the process?	

Construct Name	Question Text
Distribution Network Management	Does your information system support Distribution Management?
	Are the network inter-relationships (variability, metrics) understood and documented?
	Are impacts of changes examined in enough detail before the changes are made?
	Do you use a mathematical "tool" to assist in distribution planning?
	Is the Distribution Management process integrated with the other supply chain decision processes (production planning and scheduling, demand management, etc)?
	Does each node in the distribution network have inventory measures and controls?
	Do you use automatic replenishment in the distribution network?
	Are Distribution Management process measures in place?
	Are they used to recognize and reward the process participants?
Order Management	Do you maintain the capability to respond to unplanned, drop-in orders?
	Do your information systems currently support the order commitment process?
	Do you measure "out of stock" situations?
	Can rapid re-planning be done to respond to changes?
	Are the customer's satisfied with the current on time delivery performance?
	Do you measure customer "requests" versus actual delivery?
	Given a potential customer order, can you commit to a firm quantity and delivery date (based on actual conditions) on request?
	Are the projected delivery commitments given to customers credible (from the customer's view)?
Process Governance	Do you have a Promise Delivery (order commitment) "process owner"?
	Is a Distribution Management process owner identified?
	Do you have someone who "owns" the process?
	Is there an owner for the supply chain planning process?
	Is there an owner for the demand management process?
Foundation Building	Is a "process owner" identified?
	Are changes made in response to the loudest "screams"?
	Are deliveries expedited (manually "bypassing" the normal process)?
	Do you promise orders beyond what can be satisfied by current inventory levels?
	Is your order commitment process documented (written description, flow charts)?

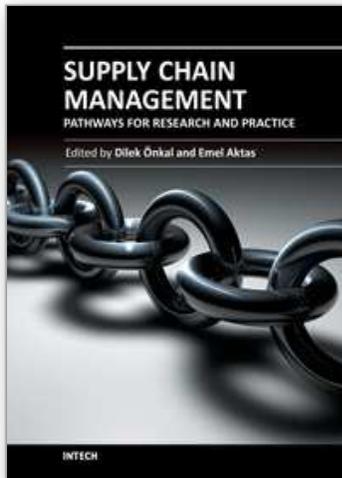
Construct Name	Question Text
	Is your Distribution Management process documented (written description, flow charts)?
	Is your Procurement process documented (written description, flow charts)?
	Does your information system support this process?
	Are the supplier inter-relationships (variability, metrics) understood and documented?
	Do you have strategic suppliers for all products and services?
Responsiveness	Do you meet short-term customer demands from finished goods inventory?
	Are supplier lead times a major consideration in the planning process?
	Are supplier lead times updated monthly?
	Do you track the percentage of completed customer orders delivered on time?
Collaboratively Integrated Practices	Do the sales, manufacturing, distribution and planning organizations collaborate in the order commitment process?
	Are your demand management and production planning processes integrated?
	Do sales, manufacturing and distribution organizations collaborate in developing the forecast?
	Is your order commitment process integrated with your other supply chain decision processes?
	Do you automatically replenish a customer's inventory?
Customer Integration	Do you "build to order"?
	Do the sales, manufacturing and distribution organizations collaborate in the planning and scheduling process?
	Is your customer's planning and scheduling information included in yours?
	Are changes approved through a formal, documented approval process?
	Is a forecast developed for each customer?

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Challenges faced by supply chains appear to be growing exponentially under the demands of increasingly complex business environments confronting the decision makers. The world we live in now operates under interconnected economies that put extra pressure on supply chains to fulfil ever-demanding customer preferences. Relative attractiveness of manufacturing as well as consumption locations changes very rapidly, which in consequence alters the economies of large scale production. Coupled with the recent economic swings, supply chains in every country are obliged to survive with substantially squeezed margins. In this book, we tried to compile a selection of papers focusing on a wide range of problems in the supply chain domain. Each chapter offers important insights into understanding these problems as well as approaches to attaining effective solutions.

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