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A global investigation of key turning points in business process maturity

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Abstract

Purpose – The purpose of this paper is to report on the results of research into the precedence of the maturity factors, or key turning points in business process maturity (BPM) implementation efforts. A key turning point is a component of BPM that stabilizes within an organization and leads to the next maturity level.

Design/methodology/approach – Several years of data from over 1,000 companies in the USA, Europe, China, and Brazil that have completed a BPM assessment are analyzed to identify which components of BPM stabilize, when and in what order. Different analysis methods are employed in order to identify global commonalities and differences.

Findings – The paper identifies key turning points from several different perspectives using several different approaches and develops some conclusions common to all methods used in this research.

Research limitations/implications – The relationship between the components (dependencies) is only suggested but not statistically analyzed. Several data sets are also on the low end of sample size for the methods used and some parts of the research used *ad hoc* selection of companies of arbitrarily distributed companies into different groups.

Practical implications – The results can be useful for leaders and teams that are attempting the journey to process maturity. The guide-posts, milestones, and measures can help answer the question "Where am I on this journey and what is next?"

Originality/value – A plethora of maturity models has emerged that claim to guide an organization through the process of building levels of maturity that lead to competitive advantage. To date, there has been a lack of quantitative studies documenting these road-maps. The paper provides global, quantitative evidence of the critical maturity components associated at each level of maturity.

Keywords Business process re-engineering, Process management, Business development

Paper type Research paper

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Introduction

Competition in many industries has been based mainly upon strategic assets and on the ability to deploy these assets. Competition in today's global economy is now based upon capabilities, or "complex bundles of skills and accumulated knowledge, exercised through organizational processes" (Day, 1994). Owing to this new capabilities business approach, many firms are now viewing processes as strategic assets. Under this perspective, 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.

Since the 1980s, a plethora of maturity models have emerged that claim to guide an organization through the process of building levels of maturity that lead to competitive advantage. Road maps and step-by-step recipes are being offered that claim to describe the order that maturity components must be implemented to achieve success. To date, there has been a lack of quantitative studies documenting these road maps that rely mainly upon anecdotal evidence and case studies describing success stories.

This paper reports on the results of exploratory research into the precedence of the maturity factors in business process maturity (BPM) implementation efforts. Several years of data obtained from over 1,000 companies in the USA, Europe, China, and Brazil, which have completed various forms of a BPM assessment, were analyzed in an attempt to identify which components of BPM stabilize when and in what order. Several different maturity models (based upon the McCormack BPM model) and analysis methods were employed in order to examine global commonalities and differences. The results are used to suggest implementation approaches and issues that must be addressed during BPM efforts.

The paper is organized in the following way; first, the background of BPM is presented, second, the concept of turning points is explained, third, research results are presented for each approach and region, fourth, implications and conclusions are presented and finally, future research is discussed.

Background – business process maturity

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 (Davenport, 1993; Hammer and Champy, 1993; McCormack and Johnson, 2001; Burlton, 2001; Harmon, 2003, 2007; McCormack, 1999; Seltsikas, 2001; Aysar and Johnson, 2003).

The concept of BPM or the broad adoption of process orientation within an organization, derives from the understanding that processes have life cycles or developmental stages that can be clearly defined, managed, measured and controlled throughout time. Higher levels of maturity in any business process result in:

- better control of results;
- improved forecasting of goals, costs, and performance;
- greater effectiveness in reaching defined goals; and
- improving managements' ability to propose new and higher targets for performance (Lockamy and McCormack, 2004; McCormack, 2007; Poirier and Quinn, 2004).

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 process oriented or horizontal 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 BPM, 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 (McCormack and Johnson, 2001).

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.

In the current business environment, there is no scarcity of process maturity models (Curtis *et al.*, 2002, 2004; Rosemann *et al.*, 2006; Hammer, 2007). For the purpose of this research, the BPO maturity model and assessment instruments from McCormack and Johnson (2001) were used as a starting point and adapted as needed for each individual research objective. The original model was developed based on the concepts of process maturity, BPO, and the capability maturity model developed by the Software Engineering Institute at Carnegie Mellon University (McCormack and Johnson, 2001; Lockamy and McCormack, 2004; McCormack, 2007).

The McCormack BPM construct describes a four-step pathway for systematically advancing business processes along the maturity continuum (*ad hoc*, defined, linked, and integrated level). Each step builds on the work of the previous steps to apply improvement strategies that are appropriate to the current maturity level. The following definitions for the stages that an organization goes through when becoming BPO are provided (McCormack and Johnson, 2001; McCormack, 2007):

(1) Ad hoc. The processes 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 processes.

(2) *Defined.* The basic processes are defined, documented and available in flow charts. Changes to these processes must now go through a formal procedure. Jobs and organizational structures include a process aspect, but remain basically functional. Representatives from functional areas (sales, manufacturing, etc.) meet regularly to coordinate with each other, but only as representatives of their traditional functions.

(3) *Linked.* The breakthrough level. Managers employ process management with strategic intent and results. Broad process jobs, and structures are put in place outside of traditional functions.

(4) *Integrated.* The company, its vendors and suppliers, take cooperation to the process level. Organizational structures and jobs are based on processes, and traditional functions begin to be equal or sometimes subordinate to process. Process measures and management systems are deeply imbedded in the organization.

Turning points in the BPM journey

According to the McCormack maturity model, there are several components of maturity. The basic components of the model are process view, process jobs, and process management and measurement. Each of these components is explained:

- *Process view.* Documentation of process steps, activities and tasks comes in both visual and written formats that allow people in different job functions and companies to communicate using the same vocabulary. This component includes broad understanding of the processes across the organization, not just documentation.
- *Process jobs.* These jobs included horizontal rather than vertical responsibility. People participate and take ownership of the entire process. Titles such as "Supply chain team member," "Order fulfillment process owner," and "Global supply chain manager" are examples.
- *Process measurement and management systems.* This component includes process measurement systems, rewards for process improvement, outcome measurements, customer-driven and team-driven measures, and rewards.

In addition to the basic components there are two supporting components. These provide the structure and culture that enable the basic components to operate, interactively. These components are:

(1) *Process structure.* This is the framework that defines the process management team and breaks down the old functional "compartments," such as sales and manufacturing, which inhibit enterprise-wide or horizontal thinking. Without it, people with "process owner" titles cannot do their jobs. These structures included horizontal teams, partnerships, and shared ownership.

(2) *Customer-focused 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 continuous process improvement.

In each maturity level certain components of BPM become evident and others barely registered. Using case examples and anecdotal evidence, high-level definitions of each maturity level have been constructed and were presented earlier in the background section of this paper. These definitions have not been quantitatively tested. The question of which components become stable and which components appear later, building upon the previous levels, has not been quantitative examined. This is an important aspect of any maturity effort. The question of which components must be established and stable before others are emphasized is an important one that justifies the investment in a detailed quantitative study.

With this in mind, this exploratory research investigates the precedence of the maturity factors in BPM implementation efforts by using a "key turning point" concept. A key turning point can be defined as a component of BPM that stabilizes within an organization and leads to the establishment and expansion of other factors that move the organization to the next maturity level.

This paper is an important contribution in the research on BPO. First, it uses the experience from numerous consulting projects to develop the concepts of turning points.

Then major components of maturity levels are empirically confirmed. Then additional the BPO domains are identified and the main clusters of items with significant differences in at least one group are extracted. The decision tree technique in the next section is useful both for classification of companies to various maturity levels and to obtain the most important aspects of BPO for transitioning from Levels 2 to 3. Finally, the BPO concepts are extended to the supply chain level. Cluster analysis is performed to identify the important baseline for the planning and implementation of supply chain management (SCM) improvement efforts.

Additional advantage of the paper is that data from over 1,000 companies across several industries in the USA, Europe, China, and Brazil that have completed a variation of the BPM assessment were analyzed to also examine to identify which components of BPM stabilize when and in what order. Several different variants of the McCormack maturity model were used and different analysis methods were employed in order to examine global commonalities and differences. Different techniques for each data set and methods used are discussed and the results are used to quantitatively define maturity levels and suggest implementation approaches and issues that must be addressed during BPM efforts.

Research results

Model development – anecdotal evidence

Data set. Since 1996 several 100 companies from the USA, Canada, Europe, and China were assessed across most industries and company sizes. The McCormack maturity model was used to evaluate the level of BPM currently present in the company and prescribe priority actions that could improve the levels of maturity of the companies investigated.

Method used. During workshop presentations and discussions of assessment results with process teams and by observing several multi-year maturity programs, anecdotal evidence of patterns have emerged. Several key visual road maps were developed from these patterns and validated over several years of use with companies involved in maturity efforts. Figure 1 shows the first visual created that implies key turning points in the maturity journey.

Based on discussions with several companies during 1997 and 1998, the emphasis of functions or processes took on visual forms for each level. At Level 1, the vertical functions are strongly visible and the horizontal processes are very faint. As the maturity increases, the horizontal lines become more defined representing different levels of implementation of the horizontal view. This indicated key turning points of the process view concept of BPM, from barely present to equal to the functions and in some cases dominant.

The second visual was developed in 2001 and is shown in Figure 2. It depicts various slopes of progression within a maturity journey and suggests issues and actions needed to more forward. Suggested time frames include three phases. This visual was based upon several years of discussions with BPM program leaders and practitioners but is still based upon anecdotal evidence.

The final visual model of BPM was created in 2002-2003. Figure 3 was developed by Richard McKnight, an organizational development consultant, working on a project to improve BPM in a major chemical company. The picture was produced after interviewing dozens of company employees and leaders. It is a picture of a mountain to

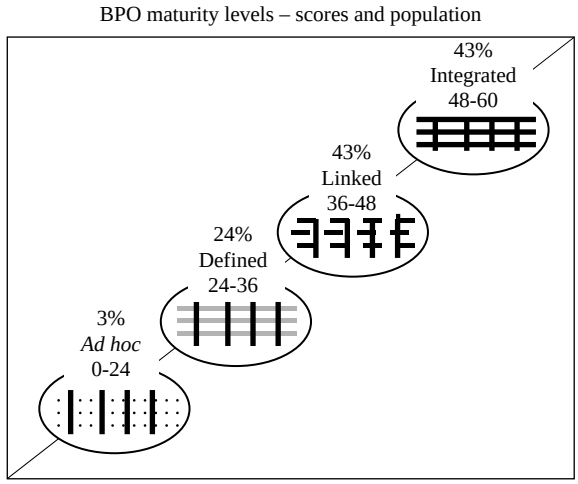


Figure 1.
BPM levels – 1998

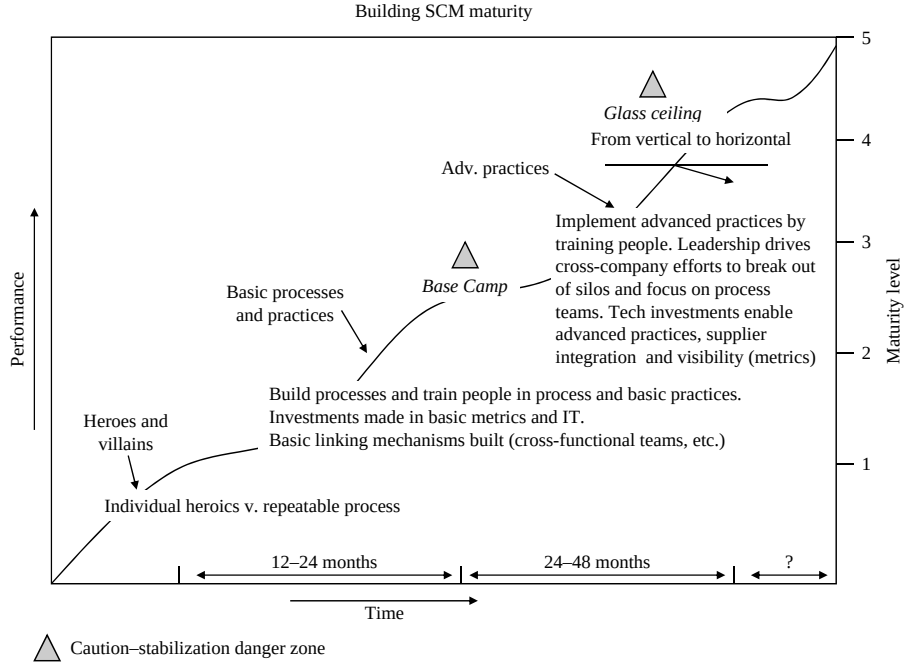


Figure 2.
Supply chain maturity – 2001

represent the maturity journey with different slopes and a plateau. The maturity levels are place on the mountain at key points that are analogous to the turning points in the journey.

There are two different "climbs" in the journey. The gradual slope, often called the approach, and the steep slope leading to the summit. In between the two is

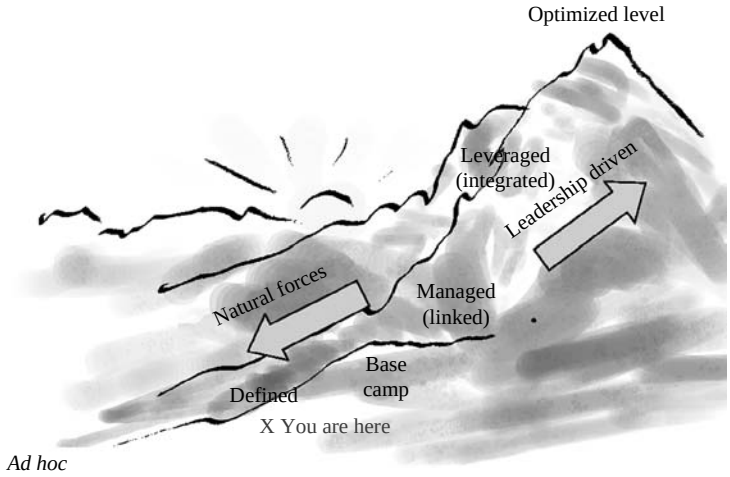


Figure 3.
Business process maturity 2003; climbing the mountain

a "base camp" which is flat and easy to stay put. Natural forces are shown as pulling people back down and leadership forces are shown as the key to climbing the summit.

Results and conclusions. All of these visual and anecdotal models were very useful as discussion and change management documents but lacked a quantitative precision needed for detailed diagnoses and situational assessments. The turning points are visually depicted (base camp, different maturity levels, etc.) allowing for discussion concerning the journey of BPM.

Quantitative and graphical testing of developed model

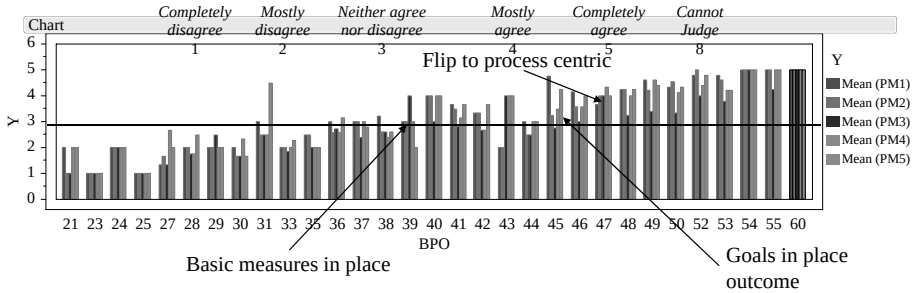
Data set

The same data set used in the earlier anecdotal section was used for the quantitative models.

Method used

The maturity assessment used consisted of three main maturity components; process view, process jobs, and process measures and management. Each component was assessed using three to five measures with a Likert scale from 1 to 5 – strongly disagree to strongly agree. The maturity scores were simply a sum of the scores for each measure. In order to determine the key turning points between maturity levels, a graphical analysis technique was used (Figure 4).

This graphical technique was visual and quantitative and seemed to bring out the major components that represent maturity levels. It also suggests precedence to these components. For example, process language develops during the defined stage which leads to usable process definitions at the end of this stage as expected in the model. Measures and goals became evident and process designs stabilize in the managed phase enabling jobs to become aligned with processes at the end of this stage. The flip to process centric management also occurs prior to the integrated stage and after shared budgets appear. The main issue with this approach is that the maturity level boundaries were subjectively drawn. Further research was needed to identify a quantitative technique for setting these boundaries.



PM1. Process performance is measured in your organization
PM2. Process measurements are defined
PM3.Resources are allocated based on process
PM4. Specific process performance goals are in place
PM5. Process outcomes are measured

Figure 4.
Graphical method for identifying key turning points

Confirmation and refinement of the findings

Dataset

The previous findings were further triangulated based on an additional survey assessing 68 BPO characteristics in 39 BeNeLux (Belgium-the Netherlands-Luxembourg) organizations. The survey was developed at the Vlerick BPMNetwork, Vlerick Leuven Gent Management School, Belgium and is an elaboration of the McCormack maturity model and concepts. In the survey 68 questions are probing for BPO characteristics in eight different domains, each measured on a seven-point Likert-scale. These eight BPO domains are:

(1) customer orientation;
(2) process view;
(3) organizational structure;
(4) process performance;
(5) culture, values and beliefs;
(6) people management;
(7) information technology; and
(8) supplier orientation (Willaert *et al.*, 2007).

The 39 organizations were selected on an *ad hoc* basis and represent various sectors and sizes. Online questionnaires were sent out to a group of 10-60 participants in each organization between June 2006 and March 2007. Participants were selected from different departmental backgrounds and management levels. In total, 821 valid individual responses were included in the analysis.

Method used

To perform the additional analysis three preparatory steps were deployed:

(1) The organizations were sorted from low to high, based on their general BPO scores (average score of eight dimensions). Subsequently, the ranked organizations were divided in four succeeding groups of equal size

(first group has nine organizations, Groups 2-4 each have ten organizations). This arbitrary classification of four groups was chosen in order to have on the one-hand sufficient cases in each group for validity purposes, but on the other hand to have enough groups, in order to be able to make sufficiently differentiating conclusions.

(2) For each organization the relative contribution of each item to the general BPO score was calculated. These figures give an indication of the relative importance in an organization of a certain BPO characteristic compared to all other BPO characteristics.

(3) For each item, the averages of these relative importance item scores were calculated for the four groups. ANOVA testing was conducted in order to find significant differences between these group averages. Comparing the means of the relative contribution of each item between the different groups, could give an indication of relative higher or lower importance of certain items in certain stages of the growth path. Items that showed a similar pattern over the different groups and that are a part of the same domain are grouped to ease further discussion of the results.

Results and conclusions

The comparison through the stage 4 categorization (Figure 5) showed three clusters of items with significant differences in at least one of the groups. The comparing means analysis showed statistically significant evidence of three main trends in the BPO growth path. Two clusters of items, "knowing the customer needs and preferences" and "endorsing teamwork and multi-skilling," show values indicating higher importance compared to other items for cases in early BPO stages. For cases with higher general BPO scores items probing for "consistent use of process metrics" become more important than other items. This means that in early BPO maturity stages core efforts in two main areas are deployed. On one hand these organizations focus strongly on creating a sense of teamwork. On the other hand a focus exists on creating an extensive understanding of customer needs and preferences. These areas of

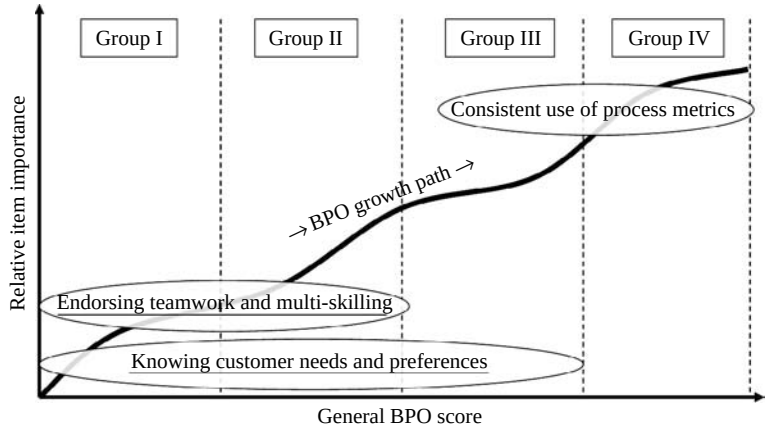


Figure 5.
Four-stage categorization model

BPM can be considered as "initial" in the BPM growth path. On the contrary, the set-up and use of a process metric system, is an area that develops only when a certain BPO level is accomplished. Therefore, this area can be considered as "subsequent" in the BPO growth path.

For the other items, no significant differences were found. This could indicate that for those items a more steady growth occurs in organizations, without any higher or lower relative importance in the entire growth path. As a result it would mean that it takes many small incremental efforts for these aspects to support growth in BPO. However, the lack of evidence for other turning points in this part of the analysis could also be assigned to the limited sample of organizations. Therefore, a larger set of cases could provide more detailed conclusions in further research.

Advantages and limitations of the method used

The main advantage of this method is the fact that data are aggregated from individual answers to organizational level, and subsequently analyzed on this level. This gives a more objective view on the actual BPM status of organizations, as BPO is mainly an organizational attribute. The method is also exploratory, and therefore a large flexibility in analysis options is possible. Otherwise, the fact that data are aggregated to a company level, results in the fact that few units of analysis remain. Because of this, it is hard to make fully validated statements. The method, as currently described also uses arbitrarily chosen groups, which again encounters the robustness of the analysis. More analyzed companies could therefore solve this issue.

Practical business use

The method, notwithstanding the limitations, has a large practical business value. With a group of employees surveyed in each company, an objective benchmark between the organizations could be conducted. Basically, a comparison of the absolute values for each of the dimensions, and even items, could give a first practical insight. Even more, for each organization the relative importance of the items can also be compared. In this way, the organizations get a first indication, and input for internal discussion, on what items they score well (in absolute figures), and on what items they score better than other organizations (relative figures).

Decision tree learning for turning points detection in BPO: Central Europe

Dataset

In order to provide a set of operational rules to determine and define turning points between maturity levels the Faculty of Economics and Business in Croatia and the Faculty of Economics in Slovenia carried out a joint empirical research study in 2005. A total of 15 questions were included in the questionnaire regarding the BPO characteristics, divided into three different domains: process view, process jobs and process management and measurement. Each question was measured on a five-point Likert scale. For this paper only the Croatian dataset is used. A total number of organizations in the sample was 1,750 out of which 202 were returned. Since split criteria cannot be evaluated if records with missing or invalid data are used, these cases were removed from the dataset. The responses contained four records with missing or invalid data so the final data set contained 198 records.

Method used

Decision tree learning is a common machine learning method used in data mining. It is a versatile predictive model used for classification problems and regression. It is used in expert systems and data mining projects within the customer relationship management systems for customer profiling, financial services systems for fraud detection, BPM for process control and reengineering, marketing systems for efficient targeting of marketing campaigns, etc. (Berry and Linoff, 2000). Depending on the data type of the dependant variable there are classification trees and regression trees. For the purpose of this research classification tree is more appropriate as the dependent variable is categorical.

A tree can learn how to classify a given set of data (training set) by determining split criteria for each branch. Various decision tree algorithms such as CHAID, ID3, C4.5, C&RT, etc. produce trees that differ in the number and choice of splits at each level and how the tree growth is limited to prevent overfitting. However, the most important characteristic of the algorithms is the criteria for determining the split. General C&RT algorithm (Breiman *et al.*, 1984; Ripley, 1996) uses statistical measurements of homogeneity of cases in a node (such as Gini index, χ^2 or G^2). ID3 algorithm and C4.5 algorithm (Quinlan, 1979, 1993) uses an information driven evaluation function based on entropy and information gain. All of the algorithms try to determine the predictor variable and split criterion that can generate the greatest improvement of the predictive accuracy.

Since there is a difference in Likert scale of the questionnaire and number of maturity levels data transformation was conducted as defined in Table I.

Next, for each domain an average score was calculated. Also overall average score was calculated based on the domain scores. Overall average was used to indicate maturity level for each record in the data set. Owing to small number of records ($N < 200$) all of the data were used for modeling decision tree.

Results and conclusions

A decision tree was created using General C&RT algorithm in STATISTICA. Maturity level was used as dependent variable and all of the other 15 variables obtained through the questionnaire were used as predictor variables. χ^2 measure was used as split criteria. Tree with the lowest classification error was selected (Figure 6).

This model successfully classifies 82.3 percent of data records. Using the rules obtained from the decision tree we can distinguish the most important aspects of BPO for transitioning from Levels 2 to 3. Some of the rules with highest support and lowest error rate are[1]:

Table I.
Maturity level map to Likert scale

Likert scale values from questionnaire	BPO maturity levels
0, 1, 2	1
3	2
4	3
5	4

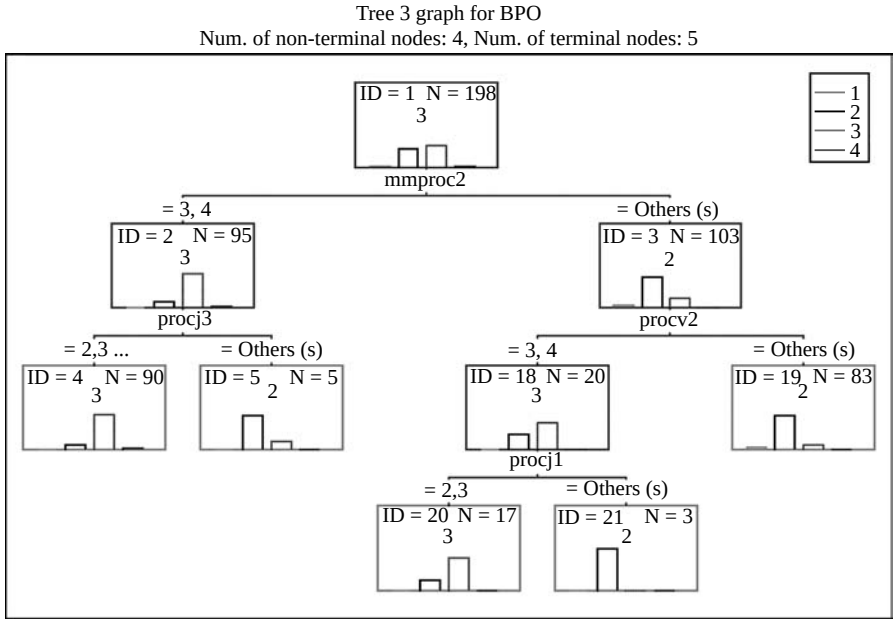


Figure 6.
Classification of maturity levels using general C&RT tree model

Node id = 4 : IF mmproc2 = 3 or 4 AND procj3 = 2, 3, or 4 THEN BPO = 3

Node id = 5 : IF mmproc2 = 3 or 4 AND procj3 = 1 THEN BPO = 2

Node id = 20 : IF mmproc2 = 1 or 2 AND procv2 = 3 or 4 AND

procj1 = 2, 3 or 4 THEN BPO = 3

Node id = 21 : IF mmproc2 = 1 or 2 AND procv2 = 3 or 4 AND

procj1 = 1 or 43 THEN BPO = 2

Node id = 19 : IF mmproc2 = 1 or 2 AND procv2 = 1 or 2 THEN BPO = 2.

These rules can be used to determine and define turning point between maturity Levels 2 and 3.

As the model shows, the key factor or the turning point lies in the process management and measurement dimension. Specifically, for advancing to the third level a company must have process measured defined (score of 3 or above). Clearly, just by understanding, defining and documenting processes (process view dimension) a company has limited potential to advance its BPM. Implementing management and measurement practices gives a company new tools and variety of possibilities to increase the maturity all originating from defined process measures.

Process management and measurement is not a panacea must be supported by other dimensions. As the model shows, there are many factors influencing this turning

point. Other "subordinate" turning points must be reached in order for measure definition turning point to be effective. By analyzing the left branch of the tree an important turning point is detected in process jobs dimension. It shows that employees must be trained and must learn continually (procj3) to be able to adapt to process changes. If that condition is not met, then the third level of BPM cannot be reached. Thus, institutionalizing process measure without the accompanying employee training will prove to be futile.

Another important turning point determining the ability to transition to third level is in process view dimension. Specifically, this is the usage of process terminology (right branch – procv2). While at a first glance this turning point might not seem very important, deeper understanding of this aspect reveals its true significance. Namely, the widespread usage of process terminology is a consequence of an underlying culture – a process-oriented one. For a company to advance to Level 3 it must have the supporting process culture, manifesting itself in many ways for instance in the usage of process diction (input, output, process, and process owners) in everyday conversations.

By further analyzing the right branch of decision tree, one other turning point is identified in process jobs dimension, namely the multidimensionality of employees' jobs (procj1). If employees just perform simple tasks this hinders their ability to see the entire process. Expanding the employee's roles and making jobs more multidimensional gives them a necessary understanding of the impact of their work on the outcome of processes. Only when employees realize how their performance is linked with process performance and act accordingly will the company be able to reach Level 3 of BPM.

While we find the decision trees very useful for turning points analysis an important limitation must be outlined: this model does not discover rules for classification in the highest and lowest levels for BPO. Therefore, no turning points for BPO Levels 1 and 4 can be inferred using this data set. There are too few records of these levels so they are lost as erroneous classifications in the model. To overcome this limitation, more records should be used (for instance adding the Slovenian dataset). Another possible solution would be to also analyze other models not just the best one as they might revel other turning points, even some defining the transition from Levels 1 to 2 or from 3 to 4. This challenge is left for further research.

Advantages and limitations of the method used

Decision tree learning can provide useful insight in differences between organizations that are classified in neighboring levels of BPO maturity. These differences can provide information about critical areas that make transition between successive maturity levels. This information can be a valuable guideline to organizations adopting BPO. The results of the decision tree model can be used to generate rules that can be employed in order to automate processes within a company or knowledge management system.

Success of this method depends highly on the data set used for training decision tree model. If the data set contains small number of cases for certain maturity level (as it was the case for Level 4 in presented research) model will discard these cases as errors of classification. For these levels there will be no rules generated, so the insight in turning points between successive or precedent level will remain undetermined.

Extension of BPO maturity to SCM

Dataset

An electronic self-administered survey was conducted between January and February 2006 by researchers from the Federal University of Minas Gerais-Brazil, using a diversified sample comprising companies from different economic sectors. This included manufacturing, construction, retail, graphics, mining, communication, information technology, utilities (gas, water, and electricity) and distribution industries. The sample consisted of professionals from companies associated with a highly recognized logistics institution in Brazil. From a total of 2,500 companies, 534 surveys were received, thus yielding a response rate of 21.4 percent. The first step in data preparation was analysis and treatment of missing data within the returned surveys. This resulted in 478 remaining surveys out of the initial 534.

Method used

Aiming to address the central point discussed in this paper, "turning points," an additional effort was made to identify whether similar concepts can also be found in SCM, since SCM is gaining in importance and several authors (Mills *et al.*, 2004; Croxton *et al.*, 2001; Cooper *et al.*, 1997) define SCM as management of inter-organizational business processes. In this sense, aiming to evaluate the supply chain processes in an evolutionary perspective of maturity levels, cluster analysis was chosen as a valuable alternative approach.

Cluster analysis, also called segmentation analysis or taxonomy analysis, seeks to identify homogeneous subgroups of cases in a population. That is, cluster analysis seeks to identify a set of groups that both minimize within-group variation and maximize between-group variation. This section presents an empirical study introducing the use of general approaches to cluster analysis in order to investigate turning points on process maturity levels, and particularly, on SCM processes, of a diverse and relatively representative set of service and industrial Brazilian companies, operating in different regions of the country.

In order to develop a research instrument, a literature review on the subject of "maturity models" was first carried out. Next, the model proposed by Lockamy and McCormack (2004) was used as a basis for developing 94 questions. Lockamy III and McCormack's model draws on the SCOR model to evaluate process in four areas (plan, source, make and deliver) on a scale of 1 – poor to 5 – excellent. This model was selected because it draws on detailed measures tested and validated in previous works (Lockamy and McCormack, 2004; McCormack and Johnson, 2001). Since the activities for return or reverse logistics are not well designed in many companies, particularly regarding supply chain processes, the research model did not include the "Return" area of the SCOR model in assessment. Moreover, all variables means were normalized before data analysis.

The first step was to create new construct variables by grouping the collected variables in their specific categories, assuming the maturity model constructs (McCormack *et al.*, 2003)[2]. Next, the two-step cluster analysis was used encompassing all construct variables created in the previous step and the maturity score as the continuous variable (represented by the sum of the scores in all categories). At this point, a fixed number of five clusters was established, corresponding to five maturity levels.

The two-step cluster analysis approach grouped cases into pre-clusters which were treated as single cases.

Aiming to investigate the relationship between the constructs, hierarchical clustering was performed on the pre-clusters generated by the two-step cluster analysis. This is a method that allows users to select a definition of distance, select a linking method for forming clusters, and then determine how many clusters best suit the data. It requires neither a proximity table like hierarchical classification nor an iterative process like *k*-means clustering; rather, it is a one-pass-through-the-dataset method, and as such it is recommended for very large datasets (>200).

Finally, k-means clustering was used to identify turning points for each component/construct and its respective position regarding maturity classification. This was a useful method to identify turning points for each category in the model by using Euclidean distance to determine centroids.

Results and conclusions

The research results showed five different centroids. By considering each cluster as a distinguished maturity level, with a centroid determined for each cluster, maturity scores, i.e. maturity turning points, were identified taking into consideration the medium value between two centroids, as shown in Figure 7.

Additionally, considering the centroids determined for each cluster, category scores were also the constructs of Lockamy and McCormack (2004) reference model. In this sense, the approach is helpful to detect key turning points on these category scores, as shown in Table II.

The scores in Table II represent the percentage score (of the total points available) at the centroid of each level for each maturity component in the maturity model. It is proposed that when the score goes above 50 percent, that component is then established and stable within the set of companies at that maturity level. This represents a key turning point in the maturity continuum.

The strength of this methodology lies in the fact that it provides statistical support for defining turning points and establishing precedence relationship between constructs. For example, basic process jobs is clearly in the leading position at Level 2 with a score of 44.91 percent with basic process performance (measurement and management) following closely at 43.22 percent. This is counter to the generally understood precedence assumption that process documentation (34.36 percent) and

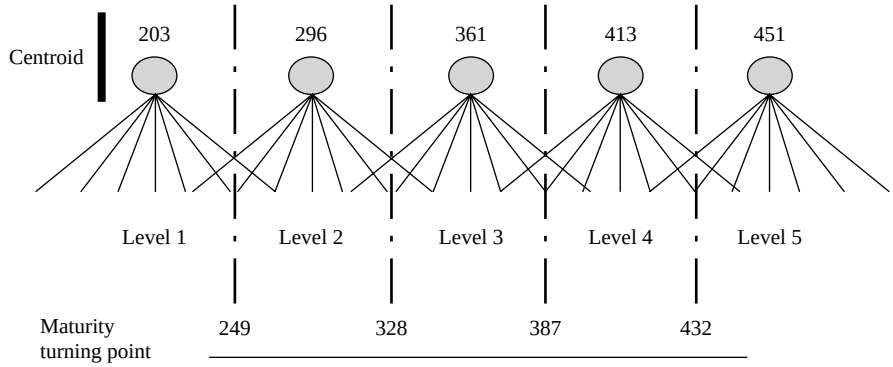


Figure 7.
Maturity turning points based on cluster centroids

	Percentage of maturity scores				
	1	2	3	4	5
Process documentation	11.11	34.36	54.64	67.23	81.37
Process structure	5.71	34.08	52.99	66.74	81.47
Basic process jobs	20.00	44.91	58.74	68.04	83.31
SCM measures	9.33	34.19	51.49	64.94	79.23
Information systems support	20.00	40.27	57.89	70.01	83.39
Basic operations strategy	20.00	41.70	53.97	65.14	78.13
Basic SCM	20.00	42.20	55.21	67.15	80.36
Advanced process focus	0.00	36.57	51.86	61.06	73.26
Basic SCM practices	20.00	40.82	54.54	65.58	76.69
Advanced SCM practices	0.00	31.74	46.35	53.93	66.21
Basic process performance	20.00	43.22	56.42	66.51	78.83

Table II.
SCM maturity scores by component and centroid

process structure (34.08 percent at Level 2) are the leading factors at Levels 1 and 2. At Level 5, it is interesting to note that basic process performance lags (78.83 percent) after leading at earlier levels and basic process jobs and information systems support are the leading factors (83.31 and 83.39 percent). This seems to support the general observations that process analytics and automated processes are important at Level 5 and metrics are still a challenge in reaching high levels of maturity. In Levels 1 and 2, there are no scores above the 50 percent level and therefore no maturity components are established at that level.

Advantages and limitations of the method used

The strength of this methodology lies in the fact that it provides – in a relatively simple and straightforward way – a support for defining turning points clearly under a nomothetical perspective, and establishing a precedence relationship between constructs, raising important contributions on facilitating management and continuous improvements of business process over time.

Some constraints for this approach such as sample size restrictions, however, need to be pointed out when choosing a methodology to approach turning points, since *k*-means requires a sample with at least 200 cases (Hair *et al.*, 1998). Moreover, caution is needed when analyzing the final output to verify if the results obtained are aligned with real experience.

Practical business use

Key turning points, which are a representation of a very complex phenomenon, can be used to address a pathway for organizing and prioritizing a set of efforts directed to reach continuous improvement in process management, and especially supply chain process management. It is expected that a growing number of researchers and professional's attention will focus on turning points in a maturity continuum as an important baseline for the planning and implementation of SCM improvement efforts.

The use of cluster analysis technique is a strong and powerful alternative to approach turning points in a supply chain process management perspective. Further, insights that could enlighten future research endeavors are:

- exploitation of some statistical tests to validate the difference between scores, like *t*-test;

- validation of the cluster analysis results by testing its structural composition using confirmatory factorial analysis and path analysis; and
- evaluation of the behavior between turning points trying to find optimal points by using genetic algorithm and related techniques.

It is expected that those research questions can drive us into a more precise understanding clarifying the scenario surrounding the dynamical behind the applied use of turning points concept and its importance for business process management researchers and practitioners.

Discussions and implications

Turning points, or key milestones on the process maturity journey, are important to understand. Where should a company focus, where will the effort be wasted, what should a company expect and what must come first in the journey? Turing points help in answering these questions. This research identifies key turning points from several different perspectives using several different approaches and develops some conclusions common to all methods used in this research.

Levels 1 and 2

The early anecdotal and graphical techniques suggest major components that represent maturity levels. For example, in Level 2 a process language is developed and the processes are defined at the end of this stage. The later statistical techniques seemed to suggest that this early focus on process documentation and language later changed and the progress on this component flattened out. Using the Ghent ANOVA approach comparing means analysis "knowing the customer needs and preferences" and "endorsing teamwork and multi-skilling" were shown to be important components in the first two levels. Using the centroid method, basic process jobs is clearly in the leading position at Level 2 with basic process performance (measurement and management) following closely. The precedence assumption driven by the anecdotal analysis that process documentation and process structure are the leading factors at Levels 1 and 2 was contradicted.

Levels 2 and 3

Using the decision tree approach, it was suggested that the most important component of BPO for transitioning from Levels 2 to 3 was the process management and measurement dimension. Specifically, for advancing to the third level a company must have process measurement and management defined. This was also the case for "consistent use of process metrics" with the Ghent ANOVA approach, the early anecdotal and graphical approach, and the UFMG centroid approach. Further, all approaches identified the process jobs turning point as critical for Level 3. This component concerns the multidimensionality of employees' jobs. Expanding the employee's roles and making jobs more multidimensional gives them a necessary insight into the processes they are involved in thereby understanding the impact of their work on the outcome of processes. Only when employees realize how their performance is linked with process performance and act accordingly will the company be able to reach Level 3 of BPO maturity.

Measures and goals became evident at Level 3 and jobs became aligned with processes at the end of this maturity stage. Process management and measurement is not a panacea by itself and must be supported by other components. Other "subordinate" turning points must be reached in order for the measure turning point to be effective. Another important turning point is in process jobs dimension. It suggests that employees must be trained and must learn continually to be able to adapt to process changes. If that condition is not met, then the third maturity level cannot be sustained. Thus, institutionalizing process measure without the accompanying employee training will prove to be unsustainable.

Another important turning point in the ability to transition to third level as identified by all methods is in process view dimension. Specifically, this is the usage of a process language. While at a first glance this turning point might not seem very important, deeper understanding of this aspect reveals its true significance. Namely, the widespread usage of process terminology is a consequence of an underlying culture – a process-oriented one. Therefore, for a company to advance to Level 3 it must have the supporting process culture, manifesting itself in many ways for instance in the usage of a process language (input, output, process, and process owners) in everyday conversations.

Levels 4 and 5

The anecdotal evidence suggests that the flip to process centric management occurs moving from Levels 4 to 5. The other components tend to level out at comparable scores without any higher or lower relative importance in the entire growth path. This suggests that it takes many small incremental efforts for these aspects to support growth in maturity at the higher levels. At Level 5, it is interesting to note in the centroid method that basic process performance lags after leading at earlier levels, while basic process jobs and information systems support are the leading factors. This seems to support the general observations that process analytics and automated processes are important at Level 5 and metrics are still the challenge in reaching high levels of maturity.

Conclusions and future research

The purpose of this research was to identify, using different geographic data sets and methods, which components of BPM stabilize when and in what order. Table III summarizes the different efforts and results.

The results of this research have several important managerial implications. Turning points, or key milestones on the process maturity journey, are important to understand. Where should a company focus, where will the effort be wasted, what should a company expect and what must come first in the journey? Turing points help in answering these questions. First, visual, anecdotal and quantitative evidence can be useful for leaders and teams that are attempting the journey to process maturity. The guideposts, milestones and measures can help answer the question "Where am I on this journey and what is next?" They can also help communicate to others a "road map" of the journey, essential in getting buy-in and participation. Finally, the vast amount of collected data can be used to benchmark a company, either against companies on similar maturity level or against "best-in-class". The decision trees can help to identify the areas, where further efforts are needed for sustainable transition to higher levels of

Table III.
Comparison of efforts and results

Region/ country	North America (the USA, Canada, and Europe)	The USA, Canada, Europe, and China	Western Europe (BeNeLux)	Central Europe (Croatia and Slovenia)	Brazil
Research methodology	McCormack maturity model – case evidence gathered during implementation meetings	McCormack maturity model: three main domains (process, process jobs, and process measures)	McCormack maturity model and concepts: questionnaire of 64 questions in eight domains	McCormack maturity model: 15 questions in three domains (process, process jobs, and process management and measurement)	Adopted Lockamy and McCormack maturity model: 94 questions
Research goals and objectives	Evaluation and improvement of business process and supply chain maturity	Evaluation and improvement of BPM	Assessment of BPO characteristics	Assessment of BPO maturity	Investigation of turning pints for process management, focused on SCM perspective
Period	1996-2002	1996-2007	June 2006-March 2007	2005	January-February 2006
Sample (data set)	Anecdotal evidence data set gathered during project meetings with implementation teams	Data base of several 100 companies across most industries and company sizes	39 BeNeLux organizations selected on an *ad-hoc* basis, 10-60 participants in each organization, 821 responses	From a total of 1,750 organizations, 202 questionnaires were returned	From a total of 2,500 companies, 534 surveys were received
Method	Anecdotal evidence of patterns, visual road maps, descriptions of levels, benefits, and actions	Visual and quantitative graphical technique used for identifying key turning points	Comparison through stage 4 categorization. ANOVA testing is conducted	Decision tree, using general C/RT algorithm, software: STATISTICA	Cluster analysis: two-step cluster analysis, hierarchical clustering, *k*-means clustering

(*continued*)

Results	Very useful as discussion and change management documents. Visual and textual view of the maturity journey, impacts, and challenges	In stage 2: process language was developed, processes were defined. In stage 3: measures and goals became aligned with processes. In stage 4, leadership viewed process as strategic	In early stages, organizations were focused strongly on creating teamwork and understanding of customers needs. Process metric systems were developed in the third stage	For advancing to the stage 3, companies must have process measures defined, employees must be trained and must learn continually, employees' roles and jobs must be multidimensional, process culture must be developed	Process documentation and process structure are the leading factors at stages 1 and 2. Basic process jobs and basic process performance are in the leading position at stage 2. Process metrics, process analytics, and automated processes are important in reaching stages 4 and 5
Limitations of results	Quantitative precision is needed for detailed diagnoses and situational assessments. Levels are subjective	Maturity level boundaries are subjectively drawn	Limited sample of organizations. Larger set of cases is needed	This model did not discover rules for classification in highest and lowest level of BPO. More records should be used	*K*-means requires a sample with at least of 200 cases

Table III.

maturity, while the extension of those concepts to SC level can help those that are embarking an even tougher challenge – to improve the BPO of the whole SC. The results from different continents, cultures and industries confirm the applicability of BPO concepts to a wide range of companies.

The paper was mainly exploratory. Since the purpose of the paper was to obtain a wide insight into the studied area, some of the research was based on four-level maturity models and others were based on five-level maturity models. The definition of the maturity level used in different data sets varied slightly.

The results of the paper (specially the decision trees techniques) are a basis for a detailed analysis of the rules for classification of companies to a certain maturity level. In further research, the maturity levels (*ad hoc*, defined, linked, and integrated) will therefore be strictly treated as dependent variables while the maturity components (process view, process jobs, and process management and measurement, process structure and customer-focused process values and beliefs) will be treated as independent variables.

In this research, key informant was usually used to provide the data about a specific company. Further research includes the detailed analysis of company's maturity level based on survey of a wide range of employees at various levels and departments of each company. While the paper showed that the concept of turning points/BPM can be used in different regions, further research includes the detailed comparison of data from different regions with the use of the same statistical method.

The paper has some limitations. Although this research was successful in identifying and validating several turning points in the journey to process maturity using different approaches, the relationship between the components (dependencies) was only suggested but not statistically analyzed. Several data sets were also on the low end of sample size for the methods used and some parts of the research used *ad hoc* selection of companies of arbitrarily distributed the companies into different groups. In the next phase, larger sample sizes must be collected and statistical approaches employed that will clearly identify and quantify dependencies.

Additional data visualization techniques can also be used to uncover patterns, dependencies and more details defining the maturity levels. For example, what does a 70 percent score on process view really mean? Is there a difference in performance if the score is increased to 90 percent? Furthermore, it would be relevant to consider the use of genetic algorithms to approach the process evolution considering its evolution and adaptation to dynamic environments.

Another important topic for further research is a longitudinal study of changes in maturity level over time in a set of companies. The study of changes over time can namely reveal more clearly which component must stabilize within an organization at a certain maturity level in order to establish and expand other factors that move the organization to the next maturity level.

Notes

1. Neither of used cases classified in node 20 or node 21 contain records with procj1 = 4, so the model is unable to determine where value 4 for procj1 appears. Bigger data set could resolve this issue.
2. Group 1 – process documentation (basic (25) and advanced added together (20)), process structure (basic (20) and advanced added together (50)), basic process jobs (30), SCM

measures (basic (35) and advanced added together (40)) and information systems support (25). Maximum score sum – 245.
Group 2 – Basic operations strategy (30), basic SCM (35), advanced process focus (40), basic SDM practices (95), advanced SCM practices (50), basic process performance (20). Maximum score sum – 270.
Maximum score sum for maturity = Group 1 + Group 2 = 515 points.

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