

## **II. CHALLENGES IN EXTERNAL SUPPLY CHAINS PROCESSES**

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## METHOD OF EVALUATING THE LEVEL OF PROCESS MATURITY OF COMPLEX SUPPLY CHAINS

### ABSTRACT

**Background:** In the literature there is available knowledge about the organization's maturity, including the Capability Maturity Model Integration (CMMI) model. In the authors' opinion, the same as there are levels of the organization's maturity, in the view of the organization as a homogeneous company, the same complex supply chains as networks of connected organizations, have levels of process maturity.

**Methods:** During the preparation of the article, the method of literature analysis was used to verify the current state of knowledge in the field of methods for evaluating the organization's maturity levels and the functioning of complex supply chains. Verification of the current state of knowledge was used to investigate the possibility of adapting the organization's assessment to determine the method of evaluating the level of process maturity of complex supply chains.

**Results:** In the result of literature analysis it was proved that it is possible to distinguish the maturity levels of complex supply chains and a method of evaluation of the process maturity level of complex supply chains was proposed.

**Conclusions:** The article presents methods of evaluation of the organization's maturity and after analysis of available literature proposes a summary of method of evaluation of process maturity in complex supply chains. The methods presented in the article is used to evaluate complex supply chains and to indicate areas for improvement of these chains.

**Keywords:** maturity levels, process maturity of the organization, process maturity of the supply chain, complex supply chains, SCM,

## INTRODUCTION

The business mechanisms are firmly based on supply chain networks, which affects competitiveness both domestically and globally. The focus is therefore increasingly on competitive networks (Chroner, 2005). In general, it can be said that the trend in logistics is aimed at providing comprehensive control over the activities of companies. Within this control, material flow is optimized from the perspective of the chain actor and decision making is about the overall benefits. In this way, logistics development plays an important role in supporting competitiveness and partnership and helps to achieve significant cost reductions.

A number of publications that translate and specify the concept of Supply Chain Management (SCM) have been analysed in the course of the literature study. According to Pastinen et al. (2003), SCM emphasises an approach to an extended value chain in which the value chains of different companies are linked in order to build a functional whole. Bridgefield Group (2005) presented supply chains as a combined set of materials and processes that starts with the purchase of raw materials and extends to the supply of finished goods to the final customer. According to the Global Supply Chain Forum's definition of SCM, SCM is "the integration of key business processes from the end-user to the original supplier of products, services and information that add value to the customer and other stakeholders". (Chan and Qi, 2003; Gunasekaran and others, 2001)

SCM only occurs when there is an active relationship between buyer and supplier and the merger involves the entire supply chain and not only first-tier suppliers. The main assumption of the supply chain is to maintain a compatibility relationship between upstream and downstream operators of the overall supply network (Vanteddu et al., 2006). In practice, the supply chain is much more extensive. For a company operating in the middle segment of the supply chain, the supply chain looks more like a uprooted tree, where the roots are in the supplier network and the branches represent the customer network. Effective supply chain management requires a change from managing individual functions to managing a set of integrated processes and further starting competition between the chain and the network (or between the network and the network) (Patterson, 2005).

Modern supply chains are exposed to increased risks of demand-supply imbalance, responsibility, supply chain security and total cost optimization (Lambert, 2004; Cohen and Roussel, 2005). Maturity of the supply chain implies intensified processes and positive progress

in achieving the company's goals. Decision making on maturity in relation to the exchange of information and expertise within the company (Archer, 2006).

This phenomenon illustrates the current level of maturity of an organisation at all levels of processes (plan, sources, execution, delivery and return) and the entire supply chain. It enables an assessment of the organisation and provides a guide for immediate action, identifying areas that deserve special attention in terms of maturity, greater reliability, responsiveness, flexibility and financial efficiency.

The concept of maturity in supply chain networks is derived from the understanding that these chains have clearly defined, managed, measured and controlled life cycles. When maturity is high, it means better control of production results, better anticipation of assumptions, costs and performance, and greater effectiveness in achieving defined objectives (Poirier and Quinn, 2004). In general, it can be observed that the most important elements for achieving a mature supply chain are smooth and efficient operations, full transparency of cooperation, event-based management and common technologies. By creating mature supply chain operations, companies are in a better position to cope with changes in the supply chain environment. A mature supply chain mechanism plays an important role when there is a need to take appropriate action to achieve a goal. This type can be used to assess the state of supply chain management processes and help companies focus on improvements in areas that are relevant to their current maturity phase (McCormack et al., 2003).

### **MATURITY MODEL**

Maturity' means the degree of ripeness which reflects the concept of development from the initial state to the most advanced state. The fundamental concept behind this issue is the development concept, which indicates that an object can pass through many intermediate states on the path to maturity. In general, it can be said that the definition of maturity is a combination of an evolutionary or experimental factor with the application of good practice. Moreover, maturity implies that all processes are understandable, based on documentation and training, constantly applied in different parts of the organisation and constantly controlled and improved by the participants (Fraser et al., 2002).

The concepts of process maturity or capability are increasingly being implemented in many areas of supply chains, both as a means of evaluation and in the context of a framework for improvement. The basic idea is to propose maturity models for a whole range of activities,

including SCM, enterprise resource planning systems, supplier relations, R&D efficiency, product development, innovation and product reliability.

Maturity models describe the behaviour of a company or organisation on many levels of activity. With these models, it is possible to present the current stage and subsequent steps towards a higher level of maturity. Determining the level of maturity comes from quality management. The earliest approach to measuring the level of maturity is Crosby's quality management grid, which presents the organisation's behaviour at five levels for each of the six aspects of quality management (Fraser et al., 2002). The best known derivative of this work is the Capability Maturity Model (CMM) for software. This model was used in various organizations to identify best practices useful in increasing process maturity. CMM adopts a cumulative set of so-called Key Process Areas (KPA). As the level of maturity increases, the key processes must be improved. This is called "step-by-step" representation and its goal is to assign a level of maturity in the range of 1-5 (Carnegie Mellon Software Engineering Institute, 2005). Later, the CMM was upgraded to Capability Maturity Model Integration (CMMI). CMMI is a process improvement approach that provides organizations with essential elements of efficient processes. It can be used to manage process improvement within a project, branch or entire organization (Kulpa and Johnson, 2003).

Although many different types of SCM maturity models are proposed, all of them similarly define dimensions or process area in separate stages or maturity levels with a description of the characteristic performance at different levels of detail. SCM maturity models can be divided into two basic groups. These groups can be characterized as maturity grids and hybrids or as Likert-like questionnaires. A Likert-like questionnaire is considered a simple form of the maturity model. The question is a statement of good practice and the respondent evaluates subjectively giving the result on a scale from 1 to n. This model is the same as the maturity grid, in which best practices are described. Hybrid models are models that combine the questionnaire with maturity definitions (Fraser et al., 2002).

## **REVIEW OF SCM MATURITY MODELS**

In the literature related to the measurement of the level of maturity of various fields, many models of maturity levels are described. Working on the software, Vaidyanathan and Howell (2007) developed the Construction Supply Chain Maturity Model (CSCMM). The aim of the CSCMM was to show the way to operational excellence. The goal was to build a common

project in such a way as to achieve the benefits of improved performance. There are also models to measure the level of maturity of supply chain systems. PRTM Management Consultants (2005) developed a four-level supply chain maturity model that shows how a company can move from functional automation to enterprise automation and effective collaboration between all links in the supply chain. Manufacturing companies often use this model to plan their supply chain strategies.

In a highly competitive market, it is considered that continuous monitoring and improvement is essential for the maintenance of the company's business. Flexible, efficient and mature supply chains can provide competitive advantage and maximize value for customers and shareholders (Lalwani & Mason, 2006). SCM's level of maturity can be assessed by several methods, such as questionnaires, financial data comparisons, so-called Benchmarking, and information exchange during workshops. Both the Srari and Gregory (2005) and Foggin et al. (2007) studies show different maturity models within the material flow. These can be simple self-assessment tests as well as complex causal and impact analyses.

The most common models for assessing process maturity of supply chains in the literature are presented below:

#### **MODEL 1**

Charles Poirier developed two models to illustrate the evolution of the supply chain. The basis for these models is his experience with his work in information technology and management, Computer Sciences Corporation (Poirier, 1999; Poirier and Bauer, 2001). The first model is divided into four levels:

- sourcing and logistics: achieving functional excellence by reducing the number of suppliers, inventory and costs
- internal excellence: based on activity-based costing and process management through activities
- network building: development of complex processes and planning of activities
- industry leader: broad application of technology tools, management through supply and demand analysis and global operations.

After a few years, Poirier and Bauer (2001) proposed the evolution of an earlier supply chain model. The new model compared to the previous model has five levels. It consists of:

- enterprise integration: supply chain based on functional processes
- corporate excellence: within the company

- partnership cooperation: both with the selected supplier and customers.
- cooperation within the value chain: through e-commerce, the Internet and other new technologies
- full network connectivity: ERP system integration at the online level for the benefit of all partners.

The five levels presented show what the company needs to achieve in order for the information about the customer's needs to be fully processed as a complete system of internal communication throughout the complex supply chain.

### **MODEL 2**

DRK Research and Consulting LLC develops a model based on business processes as key supply chain processes. These concepts are derived from Philip Crosby's mature network. Enterprises use them to deepen their quality practices.

This model gives the possibility of quantitative evaluation and allows to determine the level of maturity and best practices in comparison to other companies in the industry. It allows comparison on five levels: plan, source, execution, delivery and return.

### **MODEL 3**

The joint experience of Performance Measurement Group and PRTM Management Consultants in the field of benchmarking and knowledge gained during the implementation of projects allowed to develop a model of supply chain maturity. It allows to evaluate the capability stage in four levels (plan, source, brand and delivery), which are defined in Supply Chain Operations Reference, and "general" supply chain management practices.

By replacing current supply chain maturity practices, it encourages companies to focus on the key processes that drive maturity (PRTM Management Consultants, 2005). Maturity results from a qualitative assessment based on a questionnaire of 270 questions from key areas (plan, source, performance and delivery) throughout the supply chain.

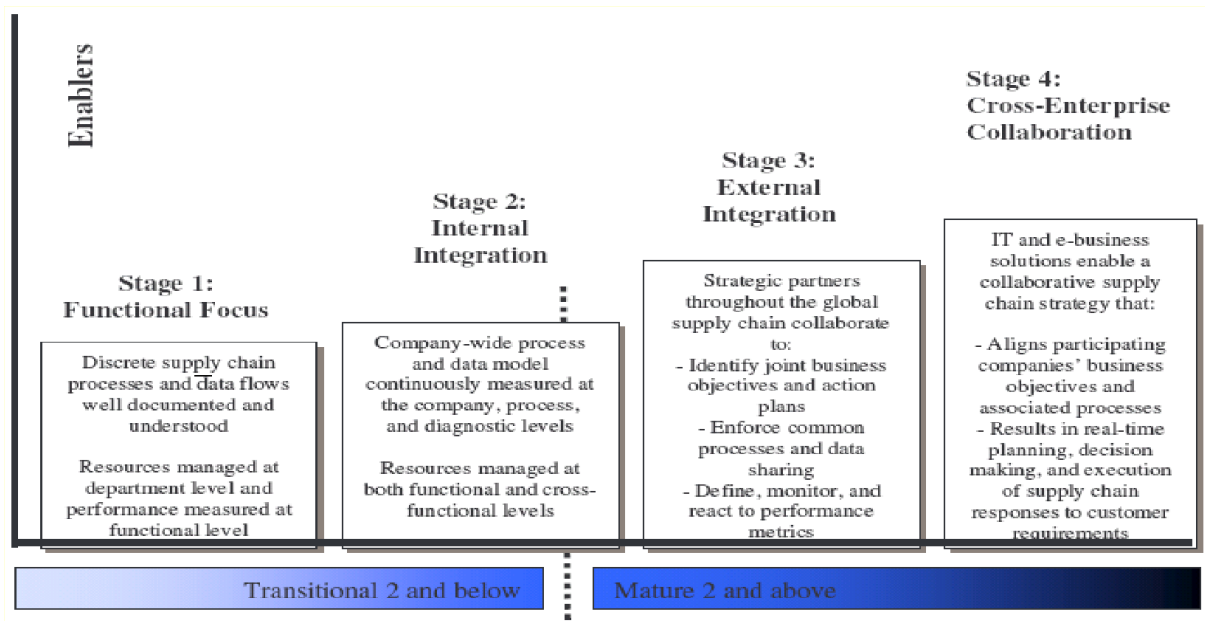


Figure 1 Stages of supply chain process maturity  
 Source: PRTM Management Consultants (2005)

Figure 1 illustrates the maturity model of the SCM, developed jointly by Performance Measurement Group and PRTM, which identifies maturity steps 1 to 4 and separates mature and immature practices.

**MODEL 4**

Handfield and Straight developed the Supply Chain Capability Maturity Model (SCCMM). It is designed to determine the relative level of maturity of business processes in the supply chain for enterprises. Conclusions from the supply chain modeling allow us to determine the actions an organization should take to increase the process maturity of the supply chain. SSCMM was created thanks to knowledge, research, interviews with SCM managers and best practices in global organizations. SSCMM takes into account a wide range of business processes, from design, source, manufacturing, sales/market, delivery to after-sales service.



Table 1 Key areas of the Supply Chain Capability Maturity Model

	<i>Design</i>	<i>Source</i>	<i>Make/Mfg</i>	<i>Market/Sell</i>	<i>Deliver</i>	<i>Service</i>
<i>Strategic</i>	Customer/ Supplier design collaboration	Supply base rationalisation and allocations	Rationalise manufacturing/ distribution network	Promotion strategy rationalisation	Negotiate contracts or outsourcing partnerships	Rationalise spares network
	Product line/mix rationalisation	Supplier Relationship Management (SRM)	Capacity rationalisation	Rationalise sales channels	Select logistics partners	Select inv stocking points
	New product requirements analysis	In/Outsourcing rationalisation	Long-term expansion	Market analysis	Rationalise transportation network	Service facilities rationalisation
	DFx	Indirect materials strategy	MRO strategy	Marketing spend	Reverse supply chain	Establish service level expectations
	Phase In/Phase Out		Order management	Partner products  Branding		

Source: Handfield and Straight (2004)

This tool can be used to calculate the level using qualitative information from the parameters of the business approach. This evaluation allows you to compare the level of maturity achieved with respect to the intended one and also allows you to identify weak areas. By showing defects in a structured way, the company can focus on key areas of the company, both strong and weak, as well as those with the highest risk. Example Key areas of the Supply Chain Capability Maturity Model in Table 1.

**MODEL 5**

Ayers, developed a model for growing up the supply chain, dividing it into five stages of adolescence. This model allows for self-assessment of the current level of maturity of the supply chain. This solution also gives the possibility to create process improvement plans to increase the level of maturity.

Table 2 Stages of SCM maturity

<i>SCM Tasks</i>	<i>I Dysfunctional</i>	<i>II Infrastructure</i>	<i>III Cost Reduction</i>	<i>IV Collaboration</i>	<i>V Strategic Contribution</i>
Strategic supply chain planning projects	No strategy exists to guide supply chain design	Supply chain awareness takes hold, however managers still view the company as standalone	Supply chain is viewed as a nonstrategic cost center for internal cost reduction	Joint strategic initiatives are pursued on a limited basis with suppliers and customers	Activity systems are implemented for strategic advantage
Internal collaborative relationships projects	Internal department measures, goals and objectives conflict with supply chain excellence	The organisation is functionally focused. Initiatives are departmental	Cross-functional initiatives begin, limited to the company and focused on cost reduction	Supply chain has moved into a single function, which manages multi-company relationships	The organisation has established multi-company infrastructure for important chains
Forging supply chain partnerships projects	Relationships with suppliers and customers are arm's length at best, antagonistic at worst	Collaboration up and down the supply chain is limited to transaction data	Efforts are limited to supplier initiatives focused on cost reduction, not revenue increases	Partners collaborate but roles are static. Partners pursue sphere strategies	Members of the supply chain expand their value contributions
Managing supply chain information projects	Basic information needed for decision-making is missing	Technology improvements focus on individual departments and maintenance	Systems efforts support cost reduction within the organisation. May or may not be process justified	Two-way information exchange supports transactions and mutual decision-making	Technology is a key element integrated into supply chain activity systems
Making money from supply chain projects	Cost reduction and process improvement is a hit-and-miss affair. Efforts-often hurt more than they help	Reductions are internal and measured through department budgets. Service is not an issue	Cost-reduction efforts cross departments but are limited to internal efforts	Supply chain cost reduction is limited to logistics and other operating costs	Cost reduction across the supply chain is the target. Benefits are shared among partners

Source: Ayers (2004)

**MODEL 6**

Operating in competitive markets and under varying conditions is the motivator of the SCM study. Thanks to this research, the SCM Logistics Scorecard model was developed and developed together with Takao Enkawa, professor at the Institute of Technology in Tokyo and the Japanese Institute of Logistics Systems (Enkawa, 2005).

SCM Logistics Scorecard, uses a simpler version of benchmarking, evaluates the effectiveness of the organization at the SCM level by means of an evaluation survey. This model consists of 22 parts in four SCM levels: strategy and organization, planning and implementation, efficiency and IT. Apart from the areas mentioned above, the study was additionally extended by economic indicators. Figure 2 describes the structure of the Scorecard

model. By assessing strengths and weaknesses, the scorecard becomes a self-assessment tool. The respondent determines the level of maturity in each area on a five-level Scorecard scale. This gives the opportunity to position the supply chain in its industry and industries in general. Scorecard is another model that gives the possibility to plan activities in SCM to improve and improve the financial condition of the company.

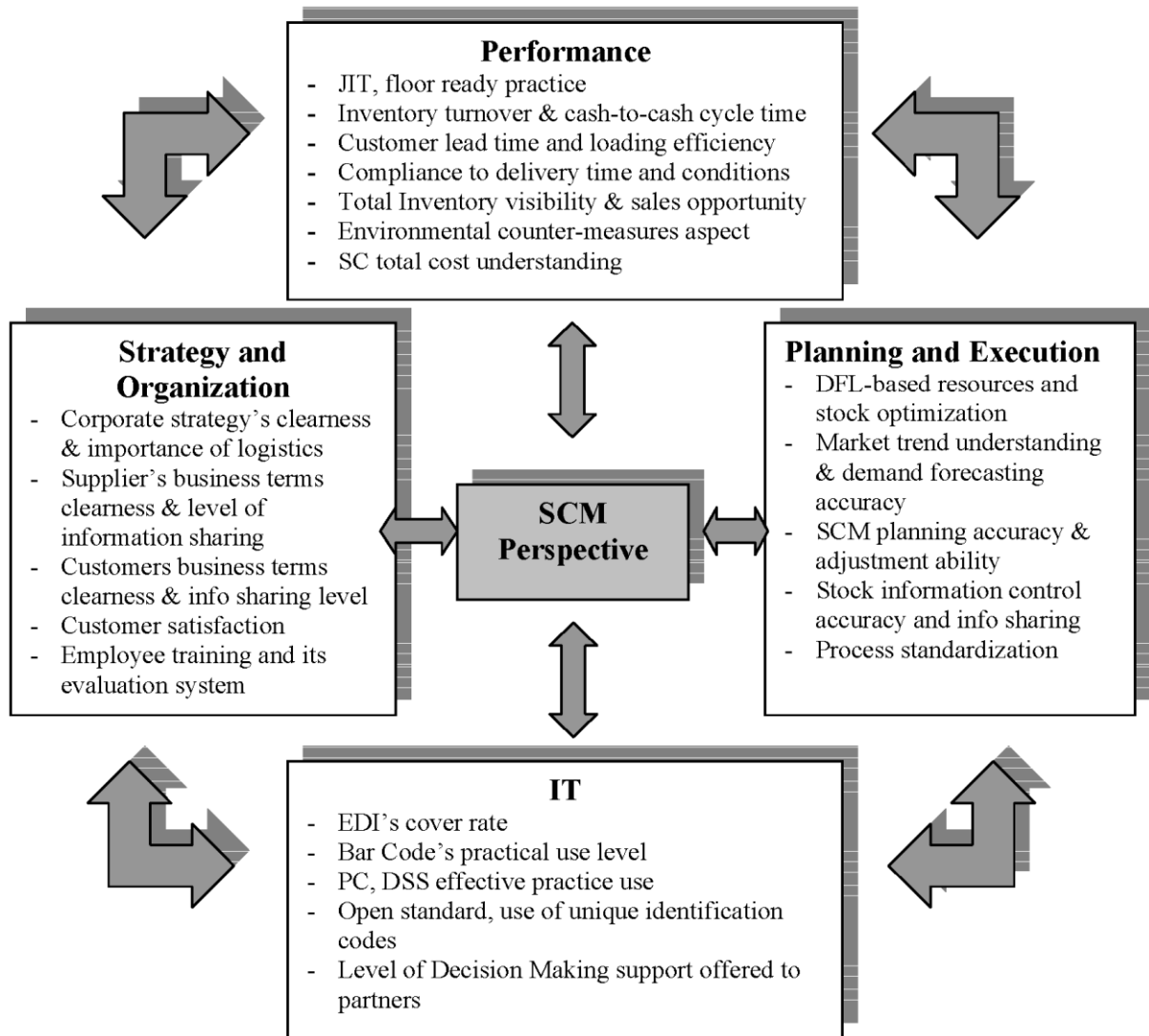


Figure 2 SCM Logistics Scorecard's structure including core areas and sub-areas

Source: Enkawa (2005)

## CONCLUSIONS

These six models suggest dividing the supply chain into different levels of maturity and are designed to determine where the supply chain is at a given stage. The supply chain can be self-assessed and ranked at its current stage of maturity through a well-defined model, or a baseline set of questions from key areas of the supply chain can be used to determine the current

stage of maturity. Some models include the Supply-Chain Operations Reference method, which divides the supply chain into key areas. Table 3 summarizes information on the different approaches to SCM models.

Table 3 Approaches of the models

SCM Maturity Model	Marurity stages					Approach
	1	2	3	4	5	
<b>Model 1</b>	Enterprise integration	Corporate excellence	Partner collaboration	Value chain collaboration	Full network connectivity	8 issues, detailed description at each stage
<b>Model 2</b>	Ad Hock	Defined	Linked	Integrated	Extended	6 issues, brief description at each stage + 5 point scale
<b>Model 3</b>	Functional focu	Internal integration	External integration	Cross-Enterprise collaboration		5 areas, 20 issues, brief description at each stage
<b>Model 4</b>	Ad Hoc	Defined	Linked	Integrated	Extended	6 issues, 105 issues, brief description at each stage
<b>Model 5</b>	Disfunctional	Infrastructure	Cost reduction	Collaboration	Strategic contribution	5 supply chain tasks, detailed description at each stage
<b>Model 6</b>	I	II	III	IV	V	4 areas, 22 issues, detailed description at each stage

Source: Lahti (2009) Developing a maturity model for Supply Chain Management

The models presented differ only in the examined areas of the supply chain. Companies should bear in mind that they should proceed sequentially through the stages of these models, building on the practices they have developed in the previous stages. In order to be able to establish that a company is at a certain stage of maturity, it must prove that it is applying the practices of that stage.

Maturity of supply chains is based on a diagnosis of the definition, measurement, management and control of business processes. The higher the level of maturity, the better the performance of the organisation (Poirier, 2006). The paper presents the results of qualitative research, in which the level of maturity of the supply chain was checked and the relationship between the maturity of the supply chain and its efficiency was mapped. These models can be used to measure the efficiency and continuous improvement of complex supply chain processes.

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