A System Maturity Model for Supply Chain Management

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Abstract.
A supply chain system is a chain of processes from the initial raw materials to the ultimate consumption of the finished product linking across supplier-user companies. Huge investment is needed to build supply chain business systems. The goals and objectives must be revised repeatedly in accordance with its growth. A methodology is needed to support system management through its system life cycle. This paper proposes a novel system maturity model for supply chain management, SCMM (Supply Chain Maturity Model).

Keywords. Supply chain Management, Capability Maturity Model, System Maturity model, Information system management

1 Introduction

A supply chain system is a chain of processes from initial raw materials to ultimate consumption of the finished product linking across supplier-user companies. It provides functions within and outside a company that enable the value chain to make products and provide services to the customers.

System development needs its goals and strategies to be clarified. In addition, these goals and objectives must be revised repeatedly in accordance with its growth. Continuous improvement is, needless to say, very important in every system management. However, a repetition of improvement alone often produces fruitless investment in system management. The concept of a qualitative, stratified framework is needed to manage system growths for supply chain system.

Enterprise evolves organization capability by using re-structuring and re-engineering. This principal is applied universally to every enterprise organization. Supply chain system is also the same as this. To correspond this primary rule, we need own process models considering organization maturity.

SCOR (Supply Chain Operations Reference) model is a process reference model that has been developed and endorsed by the SCC (Supply Chain Council) as the cross-industry standard diagnostic tool for supply chain management [1][2]. SCOR enables users to address, improve, and communicate supply chain management practices within and between all interested parties. However the SCOR model only ad-

dresses the “optimized” process operations. It does not include a concept of “Maturity” of system that is essential to phase-based system development. SCOR model is, in a sense, description of the best status of processes in supply chains.

CMM (Capability Maturity Model) was created for the software industry as a model for judging the maturity of an organization's software processes and identifying the key practices that are required to increase the maturity of those processes. The CMM has become a de facto standard for assessing and improving software processes [3].

This paper proposes a novel model for supply chain system maturity: SCMM (Supply Chain Maturity Model). Several measurements will be discussed for system’s maturity of supply chain systems. This model is an evolution model for supply chain system integration. Individual maturity level associates with supply chain management problems. First, this paper proposes the supply chain maturity model. Second, it clarifies that each maturity level responses to supply chain management problems. Finally, conclusions and perspectives of future researches are described.

2 Supply Chain Maturity Model: SCMM

This section proposes a maturity model for supply chain system. CMM (Capability Maturity Model) is, as previously described, a model for judging the maturity of an organization's software processes. It also identifies the key practices in those processes [1]. This paper has applied the system maturity levels to a generic supply chain system. The maturity levels are defined as five levels, such as “Initial”, “Repeatable”, “Defined”, “Managed”, and “Optimized”. Furthermore, supply chain management problems have been contrasted with individual system maturity levels.

2.1 Management view

(1) Process view

SCOR model defines provides key process according as its process classification; such as PLAN, SOURCE. MAKE. DELIVER and RETURN. The details of these processes are, for examples, described in the SCOR process model.

(2) Resource view

Supply chain resources are classified as the following four categories; such as “physical”, “human”, “information”, and “finance”.

Physical resources are poured in the organization, where they occupy each specific position and space. Examples of physical resources are land, factory, office, equipment, machines, vessels, raw materials, products, semi-finished products, by-products, supply of goods, and rubbish, etc. All of these resources assert their original primacy, and it demonstrates its potential power according to the verbal and written instructions, human strength in the organization, and contributions to the organization’s goal.

Human resource represents enterprise organizations and its members. Every person belongs to a particular sub-organization, and owns competence according as his/her missions. A person is basically an active resource that works based on his/her mission. However, his/her activity has often been controlled by another one. In this case,

he/she or a particular group works virtually as a passive resource. Performance of this resource depends on his/her authority, knowledge, skills, and availability of other resources; however, knowledge and skills are too hard to be measured. Accordingly, it is too difficult to measure this resource quantitatively without using simplified measure such as human-months.

Information resource includes raw data (first-hand information), meta-data, data models, ontology, and hardware systems, including both fore- and back-end systems. Many of modern enterprises own data as digitalized forms, so these data form can be automatically transformed to another one. Almost information resource is passive resource except highly intelligential software. This resource is transferable to attributes of other type resource. Information resource is generally classified into three groups, such as “Infrastructure”, “System enabler”, and “Application”.

Financial resources include assets, cash, deposits, operating funds, and investment capital, and etc.

(3) Maturity view

Every organization evolves gradually by its growths and process improvements. Capability Maturity Model (CMM) is such a model as describing such organization growth processes (maturity). The objective of this model is to define details of business processes at each maturity stage. This model provides, however, maturity in software development organizations. Accordingly, it cannot be directly applied to supply chain organizations. However, the modeling framework would be applicable to describe maturity growth of supply chain systems.

2.2 Maturity model

The maturity model represents organization maturity levels, which are composed of the following five stages.

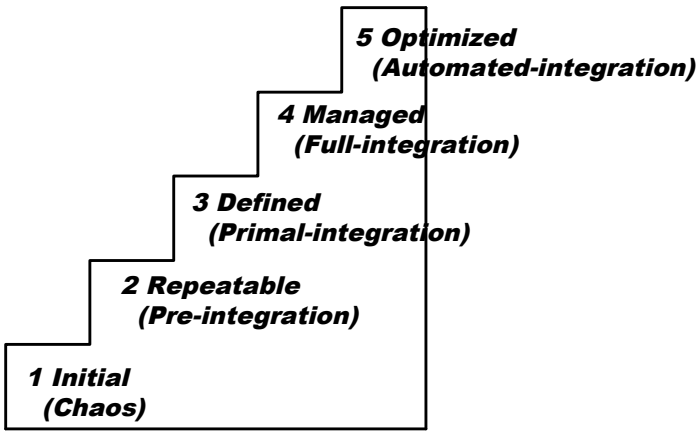

Fig. 1. Supply Chain Maturity Model

(1) Initial (Chaos): This is a pre-stage of process integrations of a firm. Almost all of business activities are operated in process-driven. Individual processes are "point solutions". In this stage, business processes are reaction-based, and often depend on specific persons. Ad hoc decisions are often done based on the past successful experiments. Accordingly, the process quality is unstable. Resources are categorized such as "physical", "human", and "information", however, the management is ad hoc and not systematic. Information systems mainly provide stand-alone applications. The data are transferred among processes and organizations, however it data exchange methods are often ad hoc. The most important item at this stage is "Vision building" for process, resource , and information management.

(2) Repeatable (Pre-integration): Business processes are stable but very limited visibility across the wider supply chain. The process definitions are primary documented, trained, and measured. The processes are partially supported by information system. Resources are mainly managed by category-dependent-way. Information system provides a set of stand-alone applications, and application-based data transformation. The common data transfer methods are provided in neither company-wide nor the chain-process-wide. Information system provides a set of stand-alone applications and Business process management and resource management are partially linked with the information systems. However, information system does not provide company-wide data connections. Companies should make detail investment plans to perform the robust information system infrastructure.

(3) Defined (Primal-integration): All of business process are fully documented, trained, and measured. And, individual process is fully supported by information systems. Resource data schemata are defined in enterprise's data repository. Information systems provide well-defined and standardized data transformation among chain member companies. The plans for Information systems are linked with business process improvement activity plans. Investment to the information systems are proceeded toward full standardization of process input/output and information system enablers. The process definitions in SCOR model are corresponded to this maturity level.

(4) Managed (Full-integration): Business Process Management (BPM) is at full throttle, and it would proceed to quantitative process quality management and real-time monitoring and performance measurement. Every resource is managed by using resource ontology in process chains, and integrated information system would be synchronized with business process and resource management. It also provide services for consumers and customers.

(5) Optimized (Automated-integration): Level 5 is as much conceptual as it is factual. Business processes are fully formalized and authorized toward continuous improvement. Resources are managed including autonomous life-cycle management, and the information system provides full support of business process and resource management.

Investment policies would discussed toward the continuous improvement in process chains

Supply Chain Maturity		Supply Chain Growth			Decision on IS investment
		Business Process Mgmt	Resource Mgmt	Information System	
I	Initial	Ad-hoc decisions	Non systematic	Stand-alone applications	Vision building
II	Repeatable	Dependent on past success	Category-dependent	Primitive standards	Company-wide Infrastructure
III	Defined	Full documentation	Synchronized with IS	Well-defined standards	Standardization on BPM and IS
IV	Managed	Collaboration with partners	Resource Ontology	Synchronized with BPM	Virtual Enterprise
V	Optimized	Continuous improvement	Life-cycle Mgmt	Full-support to BPM & RM	Continuous improvement

Fig. 2. Supply Chain Maturity Model

3 Supply Chain Maturity Model with business management problems

(1) Capacity planning problems: Capacity planning is to determine the amount of capacity required to produce in the future. This function includes establishing, measuring, and adjusting limits or levels of capacity. In general, this planning includes the process of determining in detail the amount of labor and machine resources required to accomplish the tasks of production. This group includes RSCP (Rough-cut Supply chain Capacity Planning) and SCRP (Supply chain Capacity Requirement Planning).

(2) Resource planning problems: Resource planning is capacity planning conducted at the business plan level. It is the process of establishing, measuring, and adjusting limits or levels of long-range capacity. Resource planning is normally based on long term production plans but may be driven by higher-level plans beyond the time horizon for the production plan, e.g., the business plan. It addresses those resources that take long periods of time to acquire. Resource planning decisions always require top management approval.

(3) Lead-time planning problems: Semantics of the term “Lead-time” is basically “the time between recognition of the need for an order and the receipt of goods”. The definition is often used in a logistics context. Individual components of lead-time can include order preparation time, queuing time, processing time, move or transportation time, and receiving and inspection time. This problem directly impacts the inventory planning problems through the Lead-time inventory, the inventory that is carried to cover demand during the lead-time.

(4) Production planning problems: There are two phases of production planning; the first phase is an aggregate production planning and the second phase is an

operational production planning. An “Aggregate production plan” implies budgeted levels of finished products, inventory, production backlogs, and plans and changes in the work force to support the production strategy. Aggregate planning usually includes total sales, total production, targeted inventory, and targeted customer backlog on families of products. Operational production plan is a more detailed set of planned production targets that meet the goal of the higher level manufacturing output plan. It is based on an agreed-upon plan that comes from the aggregate (production) planning function. It is usually stated as a monthly rate for each product family (group of products, items, options, features, etc.).

(5) Supplier selection problems: One of the major issues, when a system planner designs a supply chain or a manager reviews performance of the existing supply chain is supplier selection problem. It is a significant decision as it affects the system performance for a long time. From supply chain performance viewpoint it affects all the primary problems discussed above.

(6) Outsource planning problems: Outsource planning is one of the very important problems for modern manufacturing enterprises. This is because maintaining expertise in all the technologies and processes required for manufacturing a product is almost impossible in single company. In addition to that, a proper outsourcing of process lets a company concentrate its resources on particular core processes, allowing the company to maintain its competitive position. Again, the outsourcing decisions impact all the primary problems discussed above and thus impact the supply chain performance.

(7) Operational strategy selection problems: This problem includes selecting the strategy to operate the supply chain. Suppose that the supply chain designer has solved the primary problems, has selected the best business partners as his/her suppliers and has decided the non-core processes to be outsourced, he/she still needs to decide how to control the flow of products through the supply chain. The problem examples are as follows:

- How to choose between PUSH, PULL, and Hybrid PUSH-PULL?
- How to choose the strategy such as STS, MTS, ATO, MTO, at each stage of the supply chain?

The problems in the above description are typical issues in supply chain management. Each problem would be discussed according as its maturity level. (1)(2)(3) would be discussed at comparatively low maturity levels (Level I Initial, Level II Reatable), (4)(5) would be argued at middle maturity levels (Level III Defined) , and (6)(7) would be considered at high maturity levels (Level IV Managed, Level V Optimized).

4 Supply chain management problems and investment problems on information technologies

Information Technology (IT) is one of the most imperative concerns in today’s enterprise business environment. This is because information systems are one of vital

pivots in modern enterprise management. Building an effective investment policy in enterprise information systems is a critical matter.

Many discussions have been done on this matter since 1980's. Investment problems on Information systems are often discussed in the views of enterprise strategy building. (i.e. [5][6]). Furthermore, these discussions include cost-effectiveness problems [7][8], resource-based approaches [9][10], company's competitiveness [11], and etc.

Enterprise information system is one of company resources and besides; it is also a management enabler for other resources. Further, the information systems' evolution is tightly coupled with a growth of the company. Making investment policies in enterprise information system should consider that capabilities of company organizations depend on its resources and its growth.

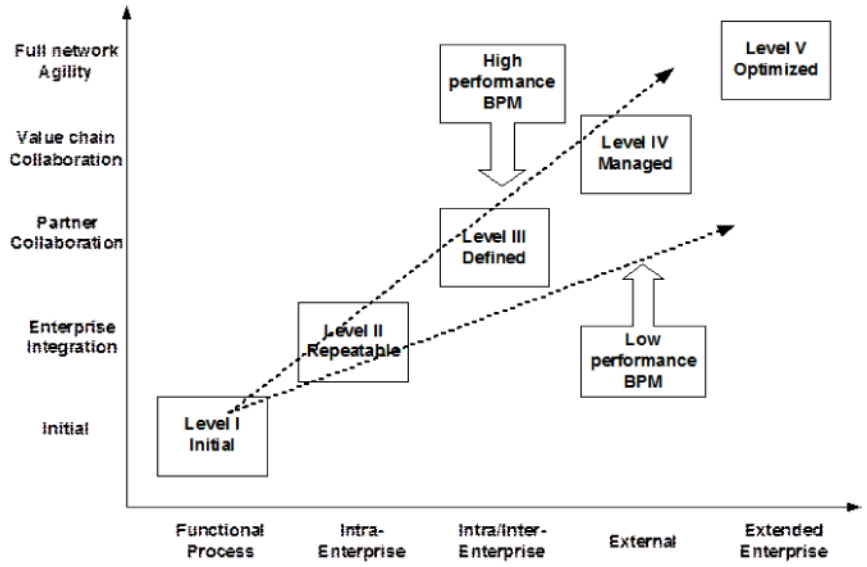

Fig. 3. Supply Chain Maturity Model with process integration

Figure.3 represents a rough sketch of SCMM. The lengthwise represents supply chain system maturity, meanwhile, the crosswise represents the extent of process integration. The boxes in the figure show system maturity levels, which are "Initial", "Repeatable", Defined", "Managed", and "Optimized", respectively. For an example, "Level III Defined" is a stage that partner collaboration is possible, and systems are integrated in partially intra-enterprise and partially inter-enterprises.

The dotted slope line represents trends of system evolution magnitude. System would mature rapidly if the Business Process Management (BPM) shows high performance; on the contrary, it would do in slow pace if BPM performance would be low.

5 Conclusion and future research

Managing supply chain is an execution of process life cycles such as system vision building, design, implementation, practice, and maintenance. A robust methodology for information system life-cycle management is needed [11]. This is a typical PDCA (Plan, Do, Check, and Action) cycle discussed in Total Quality management (TQM).

This paper proposed a novel maturity model for supply chain system (SCMM). The model proposed here, still stays at a primitive stage; however, it would be the first step to clarify supply chain system management considering systems' maturity. Our next step of this work will be detail specifications of the proposed model, and methodologies to use the SCMM for life-cycle management for supply chain systems.

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