

Structures and Technologies for Stepwise Implementation of Adaptive Supply Chain

Reggie Davidrajuh *, Velauthapillai Dhayalan **

* Electrical & Computer Engineering, University of Stavanger, Norway, Reggie.Davidrajuh@uis.no

** Computer Science, Bergen University College, Norway, vdh@hib.no

Abstract: Falling margins, globalization, and accelerating innovation cycles are forcing businesses to switch from traditional (linear and sequential) supply chains to adaptive supply chain that possess the flexibility needed to respond to the environment in real time. As adaptive supply chains are large and complex, they are built step-wise using structures; structures are a well-defined portion of the system, with carefully defined inputs, outputs, and functions. In addition, the structures must follow common standards, based on common architecture for seamless integration with the rest of the components. In this paper, first, we present the problem of implementing a new iterative-based distribution chain that has four distinctive modules. Second, we present a survey of commonly used structures in some of the well-known modern supply chain solutions (e.g. stages in SAP, layers in HP Real Time Supply Chain, modules in i2 Six/IBM) is presented. Third, by going through the structures, we present an optimal solution for implementation of the adaptive distribution chain.

Keywords: Supply chain, adaptive system, structures in design and development.

I. Introduction

Supply chain efficiency is one of the fundamental issues for the survival of enterprises in today's hyper-competitive business environment. In addition, in the world today, the amount of uncertainty that enterprises are facing (e.g. terrorist attacks, labor strikes, other sources of vulnerabilities such as sabotage and weather-related issues), makes supply chains much more vulnerable. Hence, enterprises implement *adaptive* supply chain to withstand unpredictable shocks, and to respond to the environment in real time without compromising on operational and financial efficiencies.

The characteristic of an adaptive supply chain is to have the highest visibility, greatest velocity, and best ability to manage variability [3][4]. Visibility is the ability of all the collaborating partners sees the vital data; velocity is the speed of information flow across the supply chain; variability is the ability to withstand unpredictable events. Achieving these three characteristics is not easy considering the complexity and diversity of the applications collaborating partners are using. Thus, most supply chain solutions develop supply chain step-wise, using well-defined structures.

easier to acquire, there are often too a large number of available features. For example, in the cases of book or movie recommendation, there can be a large number of keyword features of the products from their themes, genres, and text-based description of the products. These features may directly affect the choice of shoppers, and thus, are often used as key features of recommendation, especially for cultural and content-focused products. This problem may lead to inefficiency or ineffectiveness of recommendation. In terms of efficiency, inaccurate or irrelevant keywords may require huge system memory or lead to increased processing time; in terms of effectiveness, there can be often inaccurate or irrelevant words that may damage the recommendation quality. Consequently, it has been recognized to be very important to extract a more meaningful subset of features that can contribute better to recommendation performance [1, 5, 8].

In this study, we utilized a data set that was constructed from a virtual shopping experiment in an Internet book shopping mall in Korea to find out how feature reduction techniques that have been widely used in pattern matching or information retrieval can be applied to the recommendation problem. We used a Korean lexical analyzer to extract features and use the features to construct user and product profiles. The Term Frequency (TF), Inverse Document Frequency (IDF), TFIDF, mutual information, and Singular Value Decomposition (SVD) methods were chosen and adapted for the experiment.

The remaining part of the paper is organized as follows. In the second section, we provide a brief review of feature selection methods from other disciplines. In the third section, we explain the experiment procedure and present the results of the analysis. The fourth section concludes with discussion and further research issues.

I. 1 Problem definition

Figure-1 shows an iterative approach for developing agile distribution chain, for details see [1]. The iterative approach consists of two parts: the first part is to determine the strategic model and the second part is to determine the tactical model. The strategic model gets the initial values for the configuration of the distribution chain (e.g. number of distributors, location of distributors, etc.) from the ongoing or past collaborations of the virtual enterprise. Mixed Integer Programming (MIP) is used for determining the strategic model. In the tactical model, two issues are mainly considered: identifying routes for vehicles by genetic algorithm, and determining parameters for inventory control by probability theory.

After determining tactical model, the newly calculated

operation related parameters (e.g. the unit product delivering cost, average inventory level, etc.) are input again into the strategic model in order to re-optimize the configuration of the distribution chain. Thus, this is a complex to system to build; we need a step-wise approach to develop this supply chain using well-defined structures. The main purpose of this paper is to survey the structures in modern supply chain solutions, so that an optimal structure could be found for step-wise implementation of the adaptive distribution chain shown in figure-1. Since there are numerous business solutions available for developing adaptive supply chain, this paper surveys only the few well-known ones.

In this paper: a survey on the structures for step-wise development of modern adaptive supply chain solutions is given in section-2 (“literature review”). From this survey, an optimal structure for step-wise development of the adaptive distribution chain is given in section-3 (“Implementing Adaptive Distribution Chain”). Finally, section-4 presents some concluding remarks.

II. Literature Review

The structures that are used to develop supply chain step-wise should be a well-defined portion of the system, with carefully defined inputs, outputs, and functions [5]. In addition, the structures must follow common standards, based on common architecture for seamless integration with the rest of the components. Commonly used structures in supply chain development are:

- Stages [4],
- Layers [2], and
- Modules [3]

The following section presents some supply chain solutions and the structures used by them.

II.1 SAP: Development in Stages

The basic design methodology behind SAP’s adaptive supply chain is to map the three key process enablers (such as management of visibility, management of velocity, and

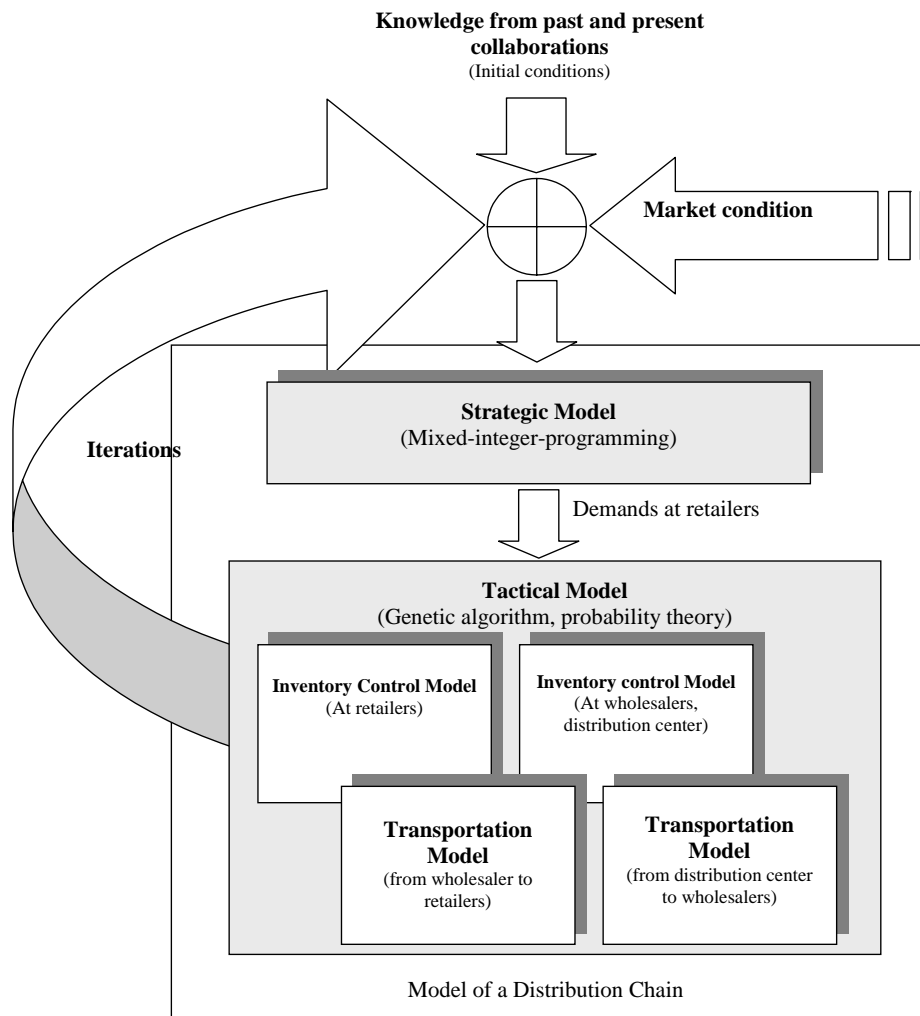


Figure-4: The iterative approach for adaptive distribution chain design

management of variability) to the three key information enablers (such as quality of information, timeliness of information, and depth of information). The mapping is strengthened in three stages such as integrated, collaborative, and adaptive [4].

The three mappings of process enablers to information enablers: Visibility of quality information is the fundamental building block for adaptive supply chain. This is because visibility to both intra- and inter-organizational information is critical for rapid response to changing market conditions. For example, information visibility of orders, plans, supplies, inventory, and shipments is key to both successfully coordinating events across the supply chain and for monitoring and taking proactive actions across the chain. Thus, the first mapping along the adaptive supply chain development is the mapping of visibility on information quality.

After achieving visibility of quality information, the next mapping is to increase the velocity of response by accessing and distributing information rapidly across the supply chain, as velocity of response is the key differentiator in business performance.

As depth of information will allow enterprises to better manage unpredictability (variability) introduced to the supply chain, mapping of these two enablers is the final aspect of developing adaptive supply chain for a dynamic business.

The three stages: To create an adaptive supply chain, SAP make sure that the enterprise advance from traditional supply chain to adaptive supply chain through three specific stages; the three stages are integrated, collaborative, and adaptive [4].

The integrated stage is the first step towards formation of adaptive supply chain where improvement of the operational visibility and efficiency is accomplished, by integrating diverse applications run by the collaborating partners. The fundamental concept behind integrated stage is that the extent of integration directly determines the degree of visibility and that visibility is the basic building block for an adaptive supply chain. In the second stage known as collaborative stage, the ability of the supply chain to exchange real time information is improved; in other words, the velocity of information is improved. The final stage is the adaptive stage, which is concerned of managing variability.

II. 2 Hewlett-Packard: The Layered Approach

Hewlett-Packard (HP) emphasizes real time application integration for developing adaptive supply chain (or in HP terminology - the real time supply chain (RTSC) [2]. The RTSC is organized around three layers:

1. The foundation layer: In this layer, the data management component creates a single, consolidated and cleansed repository of key supply chain data from all supply chain applications across the enterprise
2. The middle layer: In this layer, supply chain business

applications component integrates existing supply chain applications and provides them with a single, real time view of the entire supply chain.

3. The upper layer: In this layer, supply chain consulting and integration components provide the services and best practices from HP and its partners

In summary, HP develops adaptive supply chain in three stages: data integration, application integration, and finally service integration.

II. 3 i2: Modular Approach

i2 Six uses a modular approach for developing adaptive supply chain. The modules can be implemented independently to suit enterprise's specific needs and pressing business challenges first, enabling gradual implementation. The six modules for developing adaptive supply chain are [3]:

1. Production optimization (meeting the demand in real time),
2. Spend optimization (supplier relationship management),
3. Revenues and Profit optimization (Demand management, customer relationship management),
4. Fulfillment optimization (real time planning, build-to-order, inventory management),
5. Logistics optimization, and
6. Business optimization (Business and process definitions, supply chain analysis)

All these six modules are based on common architecture, common infrastructure, and common parameter-based tools, allowing independent implementations and addition of new functionality.

III. Implementing Adaptive Distribution Chain

Developing supply chain in stages allows an enterprise to take the time it needed; the time taken for an enterprise to implement supply chain solutions vary depending on its degree of technology mastery, the process maturity, and the characteristics of the business. The main advantage of using stages is that each stage provides a functional (it could be crude yet functional) system. The main disadvantage of the stages is that if a new stage is planned from the current stage, then it is possible that the current stage could not support evolution of the new stage from it. Then, we may have to go previous stages to make the necessary changes (meaning, rewriting code) so that current stage become robust enough to support development of a new stage from it. Hence, whenever a new stage is planned, one should anticipate drilling through several previous stages.

In developing supply chain in layers, the supply chain is broken into a number of layers (levels). The bottom layer (layer 0) is the common integrating infrastructure that connects supply chain with the communication platform; the

bottom layer is the most primitive layer offering only the basic hardware interface/communication/operating systems services. The highest layer (layer N) is the application layer interacting with the user and the rest of the applications. The main advantage of the layered approach is simplicity of construction and debugging [5]. The main disadvantage of layered approach is that a group of layers do not provide a fully functioning system; we have to have all the layers (from layer 0 to layer N) to make a functioning system offering some services to the user.

Modules give the freedom of selecting and implementing only those modules with specific functions that are needed to take care of pressing business challenges. Though modular implementation resembles layered approach, modules are more flexible than the layered system in the sense that any module can call any other module (whereas a layer can use only lower-level layers) and that modules can be implemented in any order (whereas lower-level layers must be implemented first).

None of the structures discussed above – stages, layers, or modules are adequate to develop adaptive distribution chain. The reason is that, all these structures are applicable for developing desktop applications only. However, adaptive supply or distribution chain is inherently distributed. This means, the module making strategic calculations (see figure-1) should be running on a machine at the head quarters of an enterprise, the transportation modules may be running on the computers at distributors and wholesalers, and the inventory control modules at retailers and wholesalers. This means, one expects that all the 5 modules (one strategic and four tactical) run on computers located on geographically distributed places. We need Web Services to glue the

modules together. Web services is cheap, efficient, and based on open standards; there are numerous books, articles and case studies on Web Services; see [6].

IV. Concluding Remarks

This paper surveys the structures in some of the well-known modern adaptive supply chain solutions. The structures used in those supply chain solutions were stages (e.g. SAP), layers (e.g. HP), and modules (e.g. i2). Though a supply chain solution may choose any structure (stage, layer, module, iteration, etc.) as the basic building block to ease supply chain development, it must aim to provide the basic characteristic of adaptive supply chain – namely visibility, velocity, and variability. To build an adaptive distribution chain, which is inherently distributed, the above-mentioned structures are not adequate enough. We need Web services to glue together the different modules that are running in geographically distributed places.

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