Supply Chain Multidimensional Automated Model

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***Abstract*—This project provides a historical overview of how supply chains developed. There are seven eras divided in accordance to the time in which the business world developed. This project explains the differences and the similarity between each of the eras, thus creating the supply chain Optimal Multidimensional Model of era six and the Automated Multidimensional Model of era seven. The slow pace of change in some business aspects, and the overlapping economic effects; the phrase "Era" is considered appropriate. Due to the limitations placed by the conference and the early stage of this research; this paper will explain the literature behind building the models for eras six and seven. The aim of the research is to create the Optimal Multidimensional Model for small and medium sized companies in order to help them map out the best supply chain. The supply chain Automated Multidimensional Model is an interactive system that helps industries with automated facilities and products pick the best supply chain model for their market and commodities. Both models will be tested by the use of a Delphi study which will be analyzed by fuzzy logic in order to estimate the degree of belief for each statement. This project is still in its preliminary stage; therefore the final results cannot be quantified. However an outline of both supply chain models will be presented at the conference.**

***Index Terms*—Leagile, Supply chain re-engineering, Automation.**

I. Introduction

The problematic issue facing many small to medium sized companies is the decision of which supply chain model to incorporate within their business strategy. This is due to the many models developed over the years. This problem is also found with the definitions developed for logistics and supply chain management. These models and their strategies are allocated into eras; this has been done by determining the emerging definitions which arise in that specified era.

This research attempts to identify all the supply chain strategies developed and allocate them into eras and incorporate them into an Optimal Multidimensional Model which is shaped into a matrix that helps small and medium sized companies identify and allocate the characteristics of each strategy in accordance with the company's speciality and market. The supply chain Automated Multidi-mensional Model is similar to the Optimal Multidimensional matrix but it is equipped with heuristic learning to help mitigate error. The Automated model helps industries with automated facilities to be more efficient and reduce their human error element. The supply chain Optimal and Automated models will be tested by the use of Delphi study. Delphi is a structured communication technique originally developed as a systematic study, based on an interactive forecasting method which relies on a panel of experts. The findings from the Delphi study will then be tested using Fuzzy Logic a form of many-valued logic which deals with reasoning, that is approximate rather than fixed and exact; thus estimating how and to what extent that these statements are true or false. However, the testing stage is not included in this paper, as this paper only looks at the theoretical literature concept and the models created. The next stage will be testing these models, and will commence in spring of the year 2013.

II. Era Six: The Optimal Multi-Dimensional Model-2012

Era six analyses the fundamentals that drive supply chain reengineering. There are two main elements to the reengineering processes, internal and external resources competencies of process automation and employee empowerment [1]. This requires absolute trust and advanced (IT) which combines the strength of EDI, ERP, BPM, and EAI [2].

A. The Optimal Multidimensional Model

The lean concept is used in cases with stable demand to minimise losses during the processes, maximizing profit by reducing fixed costs. Meanwhile, the agile concept is applicable when the market demand is extremely volatile leading firms to adopt virtual integration to unite all their information flows to battle any turbulence in demand [3]. Most markets are turbulent; this makes a firm's market sensitive, hence allows it to adopt an agile approach. The model is designed to incorporate different roots in order for companies to allocate their favoured model suited for their business strategy, commodity and market. Lean and agile are opposing models, however, once combined they can enable the supply chain to develop fast market knowledge, and enhance their information providing the decoupling

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point has been accurately identified between each intersection from each model. The agile logistics operates to ensure flexibility between inputting the supply within and between companies, as it focuses on maximising the response to a customer's demand. The lean logistics is to eliminate losses [4].

The Optimal Multi-dimensional Model is divided into four quarters and takes the shape of a matrix. The first upper left quarter is designated for the models with the characteristic features of a lean supply strategy, aiming to eliminate waste while maintaining quality. The lean system is a collection of operational techniques focused on resource productivity [5]. The lower left quarter is designated for the agile models which share the characteristics that focus on vertically integrating information and services with regards to market sensitivity. Agility is a collection of inclusive strategies focused on exploring volatility to gain a competitive edge [6]. The upper right corner of the matrix combines the characteristics of the lean supply chain which are shared by the agile chain; hence each characteristic can be exchanged with the lower right corner as it combines the agile characteristics which can be exchanged with the lean strategy. The two right corners are designed to create a hybrid strategy which the firm can create to compete in its chosen market with its competitive commodity.

The cross within the matrix is designed to illustrate the different segments within the matrix; for example the disintegrated supply chain strategy (upper left and lower left corners) from the integrated supply chain strategy (upper right and lower right corners). The integrated segments of the matrix allow firms to create their tailored hybrid strategy. However, the disintegrated segments of the matrix allow firms to pick one of the traditional supply chain strategies in accordance with their market and commodity. The right side of the cross (the integrated Hybrid), shows the decoupling point to be at the production phase which is divided into three categories; craft production, mass production and lean production [7]. The matrix, also, identifies two sectors by which a firm can identify under which market it belongs, the "Market Qualifiers" indicates the base line for companies to enter in a competitive market arena, while the "Market Winners" analyses the specific capabilities a firm has in order for it to fill the demand.

III. Era Seven: Automated Supply Chain Model

There are several problems that require the supply chain process to be automated. These problems are part shortages, excessive finished goods inventories, underutilised plant capacity, unnecessary warehousing costs, inefficient transportation of suppliers and finished goods. There are several pathways to automate a supply chain; one of which is to gather all the companies into an e-marketplace, where negotiations on goods and services can take place. However, automating the business dealing processes into one e-marketplace will create a centralised domination which does not foster crucial aspects of the supply chain such as collaboration, alliance, and long-term relationships, but rather it increases rivalry as companies aim to dominate one another in their pursue of the best suppliers [8].

To enable more flexibility in the automated software, a system of properties must be included, that is revolutionary to normal software. These properties are:

1) Disintermediation: creating direct association between users and their software without the use of an intermediary body. This provides participantswithaccess interactions and gathers remote information on applications and human resources.

2) Dynamic Composability and Execution: A system designed to deal with the inter-relationships of components by executing sets of distributed parts. However, the resources required will mostly be known at the dispatch point; this requires highly coordinated infrastructure to enable the discovery of resources and compositions.

3) Interaction: the specific interactions that took place would not be entirely known until the dispatch point, although this may vary, to underpin each and every interaction requires patterns of data to be explicitly represented and confirmed.

4) Error tolerance and exploitation: due to systems being extremely complex, errors occur, thus a system should have room to manoeuvre and anticipate such conduct if it occurs, thus allowing its components to interact in time and mitigate these errors and prohibit them from reoccurring by following systematic protocols.

The problematic issues of auto transactions is to ensure the correctness of the transactions, mitigate any misunderstandings between participants, and the routine handling of exceptions due to unforeseen circumstances or system errors [8].

According to the large Finnish research program during 1992-1995, as the customisationlevel lowers, the logistic cost rises. This classified the construction materials into three different categories based on the production strategy; designed-to-order, make-to-order, and make-to-stock [9]. These three categories cause problems associated with sudden change in product design, raw material inventory shortages and lead-time, respectively. This research also divides suppliers into four categories; "stock suppliers", "build-to-order suppliers", "mass producers", and "capacitated suppliers" -according to the production capacity of each supplier. The "stock suppliers" and the "Mass Producers" need accurate demand forecast as they have a short lead-time to reduce inventory and transportation costs, the "build-to-order" and a "capacitated suppliers" require accurate data on the end-users' actual construction progress and demand forecasting.

The literature indicates a new approach for supply chains is to automate the process by using computer agent software. An "agent" can be a combination of the World Wide Web and the information gathering software asit can strategically forms and re-forms coalitions, creating dynamic business partnerships without the user's immediate presence. This "agent " helps increase sales through matching the end user's needs with product offerings, as well as reduce transaction costs by using the

automated business process. Each agent communicates with other agents over the internet exchanging information dynamically such as inventory level, sales data, sales forecast and production or delivery schedule to mitigate the bullwhip effect. This "agent" gathers and shares schedule data, instead of sales data and sales forecast, this is sent to a supplier and the sub-supplier agent and on the bases of this information, the production schedule is updated and modified to meet the changes in demand [9].

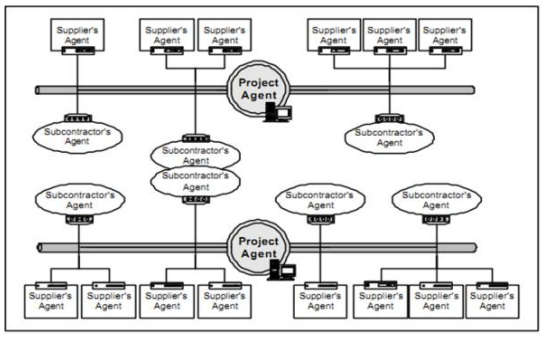

Figure 1. Cyber-network links the whole supply chain together and compares the firm's supply chain with its competitors [9].

The figure above illustrates how the "agent" creates a cyber-network that links the whole supply chain together as well as calculates or compares the firm's supply chain with its competitors. A major constraint is the willingness of these nodes to communicate with other nodes in the chain, mostly because of trust issues. Communication is very important in supply chains, simply because it enables integrating knowledge that is spread across each of the nodes to facilitate smooth flow of materials from beginning to end.

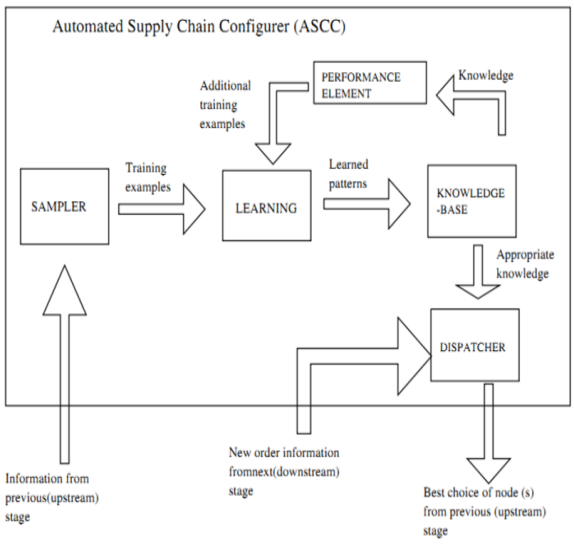

Figure 2. ASCC decisions based on information that comes a stage downstream [10].

ASCC itself can be considered an agent that re-sides at every node in the supply chain. Each of these agents make decisions based on the information they have about the nodes in the next stage up-stream to them and the order information that comes from a stage downstream from them. The "Sampler" module in ASCC filters the information to extract necessary training examples that are used as input in the next module "Learning". The "Learning" module is used to learn the patterns that exist in the training examples. The algorithm used in the Learning module itself can be chosen from a wide spectrum of currently available methods.

These patterns are then stored in a "Knowledge Base". Whenever knowledge in the "Knowledge Base" is found to be incomplete, the problem is rectified through incremental learning using the "Performance Element." "Knowledge Base" are gathered and the "Dispatcher" identifies the best choice of node(s) among those in the previous (upstream) stage. The order is then dispatched to the identified node(s) [10]. This process repeats itself continually until all orders are dispatched. The entire process can be automated.

Era seven is a continuation of era six, as it incorporates the advances in information technology to en-able fast and reliable communication among different nodes as well as stages in a supply chain. The research takes the literature in consideration when creating the Automated Supply Chain Model. This model will be similar to the Optimal Multidimensional Model matrix except that it will be equipped with Heuristic Learning capabilities. The Automated Multidimensional Model is designed to map out the best supply chain option interactively as it is equipped with a heuristic learning system which enables it to learn from errors. The data can be input into the Automated Multidimensional Model, as its calculations predict the best supply chain model. However, if that option is not favoured, the Automated Multidimensional model has the ability to adapt to this circumstance by either heuristic learning or giving the option of choosing the best supply chain model to the person conducting the search. The Automated Multidimensional Model is best suited for industries with automated products and facilities, rather than small and medium sized businesses.

These automated systems however raise a paradox; due to the ASCC being software it might not be incorporated in all industries, especially in less developed countries. The concept of (one size fits all) might not be realistically applicable. Nevertheless, this software is perfect for specialized automated production (i.e. car, oil, aerospace, cloths). There, the supply chain would benefit from the cyber software and gain production speed by additionally incorporating a cyborg production chain for fast assembling of components. Although this is present in the current industries (car, oil and aerospace) it is not there as a means to link the entire supply chain into a single unit. The aim of this research is to create an optimal and an automated multi-dimensional model. The optimal multi-dimensional model is designed to help small and medium-sized businesses map out their best supply chain model according to their market and commodity. The automated multi-dimensional model is designed to map out the best supply chain option interactively as industries with automated products can incorporate, to unify their supply chain and mitigate the human error element.

IV. Summary

This research analyses the development of supply chains through time from the 1940s to the present. The aim is to create an Optimal Multidimensional Model which small and medium sized businesses can incorporate and an Optimal Automated Multidimensional Model that industries with automated products and facilities can incorporate in order to unify their supply chain and mitigate the human error element. A number of technologies such as: clever software, novel materials, more dexterous robots, new processes for example the three-dimensional printing and a range of web-based services aiming to tailor each product precisely to each customer's taste. The factory of the future will focus on mass customization, seeing as the old way of production which involves taking lots of parts and screwing or welding is now proven to be inefficient[11]. With the third industrial revolution, the challenging economic climate and the increasing competitive pressures, era six and era seven incorporate the advances in information technology to enable fast and reliable communication among different nodes as well as stages in a supply chain. This creates a cyber-network that links the whole supply chain together as well as calculates or compares the firms supply chain with its competitors.

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LIST OF ABBREVIATIONS

ASCC:	Automated Supply Chain Configurer
BPM:	Business Process Management.
EAI:	Enterprise Application Integration.
EDI:	Electronic Data Interchange.
ERP:	Enterprise Resource Planning.
IT:	Information Technology.

Safaa H. Sindi currently lives in the United Kingdom in the city of Plymouth. Born in Saudi Arabia, Safaa H. Sindi did her B.Sc in International Business Economics at Plymouth University and graduated in 2010. The M.Sc was from the same university, yet it was in the field of International Supply Chain, Safaa H. Sindi graduated in 2011 with an honors' degree. Safaa H. Sindi is currently doing PhD in Supply Chain Automation at the same institution. She is a teaching assistant, teaching Introduction to Logistics at Plymouth University. She also assists lectures and professors in projects and markings. She also supervises third year undergraduate students in their dissertations. Miss Sindi is a member of CILT (Chartered Institute of Logistics and Transportation) and PYNDA (Plymouth Nautical Degree Association).