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DEVELOPMENT OF DYNAMIC SIMULATION MODELFOR INVENTORY LEVEL OPTIMIZATION THROUGH SUPPLY CHAIN

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Thanks God for giving me the strength and health in doing this research and I would like to dedicate this dissertation to my beloved parents who taught me how to be strong and ambitious. It is also dedicated to my best friends who their positive energies and supports always lead me in the best way.

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ABSTRACT

System dynamic is an approach to understanding the behavior of complex systems over time. Current research on system dynamics modeling in supply chain management focuses on inventory decision and policy development, time compression, demand amplification, supply chain design and integration, and international supply chain management. Less attention has been devoted on the inventory level improvement with fuzzy demand controller in dynamic simulation model. This study is aimed to consider customer demand fluctuation to improve the finished goods inventory level of Electronic Company by using dynamic simulation model. Dynamic and changes in demand and corresponding excess during time through the product life is considered as serious problems in supply chain. Data collection and analysis have been considered to find the current problems of the company. Dynamic model has been constructed by ITHINK software to represent the inventory level of company. The stock and flow diagrams are become visible to represent the structure of a system with more detailed information. Three different variables have been applied in Fuzzy controller to give the better level of inventory by MATLAB SIMULINK. Generated results have been compared by current company inventory level in ITHINK software and the best alternative was selected to suggest the company management.

ABSTRAK

Sistem Dinamik merupakan pendekatan untuk memahami perlakuan bagi sistem yang kompleks dalam satu jangka masa. Kajian-kajian semasa bagi sistem dinamik dalam pengurusan rantaian bekalan adalah menjurus kepada membuat keputusan dalam inventori dan pembangunan polisi, pemampatan masa, pengembangan permintaan, rekabentuk dan integrasi rantaian pembekal, dan pengantarabangsaan pengurusan rantaian pembekal. Penumpuan kajian kepada peningkatan tahap inventori melalui kawalan permintaan "*fuzzy*" dalam simulasi model dinamik adalah sangat terhad. Kajian ini bertujuan untuk meningkatkan prestasi penentuan tahap invetori barangan siap bagi sebuah syarikat elektronik dengan pertimbangan permintaan pelanggannya yang tidak menentu, menggunakan simulasi model dinamik. Dinamika serta perubahan dalam permintaan dan lebihan semasa dalam jangkahayat produk merupakan satu masalah yang serius dalam rantaian bekalan. Dapatan serta analisis data berkaitan dengan rantaian bekalan telah dilakukan untuk menentukan masalah semasa yang dihadapi oleh syarikat ini. Model dinamik telah dibina menggunakan perisian iThink bagi menwakili tahap inventori syarikat. Rajah "stock" dan "flow" mewakili sturktur sistem yang dibina digambarkan dengan jelas dengan perincian informasi yang lebih ketara. Tiga pemboleh ubah yang berbeza telah digunakan dalan kawalan "*fuzzy*" untuk menghasilkan penetapan tahap inventori yang lebih baik, dengan bantuan perisian MATLAB SIMULINK. Dengan mengunakan perisian iThink, keputusan yang terjana ini dibandingkan dengan tahap inventori semasa syarikat. Alternatif yang terbaik telah dipilih dan dicadangkan kepada pihak pengurusan syarikat.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

CHAPTER 1

INTRODUCTION

1.1 Introduction

In recent years, supply chain has received increasing attention from both researchers and practitioners. A supply chain is a network of suppliers, manufacturing sites, distribution centres, retailers through which raw materials are acquired, transformed, and delivered to customers. Supply chain management is to respond to the rapid change and severe competition environment in the marketplaces, enhance the efficiency of enterprises, reduce the cost of inventories and improve customers' satisfaction, which exerts great influence on business. The supply chain starts with raw-material supplier and ends at the consumers. The coordination of cross-enterprise is an important and difficult task in supply chain management. One of the critical issues in supply chain management is how to characterize such a complex dynamic behaviour in supply chain network and assure product availability throughout the chain. It makes dynamics modelling an ideal tool to model supply chain networks.Dynamic modelling is a computer-aided approach for analysing and solving complex problems with a focus on policy analysis and design which has its origins in control engineering and management; the approach uses a perspective based on information feedback and delays to understand the dynamic behaviour of complex physical, biological, and social systems.

This chapter presents an introduction of this research work reported in this study. It covers many important aspects. First, it describes the background of the problem, followed by the problem statements and objectives of the research. Next, it describes the scope of the research work, and finally it explains the significance of the research.

1.2 Background of the Study

Before investigating the problems in modelling of supply chain, it is important to have an overview of the general related aspects. This section begins with the overview of supply chain. Next, system modelling is described. Furthermore, it continues through defining supply chain modelling. Finally, it would be focused on using dynamic modelling in supply chain.

A supply chain consists of all stages including the manufacturer and suppliers, transporters, warehouses, retailers, and customers to satisfy a customer demand. Modelling refers to the process of generating a model of some real world entity, processor system. Traditionally, the formal modelling of systems to predict their behaviour has been done via a mathematical model which attempts to find analytical solutions enabling the prediction from a set of parameters and initial conditions. For many systems, however, simple closed form analytic solutions are not possible. This is the point at which computer simulation models come into play. The modelling and analysis of supply chain has been an active area of research for many years. Supply chains are multifaceted structures focusing on the integration of all the factors involved in the overall process of production and distribution of end products to the customers. Growing interest in supply chain systems has highlighted the need to adopt appropriate approaches that can ensure the efficient management of their complexity, enormity and broadness of scope(Shee, Tang et al. 2000). The purpose of supply chain management is to optimize the performance of supply chains, therefore development of modelling frameworks can be utilized to analyse and comprehend the dynamic behaviour of supply chains.

Industrial dynamics, described as the application of feedback concepts to social systems, is evolving toward a theory of structure in systems as well as being an approach to corporate policy design. Dynamic modelling is appropriate for supply chain modelling because supply chains are dynamic. It means that they display distinctive behaviour that is known to vary through time. They are interactive because system components interact with one another, and their interaction produces the distinctive behaviour of the system. In this Study, finished goods target level in inventory is investigated because, inventory is an important factor which should be considered as a main aspect that influence on delivery lead time(Özbayrak, Papadopoulou et al. 2007).

1.3 Statement of the Problem

Strategic supply chain management deals with a wide range of issues and includes several types of decision-making problems that affect the long-term development and operations of a firm, namely the determination of number, throughputs of machines and production capacity, warehouses capacity and flow of material through the logistics network, inventory management policies, distribution strategies, supply chain integration and customer delivery lead time. The methodological approach which is dynamic modelling could be used for capturing most of the named supply chain management problems. Supply chains are dynamic because they show different behaviour during the time. So, it makes dynamics modelling as a proper approach to model supply chain networks.

Demand fluctuations leads to have high inventory level in warehouse which causes high cost. However, less attention has been devoted on the inventory level optimization with Fuzzy demand controller in dynamic simulation model. A comprehensive dynamic model with Fuzzy demand is applied to fulfill the mentioned gap.This research develops a dynamic model of an electronic company through Supply Chainto optimize level of finished goods inventory through the developed system modelling. Inventory is an important factor which should be considered as a main aspect that influence on delivery lead time. The research questions of this project are as follow:

1. How does a dynamic model of supply chain can be represented for an electronic company?
2. How to optimize inventory level of finished goods through the dynamic model of the system?

1.4 Objectives of the Study

Based on the problem statements mentioned above, this research encompasses a set of objectives that is associated with the milestones of the research process. The research objectives are mentioned below:

1. To develop a dynamic model of an electronic company through Supply Chain that illustrates system behavior of finished goods inventory related to demand

2. To optimize the inventory level of finished goods inventory through the developed system modeling with the assisting of present's optimization software.

1.5 Scope of the Study

Scope of the study includes method that addresses dynamic modelling of supply chain for an electronic company that is located in Johor Baharu, and its production is lamp. In order to develop a dynamic model through the supply chain system, IThink software is used to construct the dynamic model. Also, MATLAB SIMULINK software through Fuzzy Controller for optimization is applied. Supplier order sizes, order threshold, raw material on order, number of lines, number of production, actual customer order are performance parameters are collected from the electronic company.

The available data from the company is used to optimize inventory level of finished goods in three scenarios (the first four months, the second four months, and the third four months).The study is just a proposed model using the available data from company (not a real implementation). After simulating the model, this research optimizesthe level of finished goods inventory by using MATLAB SIMULINK through the Fuzzy controller.

1.6 Significance of the study

Supply chains are dynamic because they display distinctive behaviour that is known to vary through time. They are interactive because system components interact with one another, and their interaction produces the distinctive behaviour of the system. In supply chains, dynamics are produced by different types of interaction, for instance buyer-supplier interaction, interaction between the user and the provider of information services (Shee, Tang et al. 2000), etc. They are complex because many objects interact in the system of interest, and their individual dynamics need careful consideration and analysis. The operations performed within a supply chain are a function of a great number of key variables which often seem to have strong interrelationships. The ability of understanding the network as a whole, analysing the interactions between the various components of the integrated system and eventually supplying feedback without decomposing it makes dynamics modelling an ideal tool to model supply chain networks (Özbayrak, Papadopoulou et al. 2007).

This research developed and simulated a dynamic model of supply chain for an electronic company to optimize inventory level of finished goods. Therefore, the result of this research is useful to determine a proper target level of finished goods. This model is not only used for an electronic company, but also used for other companies as well.

1.7 Conclusion

In summary, supply chains are dynamic because they show different behavior during the times. So, it makes dynamics modeling a proper approach to model supply chain networks. This research simulates a dynamic model of supply chain for an electronic company to optimize the inventory level of finished goods. Inventory is an important factor which should be considered as a main aspect that influence on cost and time.

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