ANALYSIS OF THAI CONSTRUCTION MATERIAL MANUFACTURER SUPPLY CHAIN BY USING ASDN (AGILE SUPPLY DEMAND NETWORKS) APPLICATION SOFTWARE : A CASE STUDY

THITINAN CHUKIJRUNGROTE

MASTER OF BUSINESS ADMINISTRATION
IN LOGISTICS AND SUPPLY CHAIN MANAGEMENT

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Independent Study Title Analysis of Thai Construction Material Manufacturer Supply Chain by Using ASDN (Agile Supply Demand Networks) Application Software : A Case Study

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ABSTRACT

Most Thai companies used the traditional way of doing the business. They faced they couldn't compete the innovative company. So they tried to invest in information technology. Many companies change their traditional supply chain to be the lean supply chain. But lean might not serve the fluctuation demand like agile. Agile can help company to be more flexible, speedy, and responseive. And some companies used a great amount of money to invest in new software to serve and to find the best solution for their company. In this research used Thai construction material company as the case study company. Thai construction material case study company faced several problems in lost sale and out of stock every month. I will use ASDN (Agile Supply Demand Networks) application software that was available in internet to analyze and suggest the alternatives of Thai construction material case study company supply chain.

Keywords : ASDN, Thai Construction Material Company

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CHAPTER 1

INTRODUCTION

1.1 Background

Since the start of the twentieth century, Thai companies across an extensive variety of industries have become increasingly interested in exploring opportunities for gaining competitive advantages by leveraging the core competencies and innovative capabilities among networks of business partners. Although companies have always acknowledged the importance of the relationships between themselves, their customers, and suppliers, it is only recently that creating and nurturing channel alliances has been recognized as a critical source of strategic advantages.

Most Thai companies continue to use the traditional way of doing business. Their working principle relies on paper and pen. However, some companies use software support for finding the optimal methods and control systems. SAP and Oracle are important technology providers of many support systems for solving a company's process problems, but companies must invest a lot of money for the software. Thai companies have conventional working methods, which are often resistant to change. Hence, several Thai companies have been unsuccessful in implementing the software.

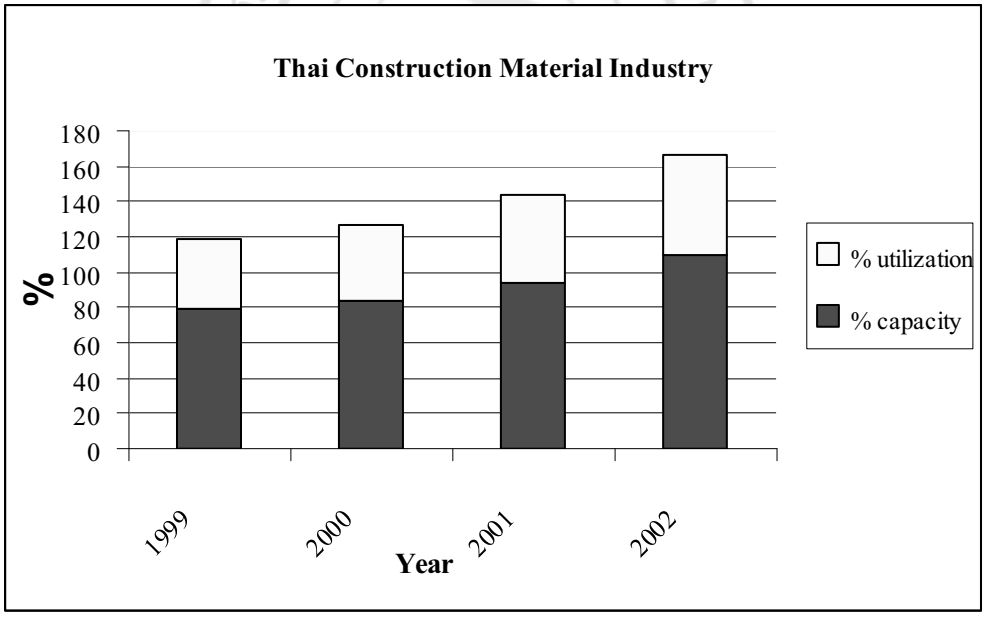
Another problem is the rapidly changing demand and increasing forecasting errors. The question is how companies can get accurate data for serving their customer demand and providing sustainable service levels. Most Thai companies rely on historical data plus the previous month's out of stock figures to forecast the demand for the following month. If such strategic decisions are wrong, companies will certainly lose profits. In general, Thai companies solve the problem by pushing inventories to customers, resulting in increasingly turbulent and

volatile markets and causing many Thai companies to seek to improve their competency through agile business (White, Daniel, and Mohdzain 2005).

The next problem is an absence of work flow integration within organizations. This research shows that the company selected for this case study (hereafter referred to as "the case company") lacks good communication structure between the manufacturing plant and the sales and marketing department, leading to distorted real demand and bad strategies for the next period. Finally, the unstable enterprise resource planning (ERP) system is unable to support employees' activities because the case company cannot catch the real demand and solve the problem.

1.2 Overview of a Case Study of Thai Construction Material Industry

In 1997, Thailand faced an economic crisis that consumer demand decreased. While the demand of automobile was declining, the construction material demand increased as shown in Figure 1.1.



Source: Business Economic Department (2002)

Figure 1.1 Thai construction material industry trend during 1999 - 2002

It was forecasted that Thailand's construction industry in 2006 would increase around 4.01% year-on-year primarily because of small and medium players in the construction industry. An average annual growth rate of 5.52% was forecasted for the period 2008 – 2012.

On the part of industry, there has been a fall in the demand for housing in tandem with a dip in the consumer confidence index. On the part of intrinsic characteristics, Thai construction industry faces widespread corruption together with an acute shortage of labor skills. Another major challenge is Chinese products that are posing stiff competition to local producers of construction materials.

Risks notwithstanding, Business Monitor International (BMI) forecasted that the Thai construction industry will grow in value from an estimated US$6.92 billion in 2008 to US$7.80 billion in 2012. This is due to the change in supply chain management. The supply chain focus of today's enterprises has increased in response to several critical business requirements. First, current leading companies have come to realize that effective management of the supply channel constitutes the final frontier in the search for new sources of cost reduction and process improvement. Over the past decade, the application of computerized information tools, the utilization of management techniques such as just in time (JIT), total quality management (TQM), and business process reengineering (BPR), and the implementation of employee empowerment and cross-functional management philosophies have led to highly agile, lean product designs and manufacturing functions capable of delivering superior quality and service.

Second, supply chain management has been stimulated by the realization that closely integrated channels of suppliers and customers can provide today's enterprises with unique sources of competitive competencies. Previous management models focused on employing quality and improvement methods that sought to increase market value by leveraging the capabilities in internal business processes. In contrast, supply chain management shifts attention to the previously unseen opportunities that emerge when companies seek to combine their innovative competencies and unique resources of their external customers and supply chains in the pursuit of radically new sources of competitive advantages.

Third, few companies today still depend on vertical integration to provide them with competitive advantages. During the past few years, companies have divested themselves of non-profitable businesses and functions for which they have weak core competencies, preferring to

use channel partners who specialize in those business areas. In such an environment, managing supply chain partners has become the key to market leadership.

Fourth, the growth of international competition has opened up new markets previously inaccessible even just a few years ago. Equipped with today's newest information and communication technologies and able to leverage the tremendous capabilities occurring in global logistics management, customers are no longer limited to national sources of productions and services. The ability to assemble closely networked supply chains provides even the smallest company with the capability to maximize customer satisfaction and accessibility at the lowest possible cost.

Because of these changes, Thai construction material companies face increasing demand unpredictability and forecasting errors. As a result, they push surplus inventories to their customers or lose profits from insufficient stocks.

1.3 The Case Company's Problems

One characteristic of the case company is the traditional way of work based on paper and pen. It is an absolute vertical supply chain. The product flows vertically while the information flow starts from customer orders being sent to the sale and marketing department and then to the warehouse for delivery planning and finally to the manufacturing plant for production planning as shown in Figure 1.2. Although the company has an Enterprise Resource Planning (ERP) system, the system does not support strategy analysis and setting, causing it to lose orders every month as shown in Figure 1.3.

The case company is forecast-driven, not demand-driven. In other words, because it has little direct feedback from the marketplace and does not share data among departments, it bases the forecasts on past sales and shipments and then converts these forecasts to inventories. However, the agile supply demand network (ASDN) software may help the company build inventories based on actual demand, solving the stock out problem. The objectives of ASDN are as follows:

(1) To study the characteristics of the domain: global investment goods delivery.

(2) To develop the tools for screening and presenting the network-level controls.

(3) To suggest optimal approaches for faster response and improved financial performance.

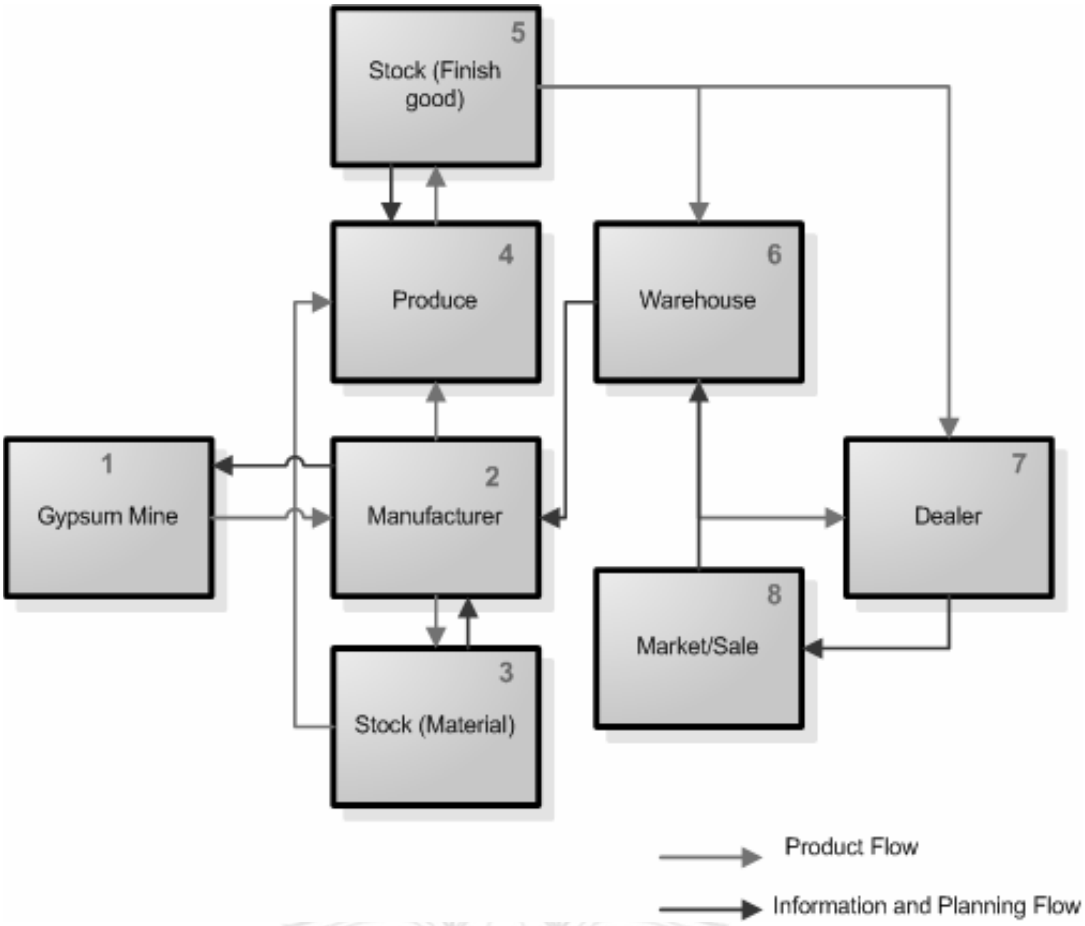
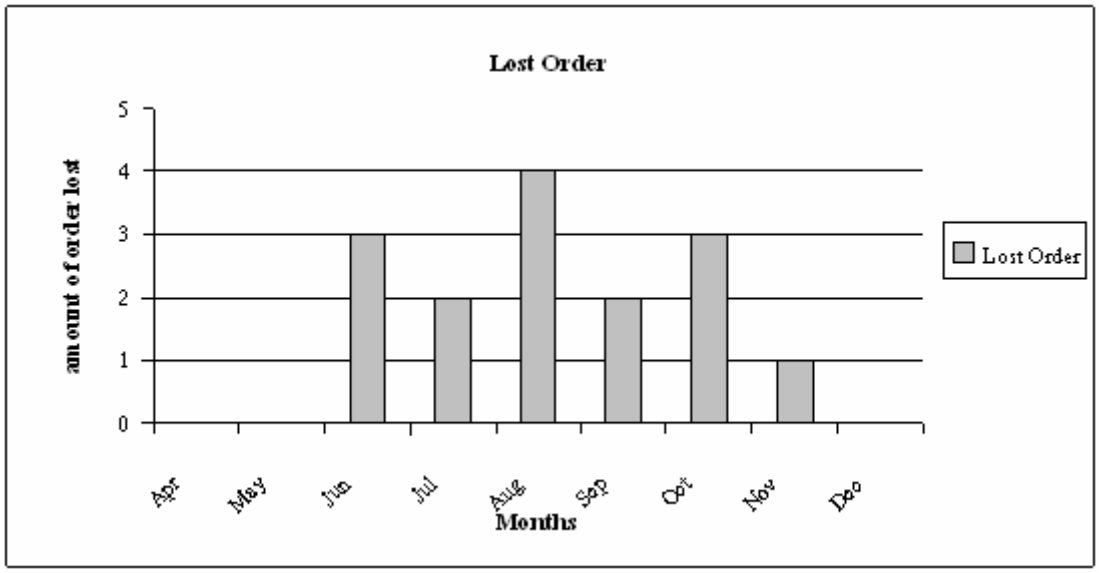


Figure 1.2 Characteristics of the case company

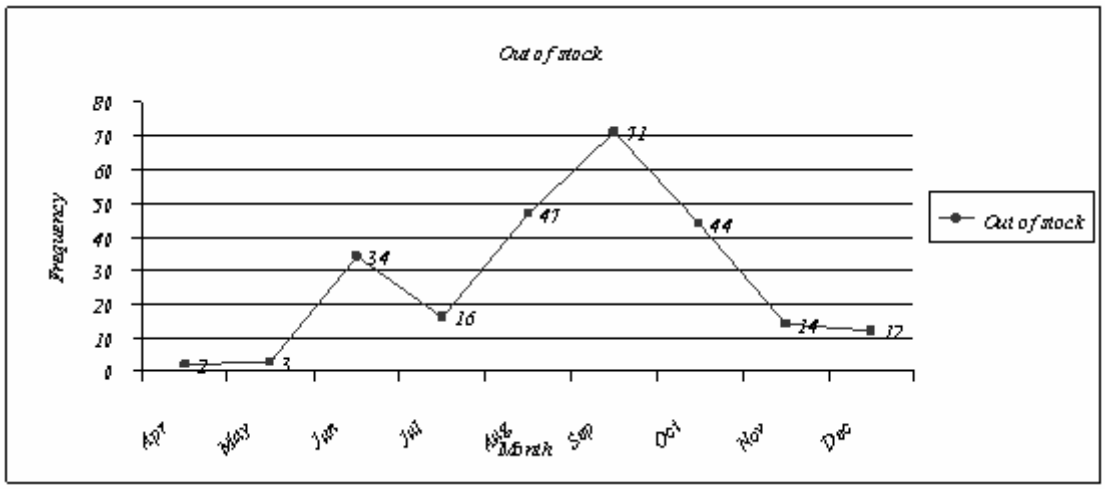
As Figure 1.2 shows, the case company is an absolute vertical supply chain having its own supplier, manufacturing plant, and warehouse or distribution center. In the product flow part, Gypsum mines send materials to the plant, which then stocks materials for production and stocks the finished goods. After that, the plant delivers the final products to the warehouse and dealers, which are the company's final customers.

On the another hand, the information and planning process of the case company starts from dealers sending their orders to the sale/marketing department, which then sends the orders to the warehouse or the plant in the customers' area. This case study assumes products are sent directly from the plant to customers. The plant will check its stocks. If the stocks are not sufficient, it starts producing products to fill customers' orders. The sale/marketing department sees the real demand and sends customer orders to the warehouse, which controls the inventory level based on the company's inventory control policies but does not update new orders, resulting in frequent stock-out as shown in Figure 1.4. The case company tries to launch new key performance indicators (KPI) in customer service, hoping these KPIs will help analyze the root problem.



Source: Customer service (2006)

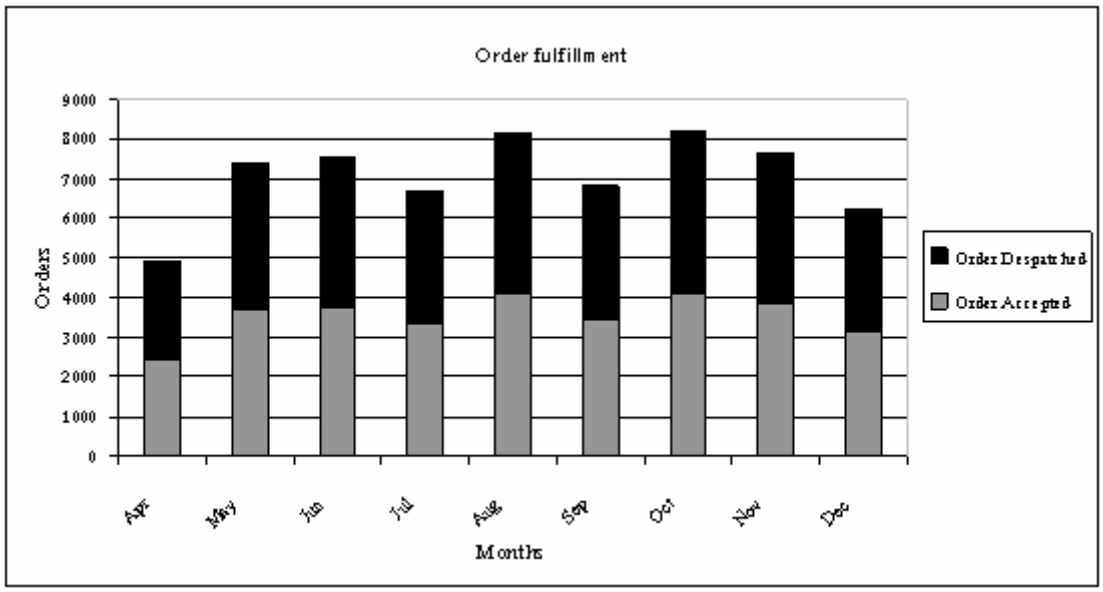
Figure 1.3 Lost orders



Source: Customer service (2006)

Figure 1.4 The case company's out of stock frequencies

An investigation of historical data reveals that the number of fulfilled orders per month does not correspond to the real demand as shown in Figure 1.5. The root cause of lost orders is the mismatch between the expected demand and the real demand. This mismatch stems from the lack of an efficient tool to integrate information across functions for decision making.



Source: Customer service (2006)

Figure 1.5 Order fulfillment

1.4 Research Objective

The objectives of this research are as follows:

1.4.1 To analyze a Thai construction material company's (the case company's) supply chains by using the open-source ASDN software.

1.4.2 To identify and improve the case company's supply chain performance by using the ASDN software.

1.4.3 To suggest which solution is suitable for the case company by using the ASDN software.

This study uses the open-source software ASDN as an alternative to solve and analyze the real demand for the case company, tests how the ASDN software program is capable of helping logistics managers set their supply chain strategies, and analyzes the advantages and disadvantages of this software. In addition, it addresses how quantitative modeling techniques, such as system dynamics simulation, may be used for improving the purchasing and distribution logistics in project-driven electrical utility industries. Complex non-linear systems including trade-off situations may be practically represented by computer simulation. Running different scenarios with a group of decision makers may improve managerial implications. Computer-based quantitative modeling tools allow opportunities to research new value adding strategies for logistics companies.

Additionally, many general-purpose models may be extended to other industries and applications of similar type. Many current software approaches are too time- and resource-consuming to be implemented in fast changing and reconfigurable supply demand network.

1.5 Research Methodology Framework

This research consists of four parts as shown in Figure 1.6. The first part introduces the case company's manufacturing plant and analyzes the company's problems. The second part contains two sub-sections: one uses the original input data, and the other uses the ASDN software to re-analyze the data and then compares the output data from the two sub-sections. The third part analyzes the root cause based on the results obtained in the second part, and the last part rectifies

the root cause identified in the third part for decision making suggestions and summarizes the results of this research.

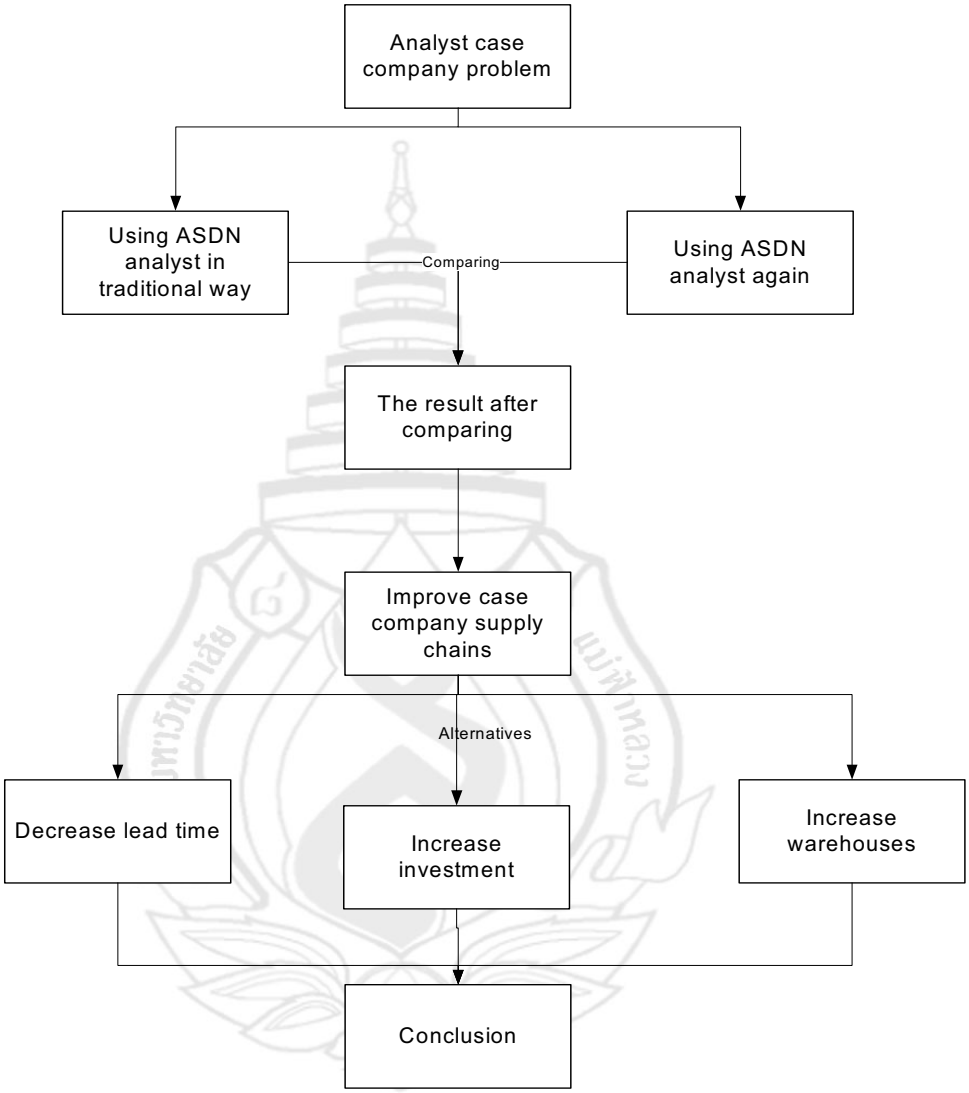


Figure 1.6 Methodology framework

CHAPTER 2

LITERATURE REVIEW

This section describes the impact of real demand, literature review about the Supply chain Network, and analyzes the two supply chain strategies; Lean and agile supply chain characteristic. Then answer why Agile is important.

2.1 Introduction

One of the biggest challenges that Thai organizations faced today are the need for responsive to volatility in demand The major reason is product and technology lifecycle are shortening, competitive pressures force more frequent product changes and consumer demand greater variety than ever before. That why, Thai companies try to invest software program for integrate supply chains to enhance end-customer value. The end-customer is become the role player in control the supply chain. In the past supply chain created value through low price and broad product assortment. But today customers control the buying process. They realize their bargaining power; they have ability to make choice and willing to utilize a variety ways to purchase goods and services to satisfy their requirement. The goal of integrated supply chain logistics is to enhance end-customer value.

The end-customer used to identify the last point in a supply chain where a specific product or service bundle is purchased for consumption. The end-customer could be a consumer or an intermediate channel member who purchases a product or a component as an industrial input. Traditionally, Thai company used supply chains to create value through low prices and broad product assortment. Today, however, Thai companies are tried learning how to accommodate customers who demand greater control of the buying process, have the financial

ability to make choices, and are willing to utilize a variety of ways to purchase goods and services to satisfy their lifestyle requirements.

End-customers have at least three different perspectives

1. Efficiency means the end-customer take away of economic value is low price

2. Effectiveness means the end-customer take away of market value is assortment and convenience.

3. Relevancy value means the end-customer take away of this type of value is business and life style accommodation.

The demand changed impact to the supply chain. Supply chain council (1997) explain this term is used increasing by logistics professionals that encompasses every effort involved in producing and delivering a final product, from the supplier to customer. Lummus (1999) combined more definitions to define the supply chain as all the activities involved in delivering a product from raw material through to the customer including sourcing raw materials and parts, manufacturing and assembly, warehousing and inventory tracking, order entry and order managements, distribution across all channels, delivery to the customer, and the information system to monitoring all of these activities. Only pass to years, the supply chains have become more important and role play in the business and relative to all the activities of company.

As the result, customer demand has changed rapidly. The company is enhancing its capacity to produce and distribute both make to order (MTO) and make to stock (MTS) products, while trying to keep lower production cost at the same time.

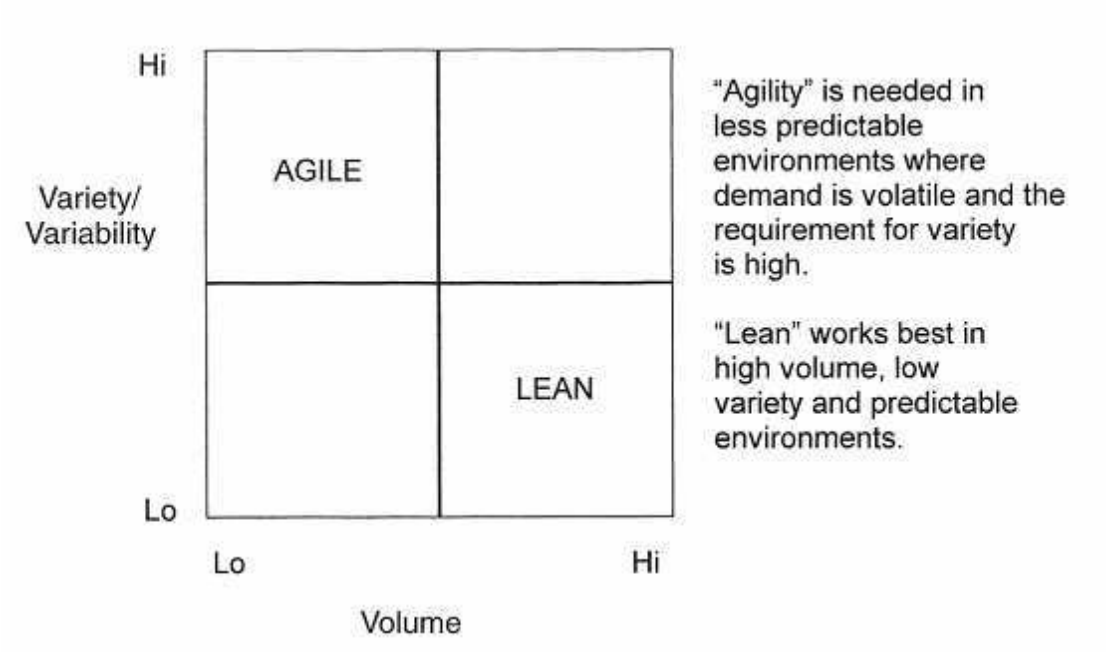
2.2 Supply Chain Network

Supply chain networks include the facilities and distribution points that perform the functions of procurement of materials, transformation of these materials into intermediate and finished products, and the distribution of these finished goods to customers (Ganeshan and Harrison, 1995). For existing in the business, Thai companies should change to be the network competition where the market and customer will be won by those companies who can better structure, coordinate, collaborate and manage the relationship with their partners in a network

committed to better, closer and more agile relationship with their final customers (Martin, 2000). Thai traditional make or buy decision can be highly complex and emotive under such an environment that involves consideration of issue such as efficiency and risk dimensions working capital and detail financial evaluation (Chung et al, 2004). Many Thai companies focused on removing or reducing the uncertainty within a supply chain as far as possible, in order to facilitate a more predicable response to change in downstream demand (Naylor, 2000).

2.3 Lean Supply Chain and Agile Supply Chain

Several studies have shown the benefit of lean and agile concept in enhancing and improving the competitiveness of the firm. Lean can reduce or even eliminate waste in the production process but lean might not to be able respond to the fluctuation in customer demand, while Agile enhances the responsiveness of the overestimate or underestimate customer demand. Figure 2.1 shows the variety, variability and volume effect in Lean and Agile.



Source: Industrial Marketing Management (2000)

Figure 2.1 Lean or agile

Christopher (1997) has pointed out the different between lean and agile concept in qualifier and winner. As its simplest lean paradigm is most powerful when the winner criterion is cost, while service and customer value enhancement are prime requirements for market winner then the likelihood is agility show as table 2.1.

Table 2.1 Market winner – market qualifiers matrix for agile versus lean supply

	Market Qualifiers	Market Winners
Agile Supply	1. Quality 2. Cost 3. Lead Time	1. Service Level
Lean Supply	1. Quality 2. Lead Time 3. Service Level	1. Cost

Source: Mason-Jones et al. (2000)

Both agility and leanness demand are high product quality levels. They are required minimum total lead-times defined as the time taken from customer raising a request for product or service until it is delivered. Total lead-time must be minimized to enable agility, as demand is high volatile and thus difficult to forecast. Furthermore, lead-time also is minimized in lean manufacturing as by definition excess time is waste and leanness calls for the elimination of all waste. The core of difference between leanness and agility in terms of the total value provided to the customer is that service is the critical factor calling for agility while cost is linked to leanness as shown in table 2.2 that compare between leanness and agility.

Table 2.2 Comparison of lean supply chain and agile supply chain: the distinguishing attributes.

Distinguishing attributes	Lean supply	Agile supply
Typical products	Commodities	Fashion goods
Marketplace demand	Predictable	Volatile
Product variety	Low	High
Product life cycle	Long	Short
Customer drivers	Cost	Availability
Profit margin	Low	High
Dominant costs	Physical costs	Marketability costs
Stockout penalties	Long term contractual	Immediate and volatile
Purchasing policy	Buy goods	Assign capacity
Information enrichment	Highly desirable	Obligatory
Forecasting mechanism	Algorithmic	Consultative

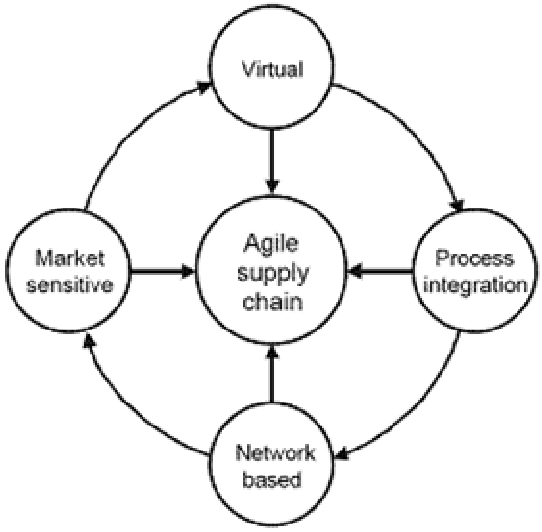
Source: Mason-Jones et al. (2000)

In traditional supply chain management policies are process-driven and have used production to forecast policy but the traditional can't effectively or efficiently support a customer-driven and dynamically changing market. Agile supply chain management has been proposed as a

new approach to provide a competitive strategy for such a business environment; in agile organization is market-driven that focus on satisfying the supply chain that the chain of events that customer's order inquiry through complete satisfaction of that customer.

Agility firstly came from the manufacturing function and with the concept of flexible manufacturing system (Pathasarthy and Prakash, 1992). Concept of Agile is defined by the Agility forum as the ability of an organization to thrive in a continuously changing, unpredictable business environment. Edmund, Markus and Michael (2001), give a very in dept definition of agility supply chain in two concepts. First speed-time it takes to ship and receive a good and second flexibility- degree in which a firm is able to adjust the time in which it can ship or receive goods. McCarthy and Tsinopoulos (2003) believe Agility is the key issues of successful manufacturing are organizations, processes and products that can sense and change or be changed in response to customers in varying demands. Kidd (2000) provided the definition of the agile is:

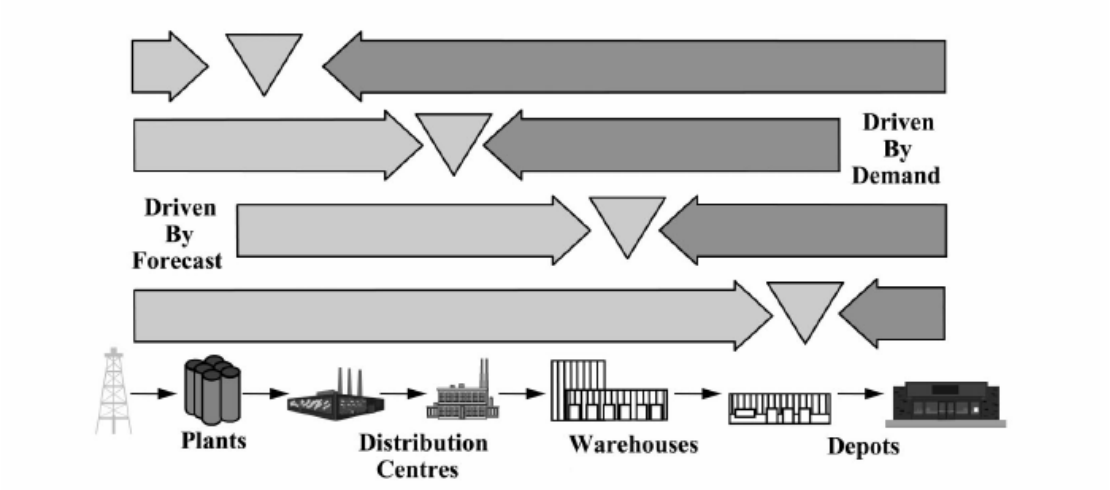
An agile enterprise is a fast moving, adaptable and robust business. It is capable of rapid adaptation in response to unexpected and unpredicted changes and events, market opportunities, and customer requirements show as Figure 2.2. Christopher (2000) explain agile supply chain must posses four keys element that agile supply chains can receive the real-time demand change and make quickly response when market sensitive.



Source: Christopher (2000)

Figure 2.2 The characteristics of agile supply chains

Firstly, the agile supply chain is marker sensitive. Supply chain in market sensitive is supply chain has the capable of reading and responding to real demand. Most Thai companies are forecast-driven rather than demand driven show as Figure 2.3.



Source: Hoekstra and Romme (1992)

Figure 2.3 Material flow decoupling point and strategic inventory

Secondly, the use of information technology can share data between buyer and Thai company (supplier) is in effect creating a virtual supply chain. Virtual supply chains are information based rather than inventory based. Most Thai Companies are based upon a paradigm that seeks to identify the optimal quantities and the spatial location of inventory. They use complex formula and algorithms exist to support their inventory based business model.

Lastly, most Thai companies lack of sharing data between their supply chain partners. Sharing data can fully leverage through process integration. Process integration help Thai companies increase their collaboration. This collaboration helps their partners supply chains know innovation of product development, common system and shared information. Agile supply chain can help Thai companies increase their competitive advantages.

Such a business is founded to facilitate speed, adaptation and robustness and delivers a coordinated enterprise that is capable of achieving competitive performance in a highly dynamic and unpredictable business environment that is unsuited to current enterprise practices. Traditional supply chain management and agile supply chain management explain in the Table 2.3.

Table 2.3 The differentiated between Traditional and Agile supply chain management.

Traditional Supply chain mangament	Agile Supply chain management
Process-driven	Market-driven
Used production to forecase policy	Foucus on guickly satisfying the supply chain
Can not effectively and efficiently support customer-driven and dynamically changing marketnd	Can support customer-driven and dynamically changing marketnd

Source: Martin Christopher (2000)

This resulted in markets that be increasingly turbulent and volatile that why many company seek to improve their competency through agile supply chain (White et al., 2005). Agile refers to the ability of a company to quickly react incoming orders and changes in the marketplace. Agile might be defined as the ability of an organization to rearrange operations, processes, and effectively business relationships while at the same time blooming in an environment of continuous change (Martin, 2000)

Key to the success of an agile supply chain are the speed and flexibility with which these activities can be accomplished and the realization that customer needs and customer satisfaction are the very reasons for the network (Lee and Lau, 1999). If implemented properly, this will provide a new dimension to competing: quickly introducing new customized high quality products and delivering them with unprecedented lead times, swift decisions and manufacturing products with high velocity (Fisher, 1997 quoted in Dekkers and Van Luttervelt, 2006)

An unprecedented number of companies are pursuing lean management to reduce cost, improve customer service, and gain competitive advantage. Lean thinking embraces the eliminate waste in is various forms. Activities that consumer resources but generate no redeeming value in the eyes of customers are waste that must be eliminated in the lean paradigm. On the other hand agile emphasizes flexible, timely action in response to rapidly changing demand environment.

Agile supply chain isn't the linear model. This system is network-based operations that require timely availability of information throughout the system in order to allow cooperative and synchronized flow of material, products and information among all participants.

In the truly agile created a demand for identifying the menu of agility-enabled attribute required for an organization to build an agile supply chain and from which organization leaders could select require items (Goldman et al, 1991) The agile supply chain supported the capacity to receive the real-time demand that change and make quick response, with use of information technology can link and share data between participants for creating a virtual supply chain.

Virtual supply chain is information-based rather than inventory-based that integration and cooperation synchronize the decision along the supply chain, reduce the inventory buffer and improve efficiency.

To meet the challenge that organization faces today is the need respond to ever increasing levels of volatility in demand. For a variety of reasons product and technology lifecycles are shortening, competitive pressures forces more frequent product changes and consumer demand greater variety than the past.

With the new trend of globalization and products customization, business competition is already shifting from single organization to supply chains where several Thai companies pool their core competency together. Agility has ability to move Thai companies from a single organization to a supply demand network. To be the truly agile, Goldman et al, (1991) created a demand for identifying the menu of agility-enabled attributes required for an organization to build an agile supply chain and from which organization leaders could select The presently, the dynamic business environment is continuously chaining because of the new information technology, increasing intensity of competition, increasingly customer demand, and mergers and acquisitions (Wing et al. 2006)

Goldman et al. (1995) summarized a survey among 500 modern manufacturing companies that all features can manage by agile:

1. The customers were demanding increasingly challenging service-level agreements.

2. The customer needs were constantly changing.

3. The ability to meet changing customer needs was regarded as a source of competitive advantage.

4. The new processes and new business models were being regularly introduced by big industry players.

5. To satisfy customers' needs required flexible manufacturing operations in place.

Moreover agile supply chain should be collaborative and should provide several benefits for Thai companies as the outline;

1. Visibility

Case study company supply chain must have full and thorough visibility into customer demand, supply sources, production planning and scheduling, manufacturing capacity, inventory level, promotion plan and transportation channels in order to make systematic optimize decisions. Companies can maximize their opportunities to find the most cost-efficient adjustments to plan the schedule, inventory level and operations. The process of case company faster materials, information, and decision flow through an organization, the faster it can respond to the demand of the market.

2. Flexibility

The flexibility offered case study company can organizes through its range and adaptability attributes is a positive enabler of its supply chain agility. The key issued 4 types of flexibility are product development flexibility, sourcing flexibility, manufacturing flexibility and logistics flexibility that support case study company activities for quick respond the customer demand.

3. Speed

Speed is a measurement of end-to-end cycle time made up of the sequential manufacturing, order/demand processing and delivery/distribution cycle time. It describes how quickly the case study company supply chain senses routine and unanticipated demand and effectively broadcast the signal for an intelligent supply chain response.

4. Predictability

The response of the supply chain should be predictable from control point of view by using the agility supply chain. Whatever kind of flexibility and speed the supply chain possesses, it has to be under control, understandable and acknowledged by all the supply chain partnerships. The predictability may be stated requirement for design the network.

5. Scalability

Most supply demand network must have the ability to scale with demand and contain all kinds of unexpected events. Companies can quickly response to changes in demand, production, supply and covert the uncertainty into opportunity by using a Java-based architecture, in conjunction with the internet's dynamic nature.

Those are reasons why the Agility supply chain is important to the business today. Agility isn't the tool although agility is the path that measures the ability how company can change when demand isn't constant. Agility of a logistics chain might be defined as the ability to operate in uncertainty whilst maintaining stable level of productivity.

Agility is more important than the pass until supply chain changed from Market driven to Demand driven. The lead-time for response customer has come important for Thai companies show as table 2.4.

Table 2.4 The Migratory model in supply chain

Supply chain evolution phase	I	II	III	IV
Supply chain time marker	Early 1980s	Late 1980s	Early 1990s	Late 1990s
Supply chain philosophy	Product driven	Market orientated	Market driven	Customer driven
SC type	Lean functional silos	Lean supply chain	Leagile supply chain	Customised leagile supply chain
Market winner	Quality	Cost	Availability	Lead time
Market qualifiers	(a) Cost	(a) Availability	(a) Lead time	(a) Quality
	(b) Availability	(b) Lead time	(b) Quality	(b) Cost
	(c) Lead time	(c) Quality	(c) Cost	(c) Availability
Performance metrics	(a) Stock turns	(a) Throughput time	(a) Market share	(a) Customer satisfaction
	(b) Production cost	(b) Physical cost	(b) Total cost	(b) Value added

Source: Murakoshi (1994)

The external uncertainties are related to demand volumes, production mix, and technological changes. These problems challenge today in many Thai industries due to international trade and increasing lead-time demands. Building fast response, low inventory chains, are a question of competitiveness. The value of lead-time is an increasingly important competitive factor in many Thai industries. Management of capacity represents a way to improve

lead-times and benefit from fast response. Traditional cost accounting methods do not always justify better lead-times since it may mean lower capacity utilization and thus higher unit costs.

At the moment, many solutions have been developed for Thai industries related to fast moving consumer goods. Examples of applying the principles of agile or fast response supply demand principles in the literature deal with computer peripherals and grocery goods. Industries with low production volume combined with high product mix do not have so many applications. These types of industries, such as machine building, construction projects, energy and infrastructure systems, and heavy machinery, are very important for the Finnish economy.

2.4 ASDN (Agile Supply Demand Network)

2.4.1 Introduction

Information systems are recognized as being a critical factor in achieving agility in the supply chain in a similar way to the contribution flexible manufacturing systems made in the past to agile manufacturing (Christopher, 2008) Information systems are seen to assume a fundamental role in developing agility, as the notions of speed and flexibility would be and inconceivable without them (Breu et al, 2001) Present day information networks processing and electronic commerce are more advance and rapidly expanding the capability to achieve powerful interactive links among organizational and functional units of the agile enterprise (Devor et al, 1997) The benefits of information systems to agile enterprise including; enterprise-wide concurrent operations that cover all the functions of the company, agreed communications and software standards, electronic commerce on international multimedia networks and better mathematical understanding of representation methods used in design (Gunasekaran, 1998)

2.4.2 ASDN (Agile Supply Demand Network)

The agile supply demand design (ASDN) application software is distributed by Guangyu Xiong, Natalia Kitaygorodskaya and Petri Helo the researchers at Vassa university of Finland. ASDN was developed by Vassa university researchers and ABB Company. The ASDN provides supporting to the manager in making improved business decisions that lead to maximizing customer service and profits by capitalizing on the value added of the entire supply

chain. The motivation for this study is to explore the behavior of an industry supply chain using computer-based software which integrates simulation, evaluation and optimization. ASDN concentrates upon the development of information technology (IT) architectures to support global supply demand network modeling and design, screening presently network-level control, optimizing supply chain for fast response time and improved financial performance.

ASDN is based on the integrated of Java Web Applet and equipped with interactive communication capabilities between peripheral software tools. ASDN operates as an information platform and supply chain design center, by which organizations integrate with their customers and suppliers and quickly build supply demand network. ASDN can be accessed via a browser or integrated into an organization's existing back-end systems through its open architecture.

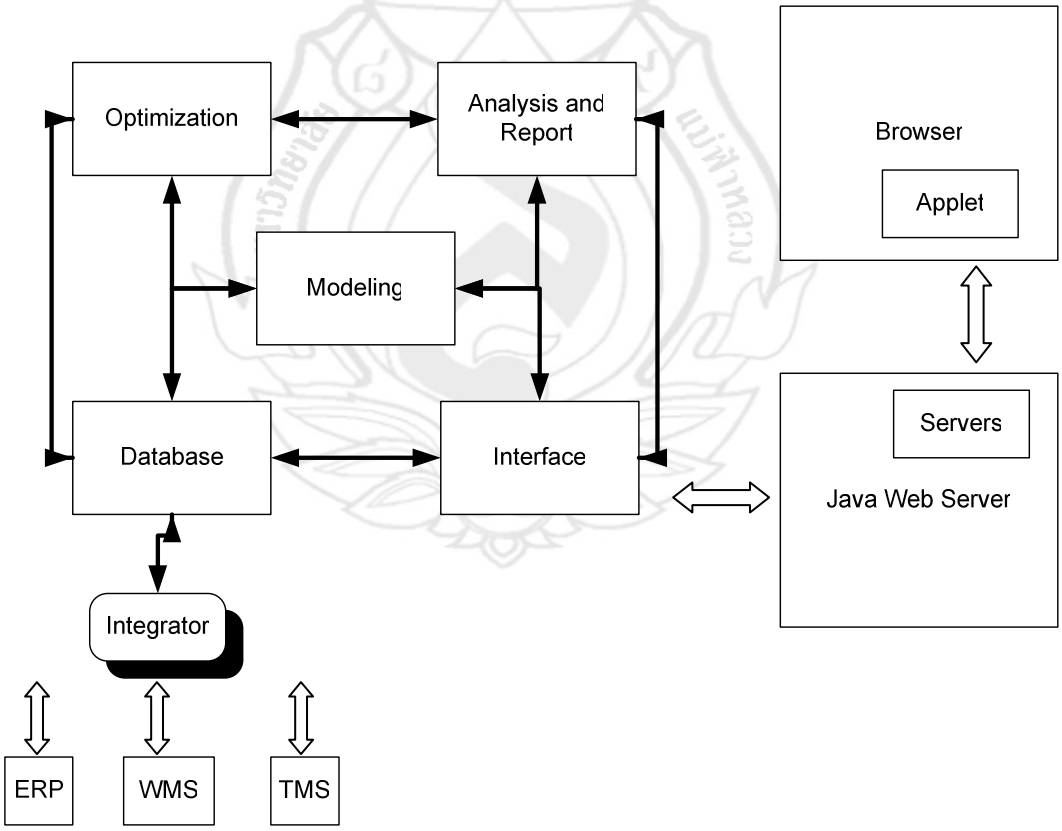
Within the organization, ASDN integrates traditional information systems like ERP (Enterprise Resource Planning), TMS (technology management system), and WMS (warehouse management system) to acquire on-time, accurate and complete information. Outside the organization, web-centric ASDN links the customer and supplier to form an agile supply demand network through the internet. The information, activities and decisions along the entire supply chain are visualized, synchronized and optimized by ASDN.

ASDN provides a common infrastructure along with modeling platform and optimization algorithms. And ASDN offers a simple means for transforming static supply chains into dynamic, web-centric, agile supply chains that are closely integrated with the manufacturer's functional legacy systems like ERP, TMS and WMS.

ASDN focuses on developing a decision-making support system computer-based that allows all members of the supply demand network to collaboratively manage and control the production and distribution policies. The ability to interface with existing manufacturing systems allows manufacturers to continually follow a centrally planned system but manage tactical and operational issues and use a variety of tools for systematic optimization of the entire supply chain. Whereas the ERP, WMS and TMS focus on internal management, the ASDN adds functions and data for external management to the supply chain structure. An important feature of ASDN is the ability for multiple organizations in the supply chain to connect with each other, allowing improved performance of the entire chain since information from any tier in the supply chain is available to any other organization in the chain.

ASDN supports configuration flexibility, view flexibility and algorithm flexibility. Configuration flexibility is the ability to configure an alternative supply chain scenario based on the main supply demand network and get the analysis results quickly. View flexibility refers to diversified reports that analyze supply chain scenarios from different types of aspects like inventory amount, value-added, and service level. Algorithm flexibility includes optimization algorithm selection in the lot size calculator which provides a variety of algorithms that are suitable for specific production circumstance.

In architecture of ASDN that has been coded in Java applet which is express the idea and summarize in a web page and accessible by user through web server. General user can make query and receive result from web server through applet. The newest version of ASDN is automated updated by web server without the interaction of human user. The standard architecture of ASDN application server is shown in Figure 2.4.



Source: A web-based logistics management system for agile supply demand network design.

Figure 2.4 ASDN architecture

ASDN has separate function module which are easy to modify and upgrade. The main function modules in ASDN are modeling, optimization, analysis and report, interface, and database. It points for modeling, optimization supply demand networks, forms a scalable, extensible and interoperable application environment as shown in table 2.5

Table 2.5 ASDN modules

Module	Option
Modeling Module	-If facilitates the user buliding and configuration the supply chain model quickly and efficienly -User can easily click and drop in the main window the supply chain nodes and link nodes with transportation arrow. -All rate data and information of the network are retrieved and processes by this module to provide a straightforward and clear model structure
Optimization Module	-A variety of build mathemetical algorithmd are provided to optimize specified performance of supply demand network -User could select the optimization models in order to adapt various operational circumstances -Comprehensive analytical model and real time calculation optimize the supply chain from a systematic view -The model customization fumction allows the user modify or replace the embebed algorithm according to concrete optimization requirement
Analysis and Report Module	-Analyzes the supply demand network performance from different kinds of aspect and visualizes the result by variety of geographical and tabular report -It help planners and managers to observe the supply demand network in a holistics view and examine issue -Such as the network service level and overall fulfillment for end customer, total inventory amount and value, capacity and capital throughout
Interface	-The enable the user and other system transform the data to ASDN and assess the concern output information -It can graphically represent the network distribution including the location of facilities, transportation channel, the attribute of supplier and customer -User interface to the designer -System interface to local information system
Database Module	-It stores the data information related to supply demand network, customer demand, supply onotlogy etc. -Intergrator is used to transform the data and information between ASDN and transactional system according to prescribed rule and format
Integrator	-Traditional approaches such as ERP,WMS,TMS to planning and scheduling the shop floor activities are heterogenoues and distributed -The integrator provides a way to integrate planning and scheduling activities depressed in diversified legacy system -Integrator adopt agent KQML (Knowledge Query Manipulation Language) massages and a subset of KIM (Knowledge Interchange Format)

Source: A web-based logistics management system for agile supply demand network design.

The main major advantages of ASDN are

1. User friendly
2. Diversified performance analysis and report
3. Multiple what if scenario
4. Real time calculation and optimization of network

CHAPTER 3

RESEARCH METHODOLOGY

3.1 Introduction

The main objective of this research is to find an optimal way to solve the case company's problem. This research employs the methodology as depicted in Figure 3.1. The first step is data collection, followed by data analysis and solution identification.

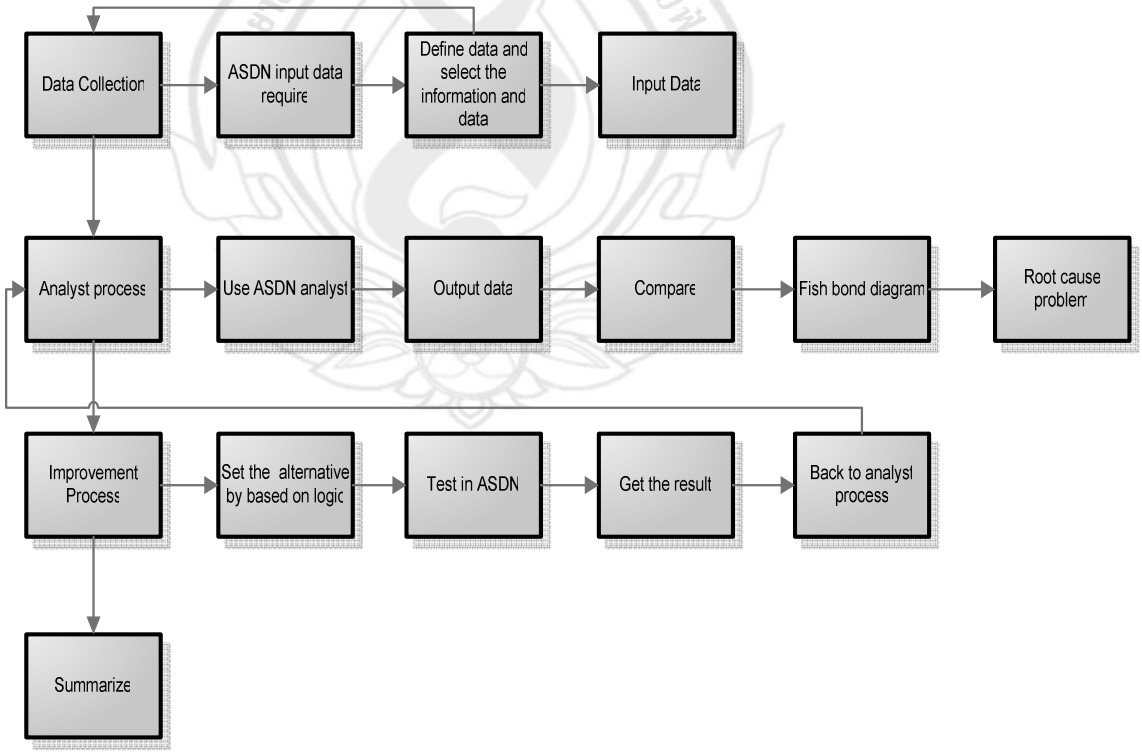


Figure 3.1 Research methodology

3.2 ASDN Input Data Collection

This research uses the walk-in method to gather the data in the case company. The process of collecting existing data is helpful in refining evaluation questions, identifying key informants, developing data collection protocol, and determining the missing data important to evaluation.

3.2.1 General

- Product type
- End customer type
- Order decoupling (made to stock)

3.2.2 Financial

- Price
- Cost
- Demand
- Demand (standard deviation)

3.2.3 Manufacturing

- Working time
- Production through
- Order backlog
- Shipping time
- Engineering lead time
- Capacity
- Maximum order
- On time delivery

3.2.4 Inventory

- Holding cost rate
- Order lead time for customers
- Average inventory in units
- Average inventory in Euro currency (EUR)
- Capacity constraint node

3.2.5 Transportation

This study uses one of the ten fastest moving products and uses the Pareto analysis to select the top ten products from 50 product lines. This product is the main product of the case company and faces the stock out problem every month. The company provides monthly warehouse summary reports.

This research started in October 2006. All input data are from the year 2006 and based on five main dealers in the north, north-east, and south of Thailand. Manufacturer and inventory input data refer to monthly warehouse summary reports, which are combined into annual data inputting. The average inventory in EUR is based on the rate 50 baht per 1 EUR. Transportation costs come from the logistics department and vary depending on the oil price rates, which range from 24 - 26 baht.

3.3 Data Analysis

Data analysis is done through the ASDN (Agile Supply Demand Network) software, with the manual shown in the Appendix.

3.3.1 Input data in ASDN

The input data are shown in Table 3.1.

Table 3.1 ASDN input data screen.

Financial, Manufacturer and Inventory input

Price	Price per unit	Euros
Cost	Cost per unit	Euros
Demand	Demand per year	Units
Demand standard deviation	Standard deviation of demand	Units
Working time	Working time	weeks
Manafacturing stage time	Time from beginning of production until the shipping of the product	Days
Standard deviation of manafacturing stage time	Standard deviation of manufacturing stage time	Days
Capacity	Capacity per day	Units
Maximum order fulfillment time	Maximum order fulfillment time asked by a customer	Days
Service level (OTD)	Percent of how many orders have to be delivered on time	Percent
Holding cost rate	Percent of cost of keeping a unit in inventory for a period of one year from the cost of unit. According to Christopher (1997) holding cost rate (40%) is a sum of interest rate (7%), price erosion (25%) and obsolescence (5%), warehousing (6%).	Percent

3.3.2 Output data in ASDN

The ASDN software operates via the formula and methods shown in Table 3.2.

Table 3.2 ASDN output data screen.

Order lead time for manufacturer unit	Time from the moment an order comes to manufactruring unit until its fulfillment and product shipment to the next production unit or to the customer	days
Average inventory in units	Average inventory in units. Cycle stock + Safety outbound stock + Safety inbound stock	Units
Average inventory in euros	Average inventory in euros. Inbound inventory value + Outbound inventory value + Cycle stock*Price+ Holding cost rate*Price	Euros
Cycle Stock	Amount of units required for the reorder time. (Manufacturing stage time*Demand)/2	Units
Safety inbound stock	Safety stock kept for the uncertainty supply. Demand*(100 - service level)	Units
Safety Outbound stock	safety stock kept for the uncertainty from demand. Manufacturing stage time * Demand standard deviation * Normsinv(service level) NORMSINV (P) returns the inverse of the standard normal cumulative distribution, where P is probability corresponding to the normal distribution. Normal distribution is standard when man = 0 and standard deviation = 1 NORMSINV (P) return value X such that $P = \int_{-\infty}^{X} \frac{1}{\sqrt{2\pi}} e^{\frac{t^2}{2}} dt$ In our case NORMSINV (Service level) returns number of units in the stock that is up to Service level.	Units
Inventory turn rate	Demand per year divided by average inventory in units. Demand * 365 / Average inventory in units	Days
Inbound inventory value	Inbound inventory value. Price * Average inventory in units	Euros
Outbound inventory value	Outbound inventory value. Price * Safety outbound stock	Euros
Capacity utilization	Capacity utilization Demand / Capacity	Percent
Throughput Dollar Days	Throughput Dollar Days (Price – Cost) / Manufacturing stage time	
Inventory Dollar Days	Inventory Dollar Days Average inventory in units / Manufacturing stage time	

Two scenarios are tested. The first scenario uses the volume of the manufacturing plant's production, while the second scenario uses the sale and marketing department's customer demand figures. The outputs from the two scenarios are then compared. The fish bond diagram is suitable for analyzing all the data collected and indicating the main cause of the problem facing the case company.

3.4 Improvement process

The improvement process is shown in Figure 3.2.

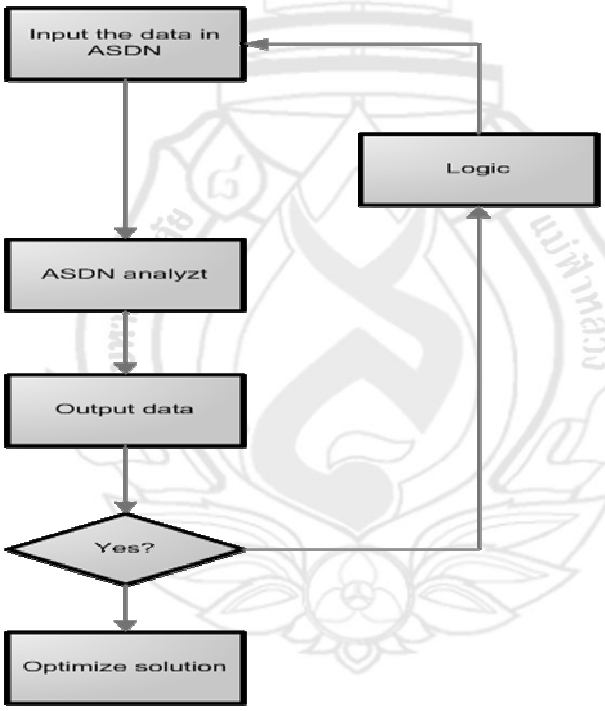


Figure 3.2 Improvement process

The improvement process starts after obtaining the output data from the ASDN analysis. The fish bond diagram is used to find the main cause of the problem. Two alternative solutions are logically identified to improve the company and are compared by using the ASDN software. The two alternatives are combined into the third one, and then the three alternatives are

combined into the last one for further testing. All the four alternatives are finally compared using the ASDN software.

3.5 Summary

The summary part reviews all the processes, explains all the alternative testing, compares the pros and cons of each alternative based on the data from the ASDN analysis, and judges which alternative is suitable for solving the case company's problem.

CHAPTER 4

RESULTS AND DISCUSSION

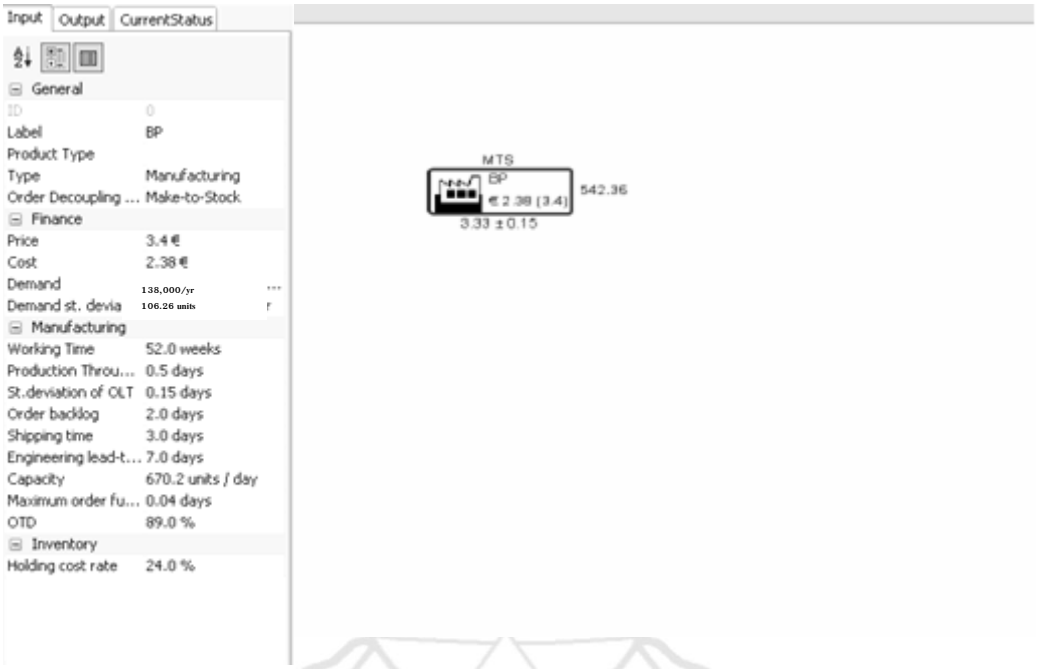
4.1 Introduction

The Thai construction material case study company is a medium-sized company. They have around 200 employees, 90 of whom work in the case study manufacturer, and they are one of three companies which produce Gypsum products. The Thai construction material case study company faced the situation of being out of stock out every month (referred to in chapter one). Although they have the orders, they can't fulfill their customer's orders. In this part will be analyzing the situation and examining alternatives to find an optimization to solve the Thai construction material case study company's problems.

4.2 Overview Thai Construction Material Case Study Company Traditional Way and New Way Using ASDN

Overview Thai construction material case study Company provided in figure 4.1, this figure shows both the Traditional way and ASDN way.

Traditional Way



ASDN way

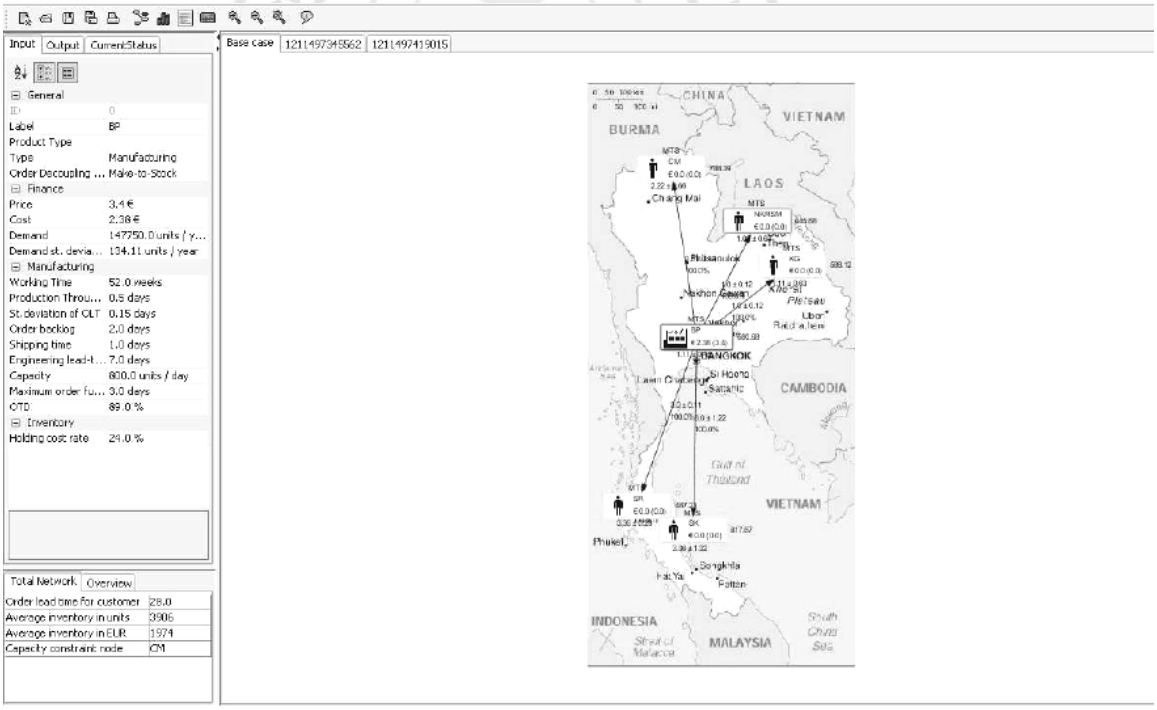


Figure 4.1 Thai construction material case study Overview

4.2.1 Input screen

Input screen First, I used the ASDN to overview the Thai construction material case study company. In the traditional way, the Thai construction material case study company forecast was based on historical data and the previous month's outgoing stock. On the other hand, ASDN uses an agile theory, which automatically combines the real demand from the customers. This result helps managers to make decisions. A comparative overview of the traditional way and the new way is shown in the table 4.1.

Table 4.1 Compare input data between Traditional way and ASDN way

Finanacial input Screen	**Traditional**	**New**
Price	3.4 Euro	3.4 Euro
Cost	2.38 Euro	2.38 Euro
Demand	138,600 units/yr	147,750 units/yr
Demand Standard Deviation	106.26 units/yr	134.11 units/yr
Manufacturer input screen		
Working time	52 weeks	52 weeks
Manufacturing stage time	0.5 days	0.5 days
Standard deviation of manufacturing stage time	0.15 days	0.15 days
Capacity	800 units/day	800 units/day
Maximum order fulfillment time	3 days	3 days
Service level (OTD)	89%	89%
Inventory Input		
Holding cost rate	24%	24%

The demand on the manufacturer increased from 138,600 units per year to 147,750 units per year. The difference is 9,150 units per year or around 6.20% above the expected demand, which is why Thai construction material company ran out of stock every month which ultimately led to a drop in sales.

4.2.2 Output screen

The ASDN analysis of the output screen based on the input data screen, referred to in Chapter 3 table 4.2, shows the result after entering the ASDN method input data.

Table 4.2 Output data

Order lead time for manufacturing unit	**4 day** (assume no lead time in supply side)
Average inventory in units	580.68 units
Average inventory in euros	1974.31 Euro
Cycle stock	290.34 units
Safety inbound stock	**0** (assume CSC didn't transfer to warehouse)
Safety outbound stock	75 units
Inventory turn rate	254.44 days
Inbound inventory value	1974.312 Euro
Outbound inventory calue	255 Euro
Capacity utilization	184%
Throughput Euro Days	2.04
Inventory Euro Days	1161.36

As table 4.2, this shows the manufacturing side when their forecasts were based on the historical data. ASDN produces the demand of the Thai construction material case study company in the previous year (2006) from data on the input screen. Thai construction material case study manufacturer spends 3 days lead-time in the production process and 3.11 days lead-time to deliver to the customer and the Case Study Manufacturer standard for 2006 is 89%. The lead-time to customer is calculated by Order backlog (day) + Internal lead time + ((100¬OTD)/100) x Internal lead time, which means order backlog (2 days) + internal lead time (1 day) + ((100¬OTD (89%))/100) x Internal lead time (1 day). Therefore, the lead time to customer is 3.11 days.

In inventory analysis, Thai construction material case study manufacturer had an average inventory of 580.68 units for BP product that is calculated by Total stock + Total Safety inbound stock + CS outbound + Safety outbound Stock. The amount of the average inventory is 1,974.31€. Thai construction material case study manufacturer has the inventory turn rate around of 254.44 days for BP product. The average inventory has a formula: (Total Cycle stock + Total Safety Inbound) x Cost + (CS outbound + Safety outbound stock) x Price and Inventory turn rate has format: Demand per year divided by average inventory in units. In outbound output, ASDN shows the customer outbound of Thai construction material case study manufacturer is 505.99

units. And the safety stock suggestion for this product to serve the domestic area around 74.69 units.

Another scenario is TOC (theory of constraint). This function screened the manufacture Case Study Company's performance. The Thai construction material case study company's capacity usage is 50.6%' a formula arrived at when demand is divided by capacity and multiplied by 100. ASDN calculates the amount of inventory that Thai construction material case study manufacturer is holding is 502,350€ per day. The Inventory Euro/Days is the value of inventory at hand multiplied by the time since the inventory entered the responsibility of the link.

4.3 Thai Construction Material Case Study Company Analyst Using ASDN

In the next step we will analyze and improve the Case Study Company by using the ASDN analysis tools. ASDN provides a variety of analysis tools that visualize in multiple dimension supply chains. The basic ones are demand, lead time and service level, network design that explain the case of Case Study Company as shown in figure 4.1.

ASDN offers internal and external measurement such as response time, cycle stock, inbound inventory and outbound inventory including the capital throughput in the network. All the data are in the input and output screens that show as above figures. ASDN allows the managers of Thai construction material company to easily take a snapshot of the supply demand network from any particular angle.

The first one is Lead-time Gantt graph as show in Figure 4.2. Lead-time Gantt shows the overview of lead-time that offers the manager of Thai construction material company a clear picture about how the supply chains affect the final customer order. Lead time Gantt show the effect of the bottleneck that impacts on the promise to customers.

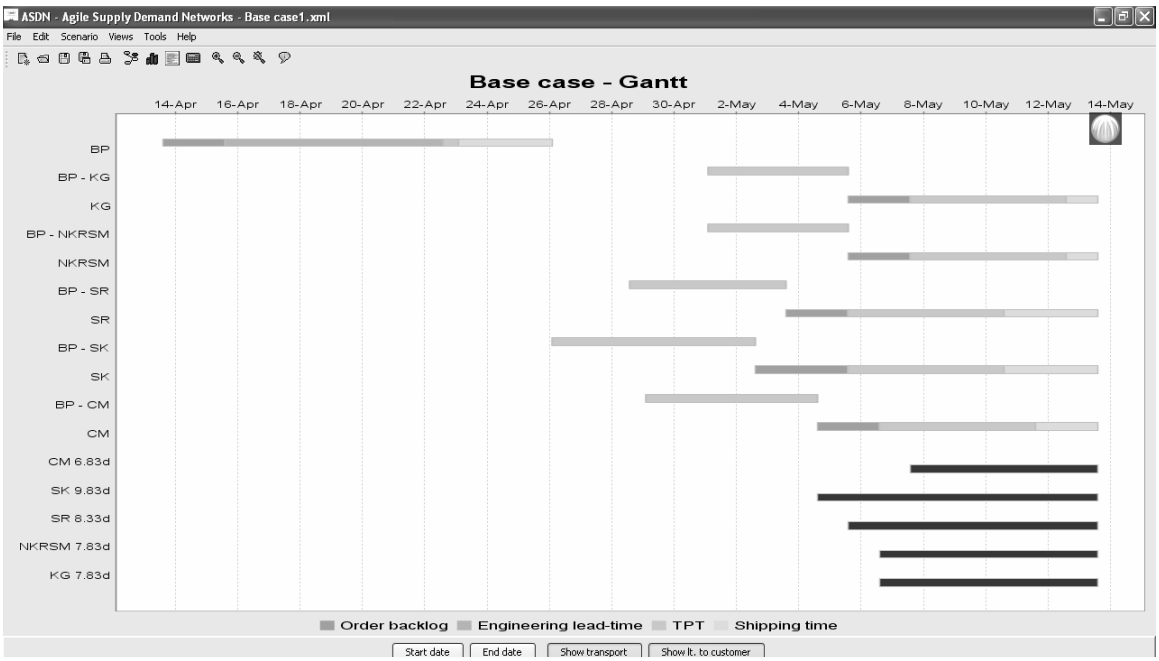


Figure 4.2 ASDN tool for analyst

From the Figure 4.2, the Thai construction material case study managers found that their manufacturing has the longest lead-time. Case Study Company used 12 days to produce product BP. The Thai construction material case study company has a lead-time delivery of 2¬3 days and they face back orders after delivering the product to its customers and took 2¬3 days to fulfill inventory rate. This means the Thai construction material case study company cannot supply the customer by the promised date. And after we divided the data into lead time analysis per activity show as table 4.3, we found out that the Thai construction material case study company wasted their time during the engineering lead time process. The engineering lead time includes planning and supplier delivery time. The Thai construction material company lacks the tools for planning; they use a manual for calculating the demand, calculating delivery lead time and planning as well.

Table 4.3 Lead time Analyst

Lead Time Analyst					
Start	Destnation	Order Backlog(Days)	Engineerng Lead time	Transportation time	LT to Customer
BP	KG	2	6	1	7.83
BP	NK	2	6	1	7.83
BP	SR	2	4	3	8.33
BP	SK	2.5	5	3	9.83
BP	CM	2	5	2	8.83

The second tool is the service chart as shown in Figure 4.3. The service level is the main point of current business, especially in this situation as companies try to maintain their service level and find a new path to increase their service level. The Thai construction material company also maintains their service level and tries to measure the service level performance.

Thai construction material case study company always pays high attention to their OTD (on time delivery) level, this is one of the key performances to measure customer satisfaction. Most companies overlook individual OTD and ignore the overall network OTD. Thai construction material company concentrated on the manufacturer OTD and neglected the OTD in customer area.

And Thai construction material case study company faced the longer customer delivery times. However, most of the Thai construction material company's customers can wait until the product is delivered to them and this distorts the data when the Thai construction material company used the service performance system. All data in the delivery is in the logistics function, kept in Excel files. The service chart shows the customer satisfaction of 5 major customers of Thai construction material company. The managers, especially in Sales and Marketing, will use this data to do their promotion and point out the worst case scenario and can explain why service level in their area has dropped.

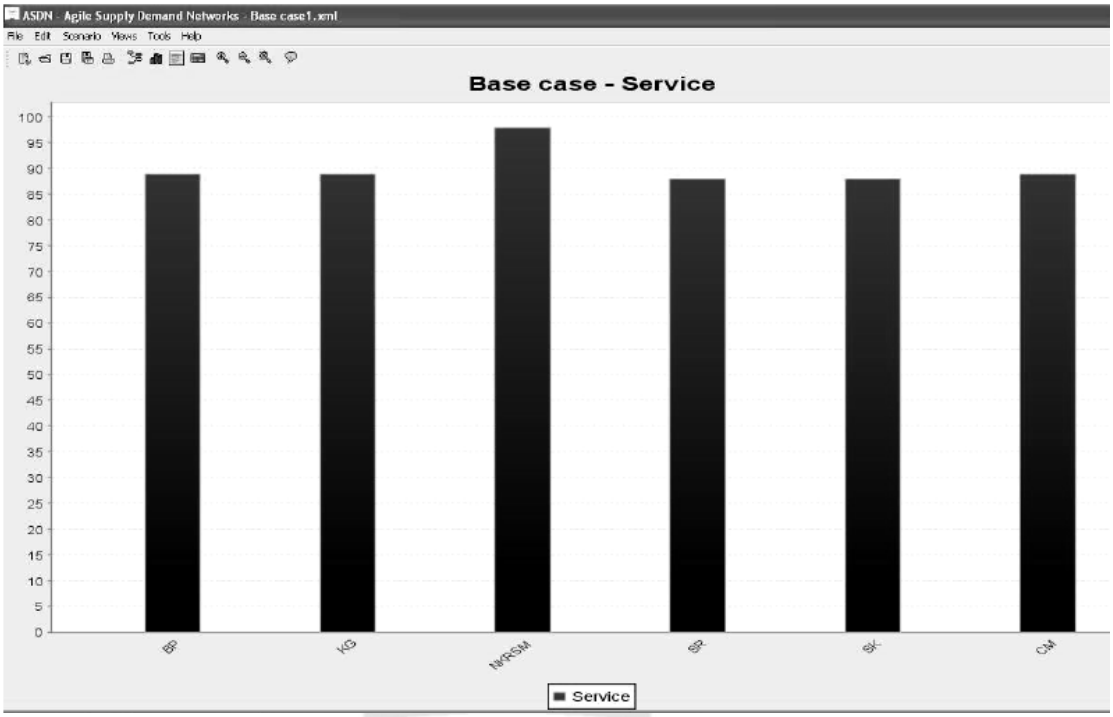


Figure 4.3 Service Chart

Third, the Thai construction material case study company managers always find themselves in a dilemma in inventory and service level transportation to balance the inventory and service level. The improvement of service level is always accompanied with an increase of the inventory level which in turn leads to higher cost. If the Thai construction material case study company wants to serve all its customers, the Thai construction material case study company should increase their inventory. Conversely the Thai construction material case study company has to bear the amount of inventory level and higher cost. It takes a lot time and effort for the Thai construction material case study company to find the balancing point that maintains a good service level without adding too much cost. ASDN provides an analytic tool to support this decision making process as shown in figure 4.4.

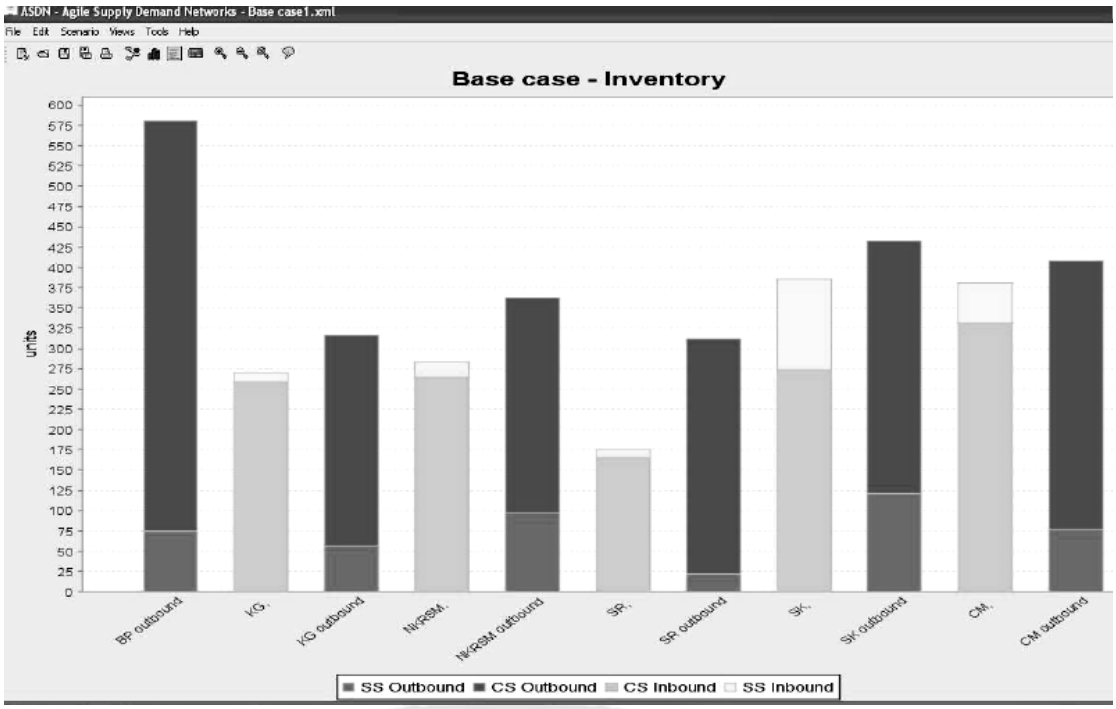


Figure 4.4 Inventory VS Service level Transport

And in the final part, the ASDN supports the Thai construction material case study company for improvement. ASDN offers the optimal value through a series of inbuilt mathematical models, which can be modified at anytime. Integrated inventory management can be achieved by the application of analytical inventory control and optimization method at every single stock-¬point. ASDN enables them to combine integration and flexibility.

ASDN has the option to find the goal seek function. The goal seek function will appear in the new scenario and be created by setting the objective of the inventory level, lead time and service level. The ASDN can assess the geographic area to provide an accurate delivery lead time. The Thai construction material case study company, for improvement, can use this function to find the solution that is suitable for making decisions and integrating all functions together.

In the financial improvement part, the first is the service level and the total inventory value shown as figure 4.6. If the Thai construction material company concentrates on cost, and uses the reduction cost policy, The company will meet the service level. The service level and the inventory value have a relationship.

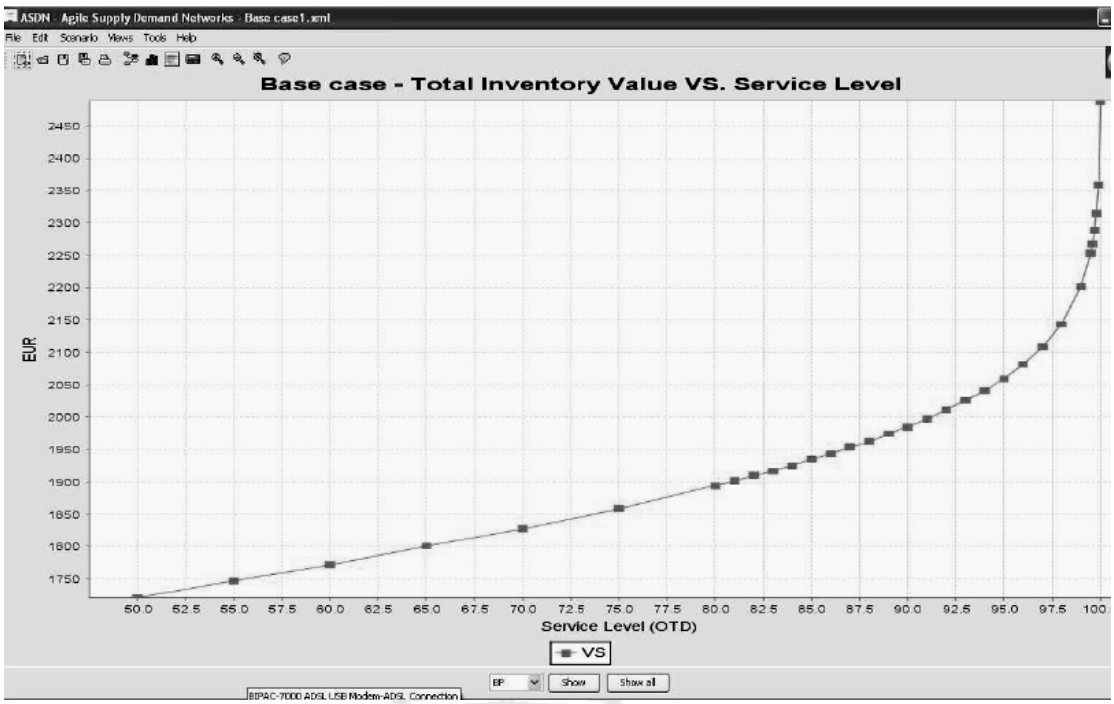


Figure 4.5 Total inventory value VS. Service level

This chart will aid the Thai construction material case study company manager reaching decisions on making improvement and what policy they will drive. If they want to retain their service level that means they should invest the same amount. To have a high service level means the Thai construction material company must hold more inventory. In this situation, real demand is the major player to set this inventory policy between; reduce costs and the service level will drop or maintain service level and invest in the same amount. Figure 4.6 shows the inventory value of the Thai construction material company and 5 major customers. Thai construction material company didn't know how much inventory value that customers held in their stock.

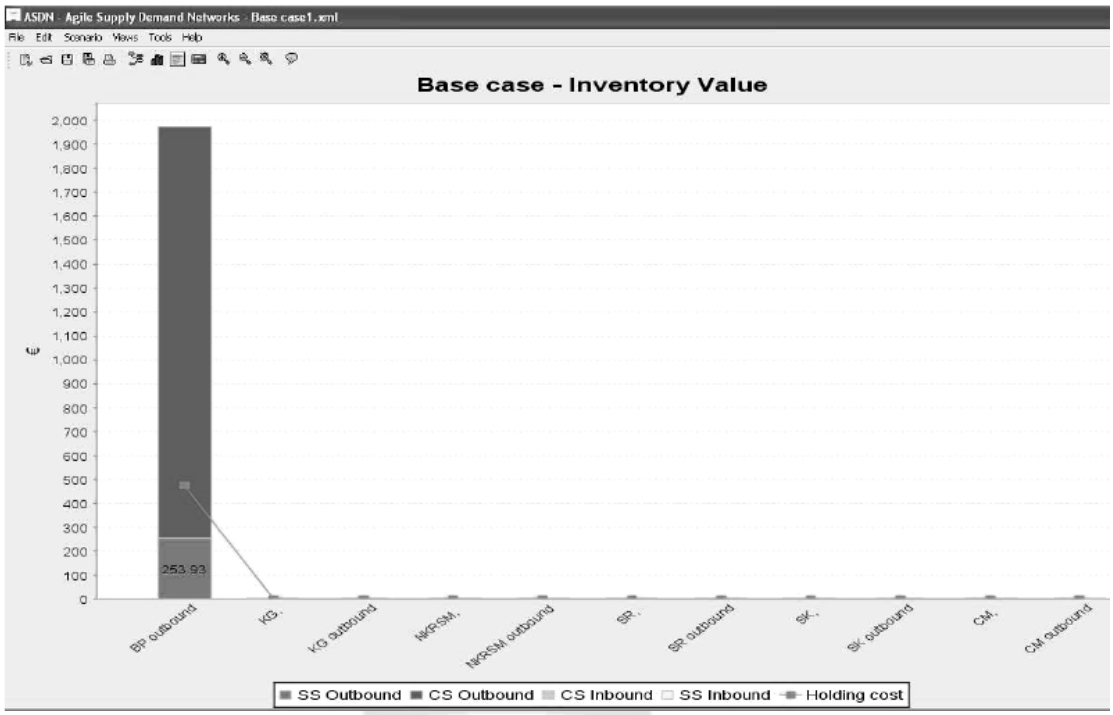


Figure 4.6 Inventory value

Thai construction material company can support their customers while they share the data between their customer and the Thai construction material company. The Thai construction material company may set the scenario to see the amount of the inventory value of each customer. In this case I assume the customer adds a value of 20% of the selling price show as figure 4.7

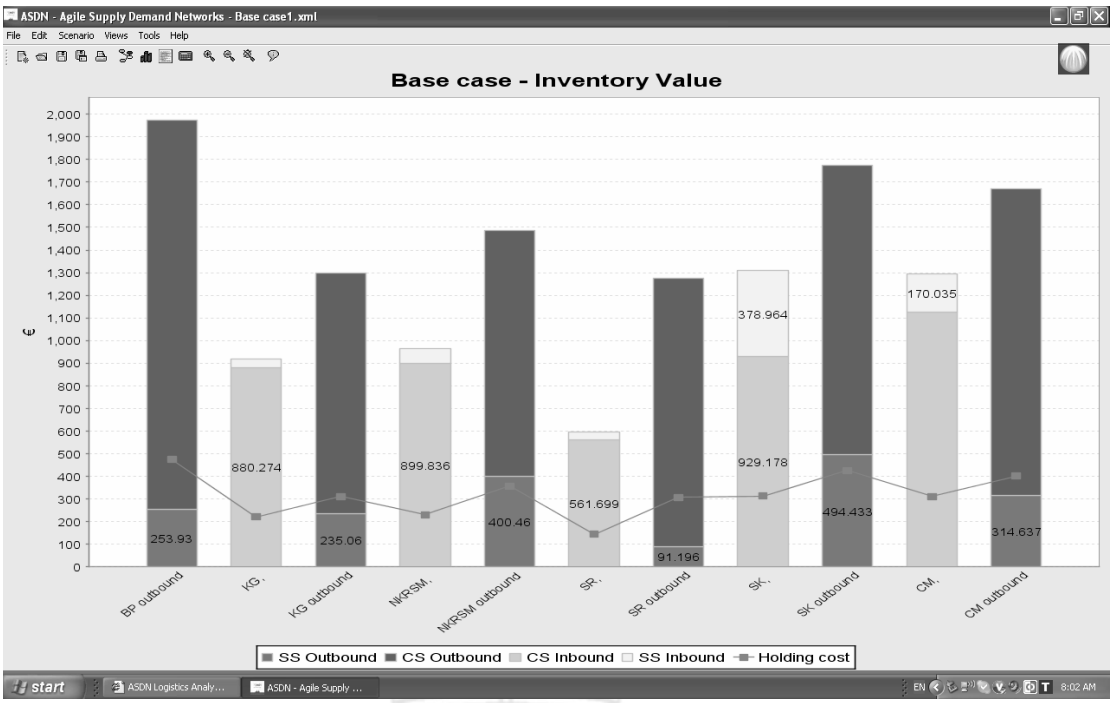


Figure 4.7 Inventory Value (20% selling price)

4.4 Analyst Root Cause

After ASDN analysis, the Thai construction material case study company can suggest the way to improve as topic 4.3. This part will analyze the main problem of Thai construction material case study company by using the fish bond diagram. In this research selected stock-out and order fulfillment as the main problems show as figure 4.8 and figure 4.9

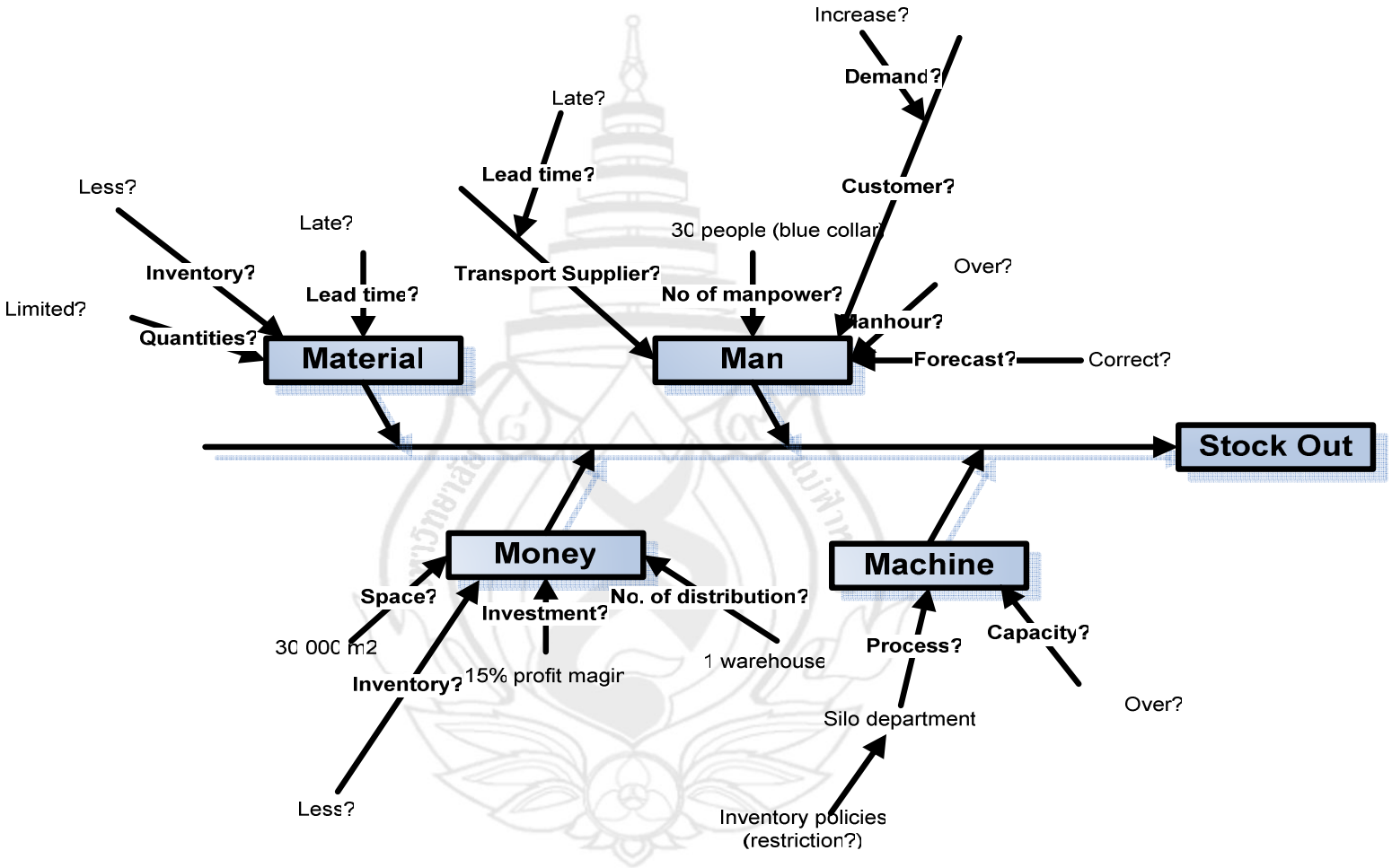


Figure 4.8 Stock out Root cause analysis

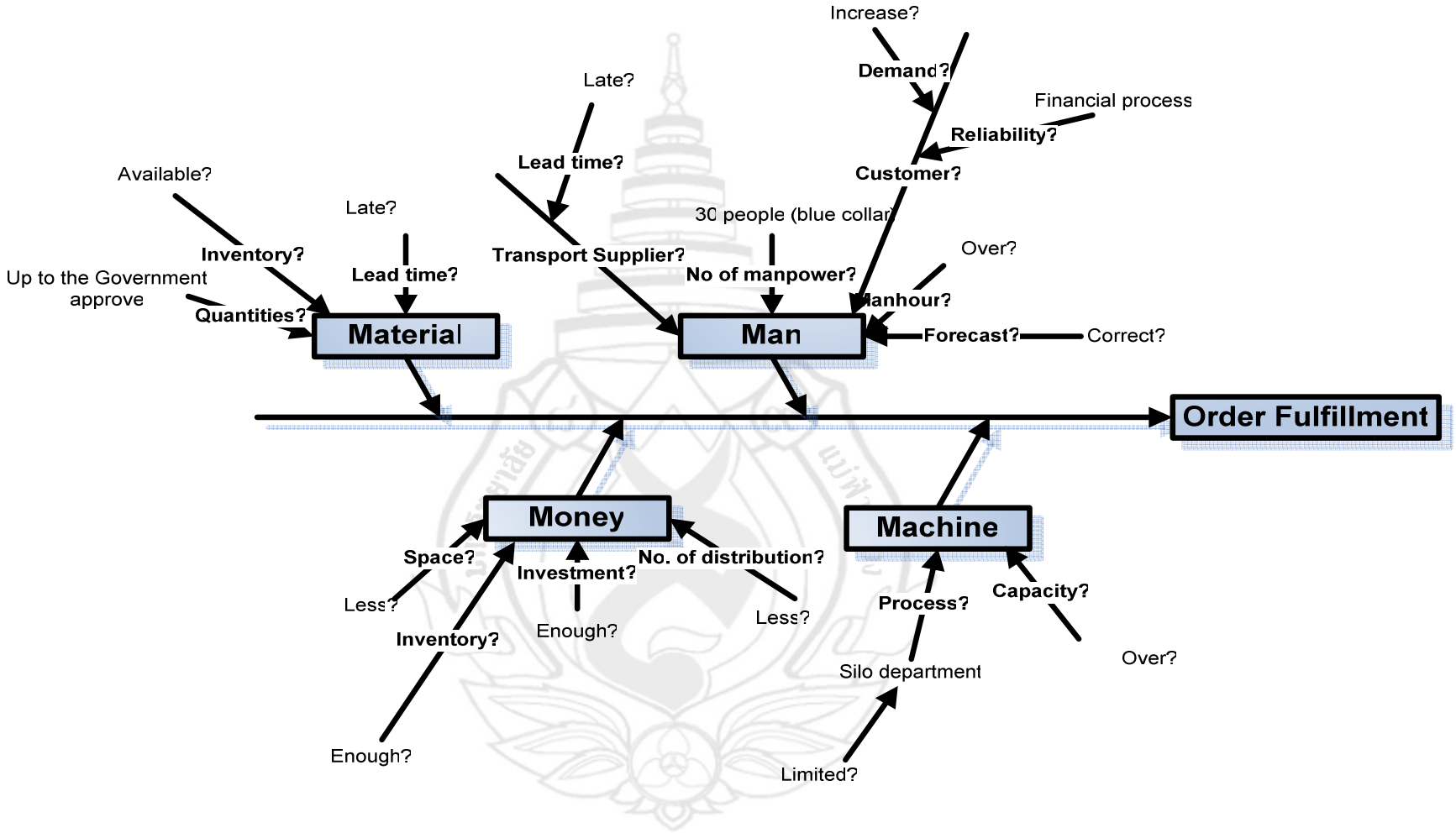


Figure 4.9 Order fulfillment root cause analysis

As figure 4.8 and figure 4.9, stock out and order fulfillment root cause analysis are divided into 4 Ms: Man, Machine, Money and Material. After analyzing the root cause by using the fish bond diagram I found out the main cause of these problems are transportation lead time to customer and inventory on-hand stock. And I select inventory and transportation lead time to be the alternative for Thai construction material case study company solution.

4.5 Alternative Solution Testing

The alternative solution test by using ASDN (Agile Supply Demand Network) and finding out which alternative is the optimum solution for Thai construction material case study company problem resolution.

4.5.1 Decrease Lead Time

The figure 4.2 and table 4.4 analyze the lead time of Thai construction material case study company supply chain. In its suggestion, ASDN provides the specific EOQ tool for reducing lead-time shown in figure 4.10.

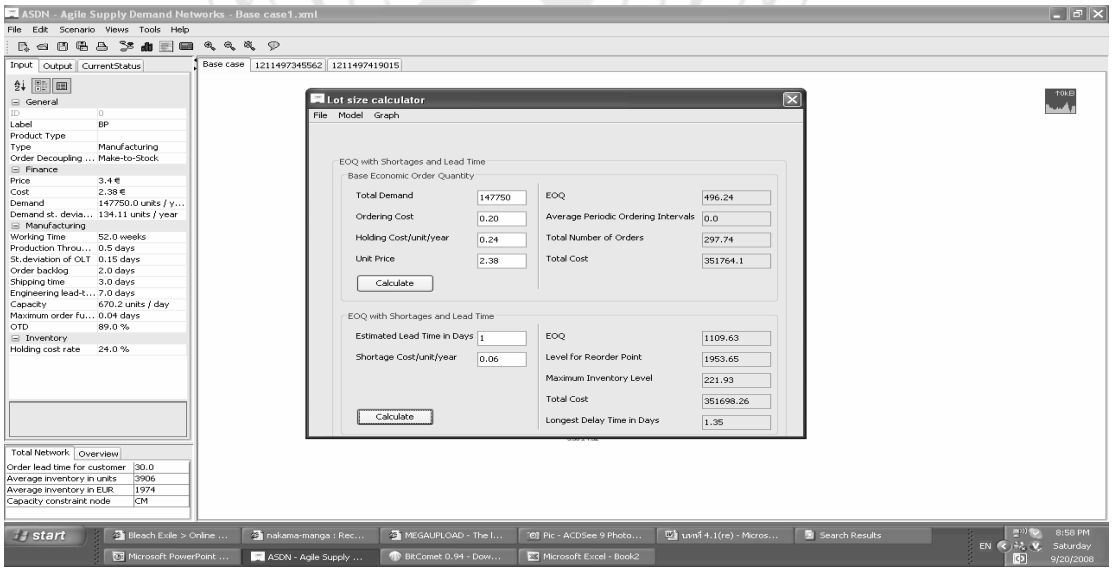


Figure 4.10 EOQ with shortage and lead time

As the result, the engineering lead time is reduced from 4¬6 days to 2¬5 days. They reduce the material planning and production planning that affects the reduction order backlog lead time as well. If the case study company reduces their lead time and manages the time gap in manufacturing process, the stock out events may decrease.

4.5.2 Increase inventory

Increase inventory is the best way to solve the problem of running out of stock, but the question is how much inventory should be stock? The inventory that affects investment and service level is shown in figure 4.11 and 4.12. And table 4.4 shows the comparison inventory value VS service level in Traditional way and ASDN way

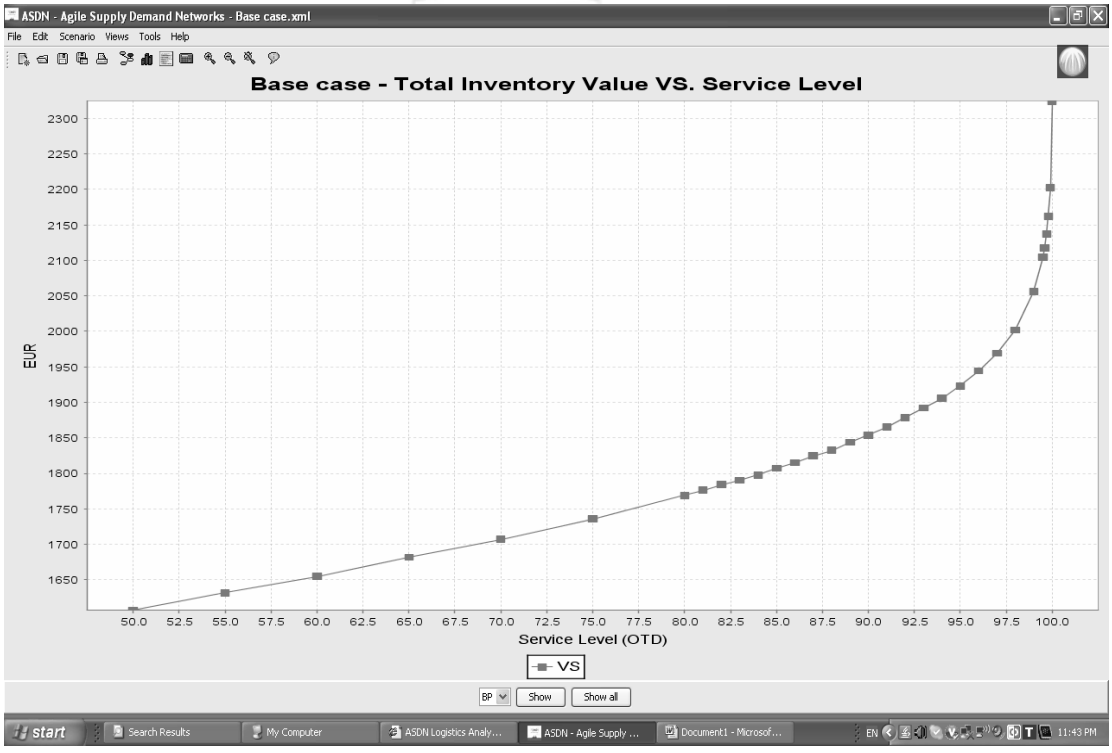


Figure 4.11 Total inventory Value VS Service Level (Traditional Way)

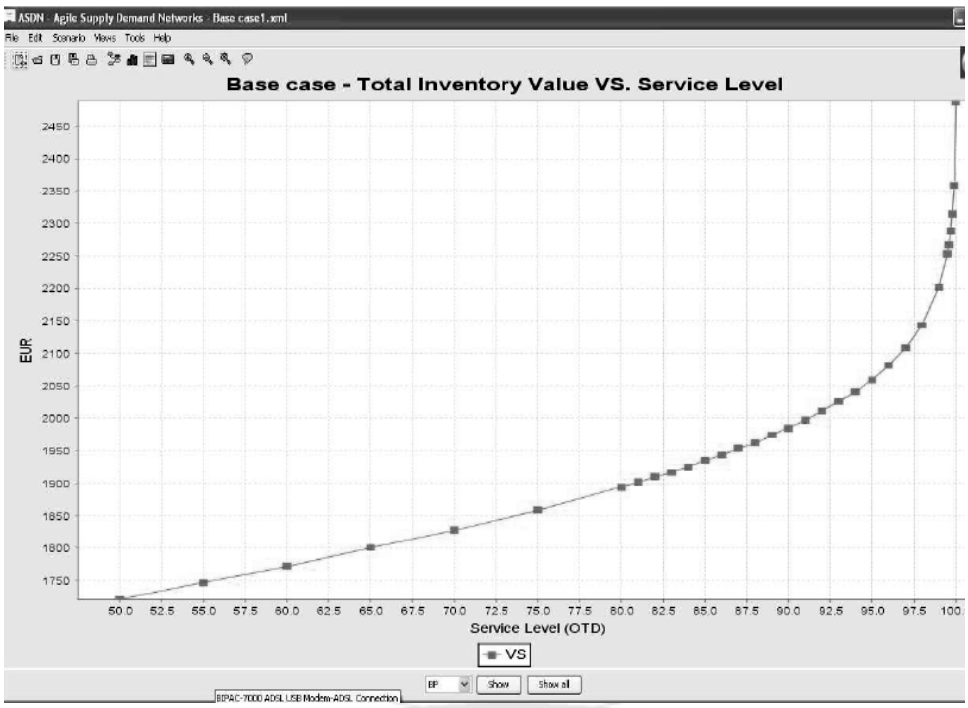


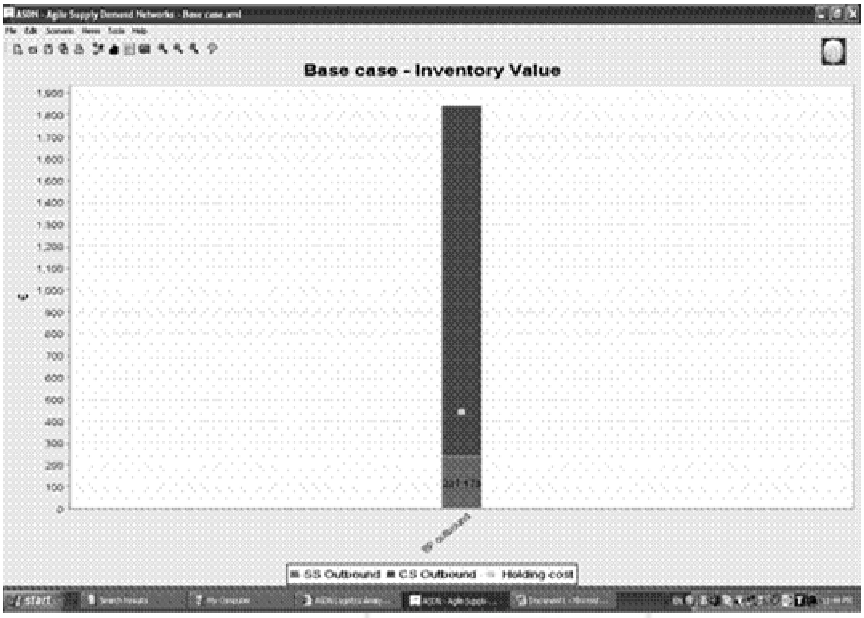
Figure 4.12 Total inventory Value VS Service level (ASDN Way)

Table 4.4 Compare inventory value VS service level in Traditional way and ASDN way

Service level	85%	90%	92%	95%	97%	98%	99%
Traditional way	1,800	1,850	1,870	1,930	1,990	2,050	2,100
ASDN way	1,940	1,990	2,000	2,050	2,100	2,150	2,250

Thai construction material case study company safety stock part; after comparison between Traditional way and ASDN way there is a difference of around 7% shown as figure 4.13. The safety stock analysis of traditional and ASDN way is shown in table 4.3 the output data.

Traditional way



ASDN way

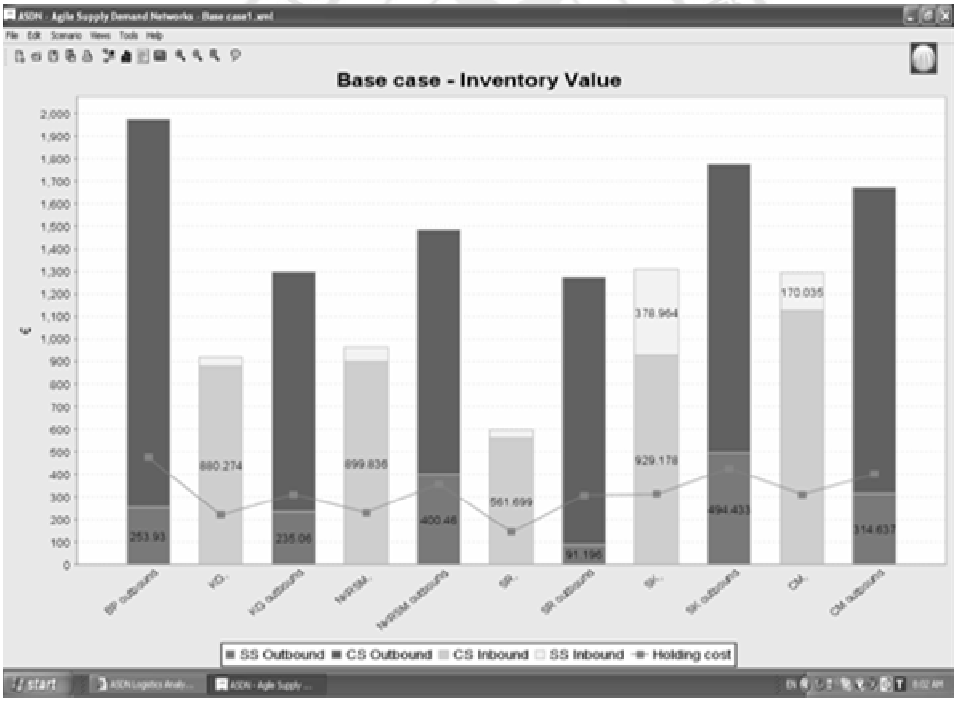


Figure 4.13 Safety stock

Thai construction material case study will make the decision of how much inventory should they keep in stock to retain their service level and reduce the out-of-stock dilemma.

4.5.3 Alternative combine

The increase in lead time reduction and inventory is an advantage itself. Now I combine the advantage point of the first and second alternatives to be the third alternative. And I use the ASDN tool to determine the optimization solution. ASDN provides optimization tools that support increase or decrease inventory by reducing the lead time as shown in figure 4.14.

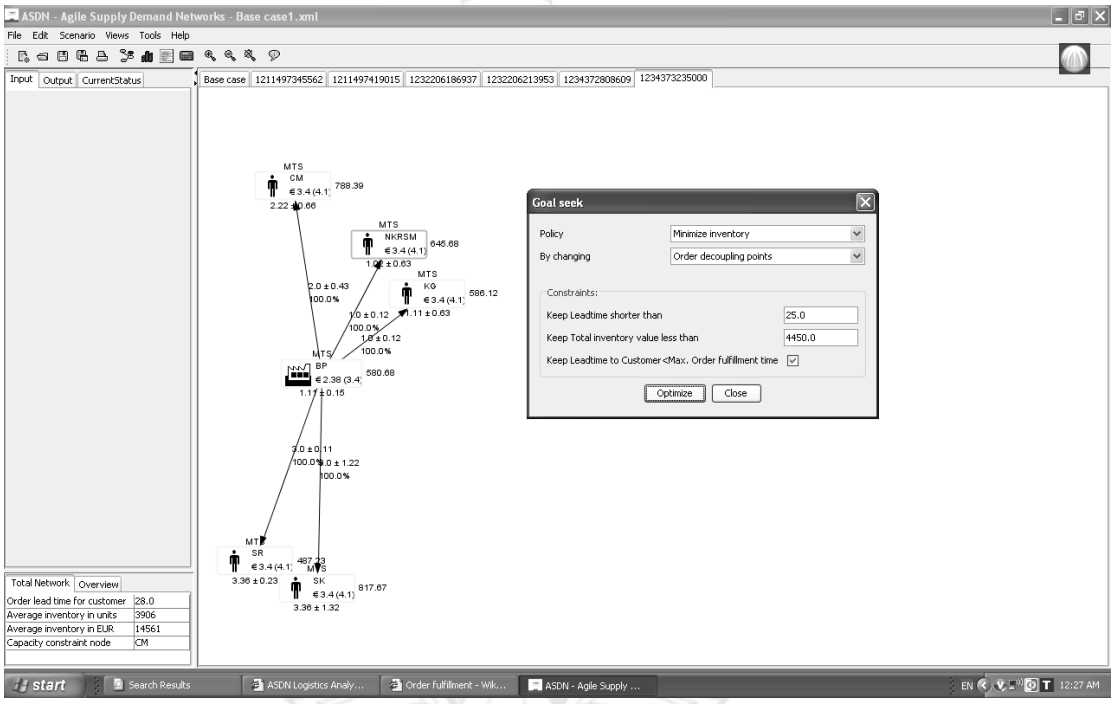


Figure 4.14 Goal seek: Increase inventory and reduce lead time

The increased inventory and reduced lead time are short term solution methods for the Thai construction material case study company. In the increased inventory alternative, they face a restriction in storage. Referring to the output data, ASDN suggest the level of safety stock and inventory on hand but they face the problem of over capacity. It shows Thai construction material case study company at around 184%. If they increase their inventory, they don't have enough space to keep their stock. And with the lead time reduction alternative, Thai construction

material case study company found they couldn't reduce the supply side lead time for material transportation. Otherwise Thai construction material case study company can only reduce the lead time to their customer. If we reduce the transportation lead time, we can reduce the order back log. Referring to the data from 2006, the demand of Southern dealers had a greater increase than 2005 by around 15% but the lead time send to Southern dealers took 3 days. And the lead time affected their service level. The decreased lead time will support an increase in the order fulfillment. With the problem of limited space and lead time delivery to customer, expanding the new warehouse is the better alternative

4.5.4 Expand new warehouse alternative

Referring to the data from 2005, the Northern (combined three dealers) demands increased around 10% in 2006. And The Southern demand increase estimate was 15% in 2006 as well but they have a trend to increase referring to data in the first quarter in 2007. The Southern demands increased to 25%. And the transportation lead time from the Thai construction material case study company took around 3 days. All these are the reasons that I choose to place the new warehouse in the Southern area as shown in figure 4.15

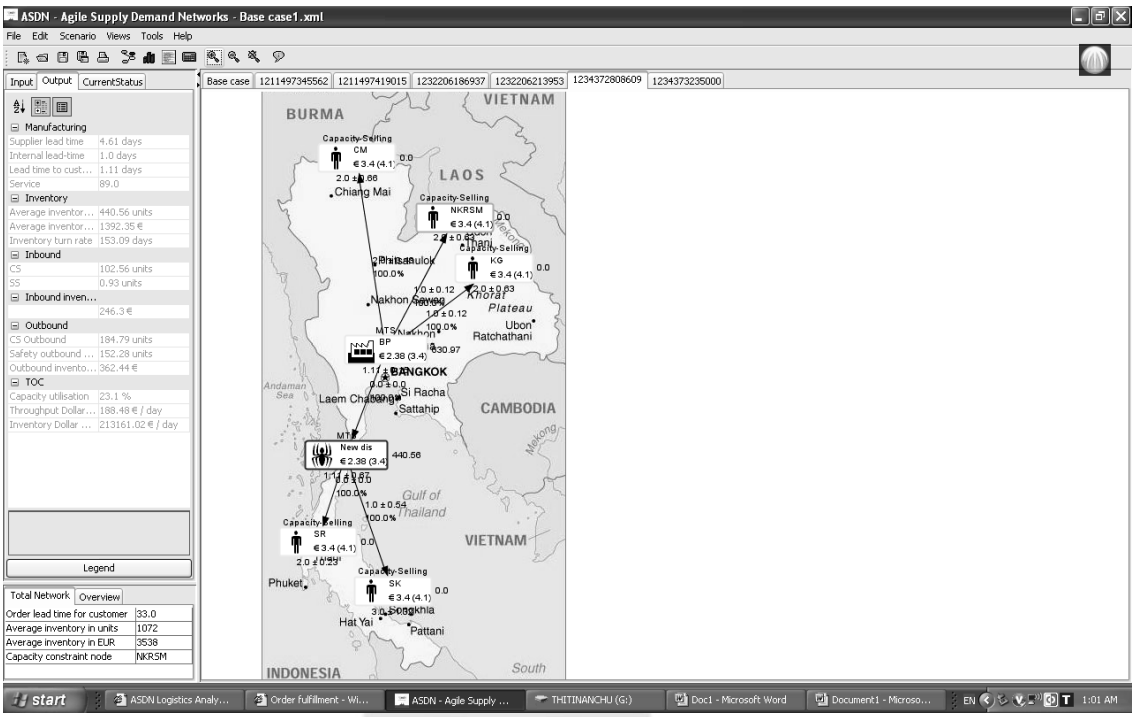


Figure 4.15 Expand new Warehouse

The expanding the new warehouse alternative solution will cause an increase in holding cost and inventory value, but they have the opportunity cost that is hidden in this warehouse. The Thai construction material case study company can deliver their stock to their customers on time and the right quantity. The Thai construction material case study company had the demand but they didn't have the inventory to supply and that caused them to run out of stock and eventually face losing their customers.

4.6 Alternative Comparing

After testing all alternative solutions, ASDN provides a table to compare alternative testing as shown in table 4.5 referred to as figure 4.16. This comparison screen is based on 4 indicators; Lead time to customer, Cycle time, Inventory turn and inventory holding cost.

Table 4.5 Alternative comparing

Alternative	Increase inventory	Decrease lead time	Increase Inventory and Reduce lead time	Expand new warehouse
Lead time to customer	8.53	6.31	6.31	5.61
Cycle time	28	28	28	33
Inventory turn (Turns/years)	37.83	37.83	37.83	149.83
Inventory Holding cost	3494.61	473.83	3494.61	3953.36

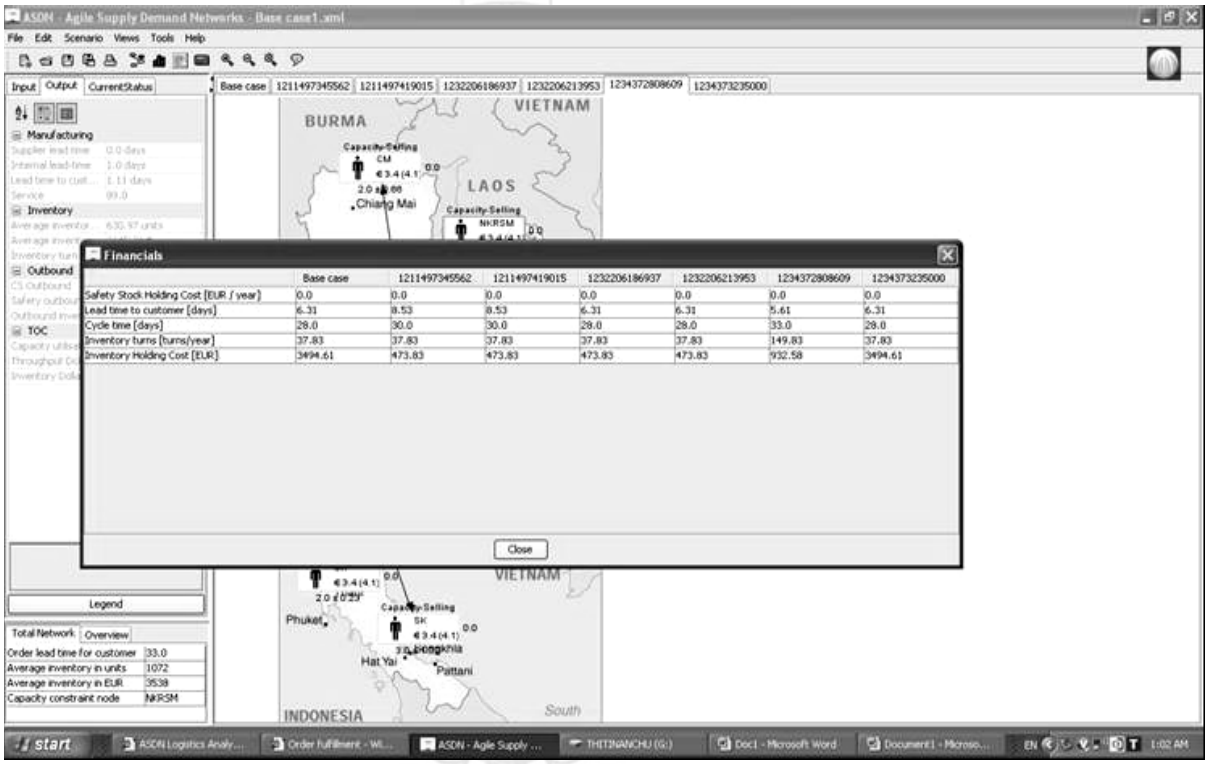


Figure 4.16 ASDN comparing

The First alternative, the increased inventory alternative took 8.53 day for customer lead time. As for the cycle time, the cycle time is the time it takes for a business to receive, fulfill and deliver an order to customer. This process is measured in days. The increased inventory cycle time is 28 days. Inventory turn is the number of times inventory is replenished in a year, generally calculated by divided the average inventory level (or current inventory level) into the annual

inventory usage (annual cost of goods sold) around 37.83 turns. And the inventory holding cost is 3494.61 Euro.

The Second alternative, the reduced lead time alternative solution, this alternative can reduce lead time to customer from 8.53 to 6.31 days. And it has the same cycle time as the first alternative. The inventory turns same as first alternative as well. But the inventory holding cost in reduce lead time was less than the other alternatives at around 473.83 Euro.

The Third alternative combines both increased inventories and reduced lead time. It takes 6.31 days for the lead time to customers and 28 days for cycle times. Inventory turn around is 37.83 turns per years and inventory holding cost is 3494.61 Euro.

The last alternative the lead time to customers is less than the other three alternatives. It takes 5.61 days. But its cycle time is more than the other alternatives at 33 days because of increasing demand. (see in appendix and in table 4.6) The last alternative has an inventory turn over higher than the three alternatives as well. It has 149.83 turns per year. And the inventory holding cost is 3953.36 Euro.

Table 4.6 Compare between Input new warehouse expanding alternative and Combine alternative

Finanacial input Screen	**Combine**	**Expand**
Price	3.4 Euro	3.4 Euro
Cost	2.38 Euro	2.38 Euro
Demand	147,750 units/yr	160,547 units/yr
Demand Standard Deviation	134.11 units/yr	145.75 units/yr
Manufacturer input screen		
Working time	52 weeks	52 weeks
Manufacturing stage time	0.5 days	0.5 days
Standard deviation of manufacturing stage time	0.15 days	0.15 days
Capacity	800 units/day	800 units/day
Maximum order fulfillment time	3 days	3 days
Service level (OTD)	89%	89%

4.7 Summarize

The Thai construction material case study company can see the root cause of their supply chain problem. ASDN has facilitated the Thai construction material case study company to quickly build the supply chain demand network to analyze the root cause. The number of out-of-stock items will be reduced and finally the loss of sales will disappear.

ASDN enables the Thai construction material case study company to see the bigger picture of their supply chain side and demand side to improve their performance and resource planning of their inventory. At its best, the ASDN type of software can enable inventory management and control through detailed review, scheduling of replenishment time in each node, and assigning customer orders to the best point of supply based on lead time and availability. The combination of advanced computational OR techniques with a friendly graphical user interface proves to be adequate for management and optimization. The intangible profit of ASDN is increasing the collaboration of the sales and marketing department, the manufacturer and the logistics department.

Through alternative improvement, ASDN will generate the events and result of each choice. The manager can use the data to analyze the risk and benefit of each alternative to find the optimal solution.

CHAPTER 5

CONCLUSION

Many Thai companies try to find a new solution to remain globally competitive. The company must change to be agile and responsive to cover the real fluctuation demand. Additionally, the concoction of information technology into every aspect of operations is transforming the business environment from a production-centric model to one that is information and customer centric. This paper has presented a case study and used the framework for the design of ASDN that can be used to model, analyze and optimize the dispersed networks.

In alternative improvement, ASDN will generate the events and result of each choice. The manager can use the data to analyze the risk and benefit of each alternative to find the optimal solution. The first alternative; a decreased lead time will make the case study company supply chain better, after ASDN analysis, the manager can see what happens during their lead time. The engineering process takes the most time from the first step until the last step. If the case study company can reduce the engineering lead time their supply chain will be better than usual. The case study company will find that, once they have reduced their lead time in processing, the backlog order will also be reduce. In this situation, the case study company spent less time but retained the same production, so, the date of back orders and lost orders will decrease.

The first alternative, reducing the lead time alternative solution, can reduce the lead time taken to supply the customer from 8.53 to 6.31 days. And it has the same cycle time as the first alternative. The inventory turns over the same with first alternative as well. But Inventory holding cost in reduced lead time paid less than the other alternative by around 473.83 Euro.

The second alternative, the inventory increasing alternative is a short term solution. ASDN recommends how much inventory should be held stock to serve their customers. ASDN can present the inventory cost and service level that the case study company wishes to attain.

The second alternative, increased inventory alternative took 8.53 days for the customer lead time. The cycle time was 28 days and the inventory turn around was 37.83 turns with the inventory holding cost at 3494.61 Euro.

The third alternative was to increase inventory and reduce lead time in Thai construction material case study company. This alternative can provide the answer that the case study company wishes to increase their service level. And this alternative can answer where and how the case study company should concentrate on more. This solution can reduce lead time to the customer and can serve customer demand.

And the final alternative is expanding warehouse volume. Expanding the new warehouse alternative solution will lead to an increase of holding cost, and inventory value but they have the opportunity cost that is hidden in this warehouse. The Thai construction material case study company can serve their stock to customer on time and supply the right quantity. The Thai construction material case study company has the demand but they don't have the inventory to serve. This results in no stock on-hand and finally they lose their customer. Those warehouses will hold emergency stock when the main manufacturing runs out of stock and can serve the closest customers in one day. In the final alternative, customer lead time is increased more than the other alternatives but they have a higher cycle time than the other alternatives.

All alternatives have advantages and disadvantages as well. In my opinion, expanding the new warehouse is the optimum solution to solve the stock level issue and order fulfillment. This alternative combines the first, second and third alternatives. Not only does it increase inventory for out-of-stock problems but also reduces the transportation lead time for customer order fulfillment. On the other hand, the expanding warehouse alternative increases holding cost and cycle time. In cycle time process, it increases from 28 days to 33 days because the Thai construction material case study company received orders from customers and the new warehouse. The process time will increase. Otherwise the inventory turn is increased from 37.83 to 149.83. The inventory turn increases because the replenishment figure increases due to the new warehouse ordering.

The four alternatives should be arranged by what is the most important and can solve the problems easiest. The case study company should improve their lead time by studying the main problem and listing the detail of their work. This will help the case study company know

which part is the problem that consumes more time than necessary. And then they should invest the inventory level for serving customer demand. After that the case study company will expand their facilities nearer to their customers. Finally, the case study company will maintain their ability and control inventory level in all of their warehouses.

This is the first step to improve the Thai construction material case study company. ASDN provides the variety of tools in performance measures; such as cost, inventory, value-¬added, lead time and throughput in the network and they are analyzed and optimized through a set of embedded analytical models. The structured and detailed analysis of the different supply chain scenarios, provides a clear and comprehensive holistic view for the supply chain designer. Computing may help when collecting information and suggesting new scenarios, but still the most important factor is the strategic decisions taken by the manager.

ASDN provides many advantages but ASDN also has disadvantages such as; firstly, ASDN can't open multiple windows for analysis at one time. Secondly, ASDN can't show the difference between the previous and the next one by itself. The user should save or copy each page before using the ASDN tool. Thirdly, ASDN does not have the ability to show the best solution by itself, it only suggests and provides the tool for analysis. Fourthly, ASDN can't furnish the final solution. It only supports your decision making. And lastly, ASDN is not a simulation; it can't show the moving flow process.

Now, The ASDN software presents an open source approach for logistics analysis and much of its development is based on the community. The future ASDN may be developed into consulting-oriented software in the next few years, and we will see the result after the Case Study Company uses the ASDN to analyze their supply chains. Not only should the Case Study Company use ASDN to analyze and improve their supply chains network but also small and medium companies should use the ASDN analysis and set the simulation for improving their supply chains.

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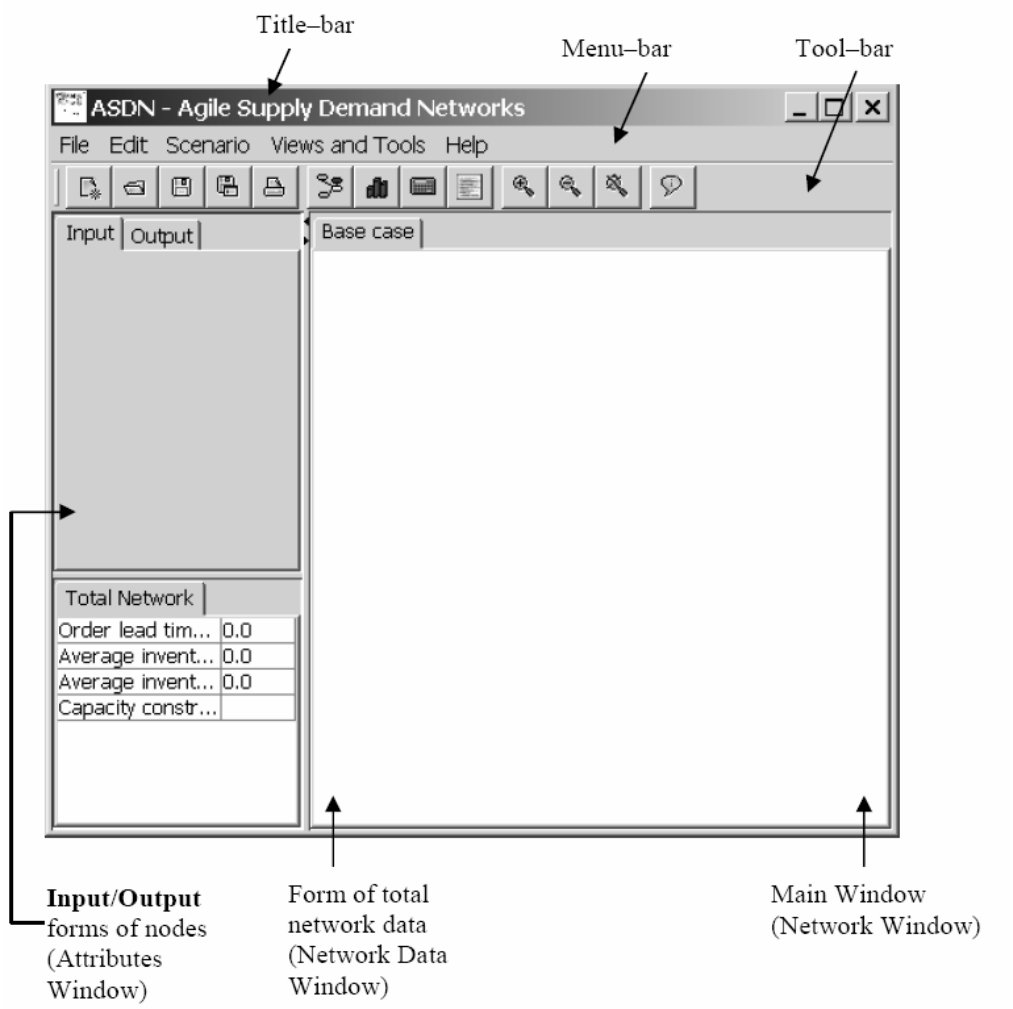
APPENDIX A

ASDN MANUAL

Starting use ASDN Analyze the Thai construction material company supply chain

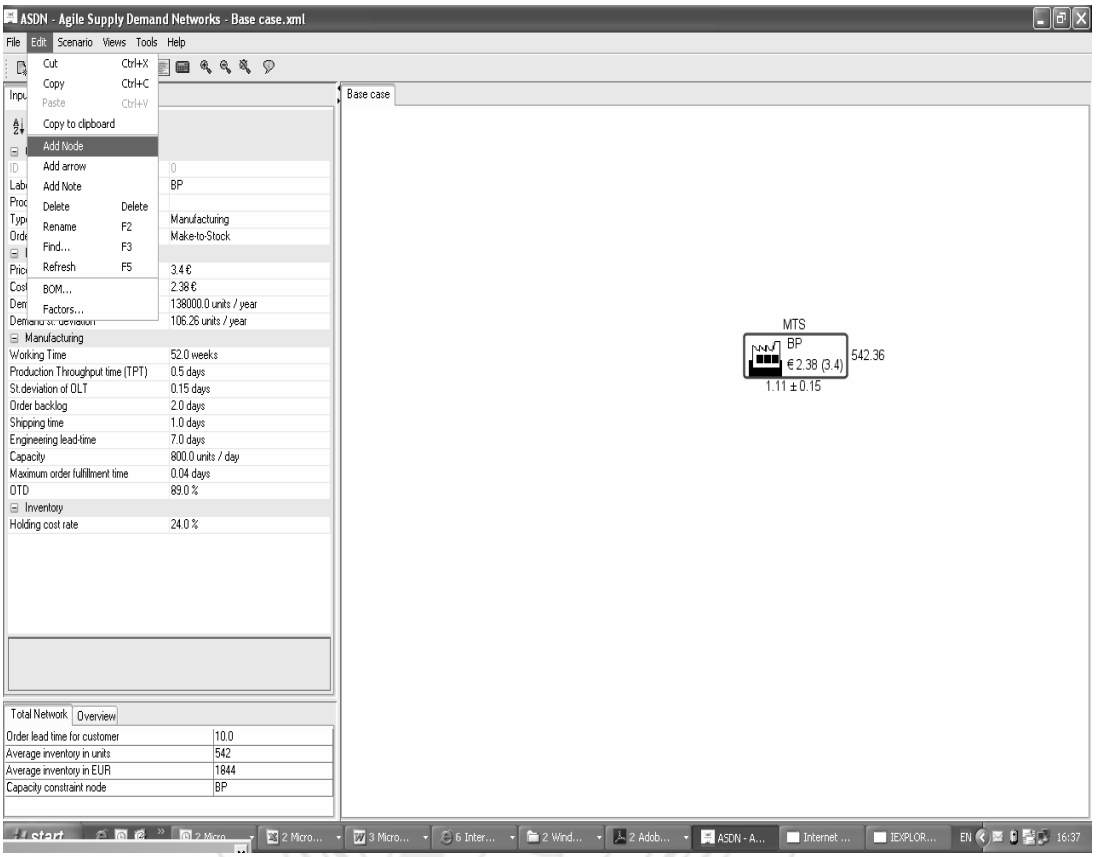
Start download ASDN program at http://sourceforge.net/projects/asdn. And this manual uses the expanding new warehouse alternative as the example.

ASDN menu page



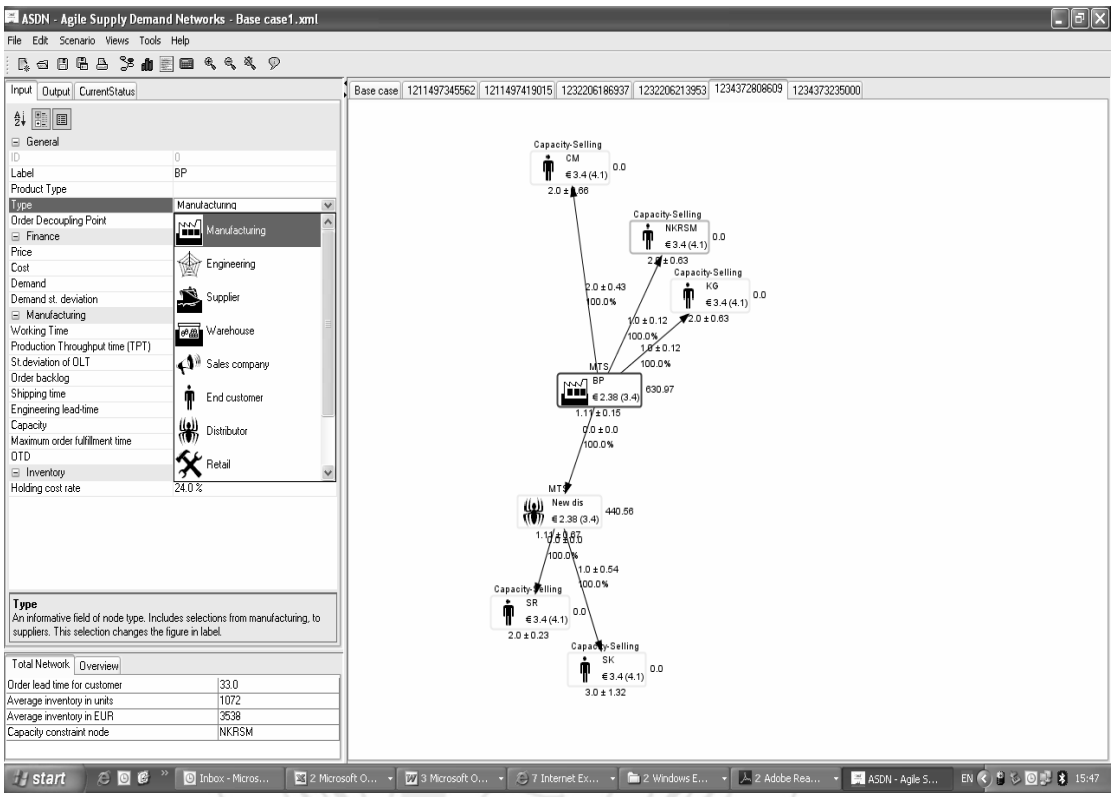
Adding Node

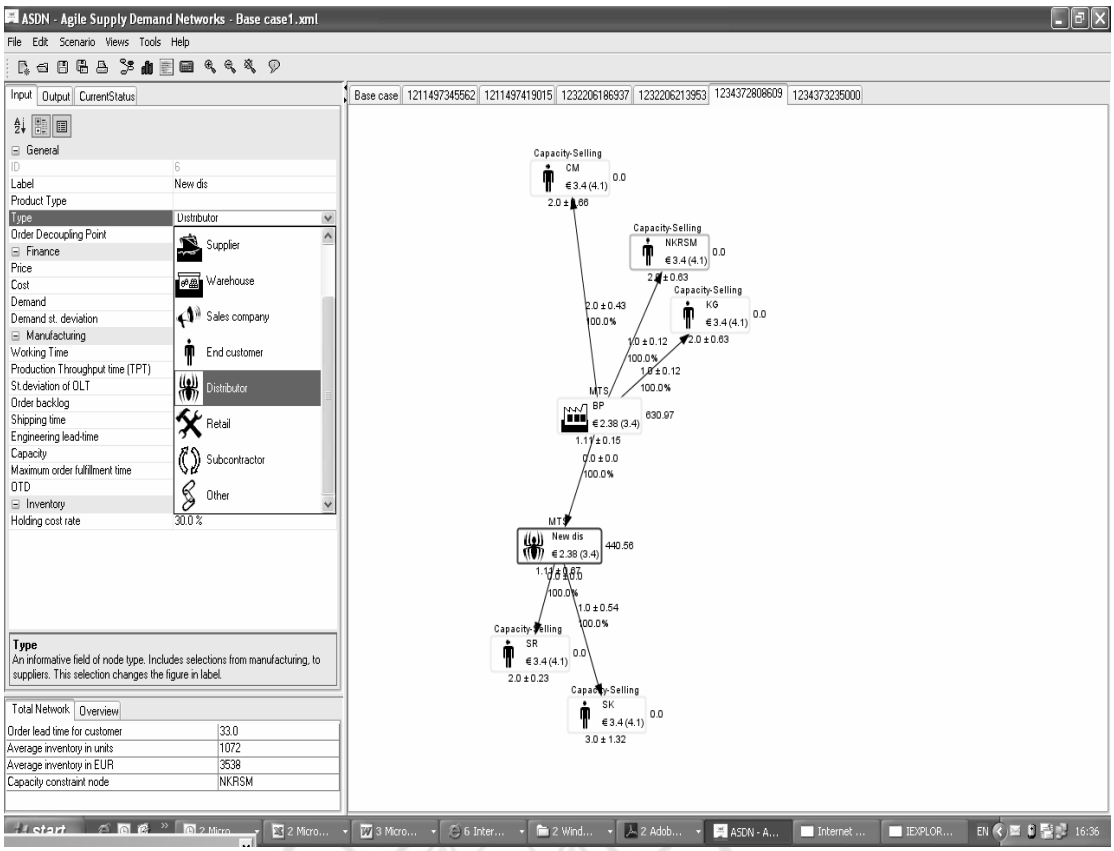
Click the Edit menu and select the Add node.



Add Label/Type

Click in Label for insert name> then click the Type dropdown lists and select the list that you need. Manufacturer is manufacturing. Dealer is customer.

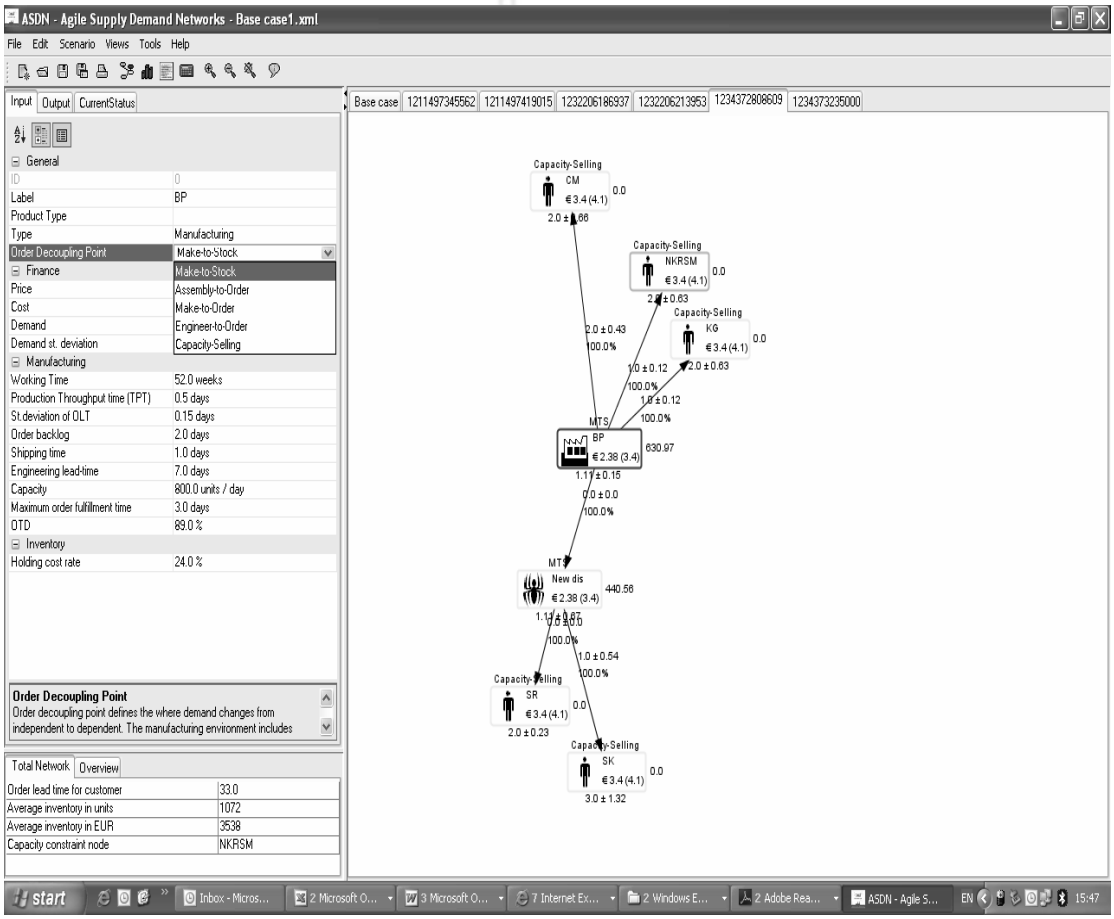



ASDN - Agile Supply Demand Networks - Base case1.xml
File Edit Scenario Views Tools Help
Input Output CurrentStatus
General
ID 6
Label New dis
Product Type
Type Distributor
Order Decoupling Point
Finance
Price
Cost
Demand
Demand st. deviation
Manufacturing
Working Time
Production Throughput time (TPT)
St.deviation of OLT
Order backlog
Shipping time
Engineering lead-time
Capacity
Maximum order fulfillment time
OTD
Inventory
Holding cost rate 30.0 %
Supplier
Warehouse
Sales company
End customer
Distributor
Retail
Subcontractor
Other
Type
An informative field of node type. Includes selections from manufacturing, to suppliers. This selection changes the figure in label.
Total Network Overview
Order lead time for customer 33.0
Average inventory in units 1072
Average inventory in EUR 3538
Capacity constraint node NKRSM
Base case 1211497345562 1211497419015 1232206186937 1232206213953 1234372808609 1234373235000
Capacity-Selling
CM
€ 3.4 (4.1)
0.0
2.0 ± 0.86
NKRSM
2.0 ± 0.63
KG
2.0 ± 0.43
100.0%
1.0 ± 0.12
MTS
BP
€ 2.38 (3.4)
630.97
1.1 ± 0.15
0.0 ± 0.0
New dis
440.56
1.1 ± 0.67
1.0 ± 0.54
SR
2.0 ± 0.23
SK
3.0 ± 1.32
start
2 Micro...
3 Micro...
6 Inter...
2 Wind...
2 Adob...
ASDN - A...
Internet ...
IEXPLOR...
EN
16:36

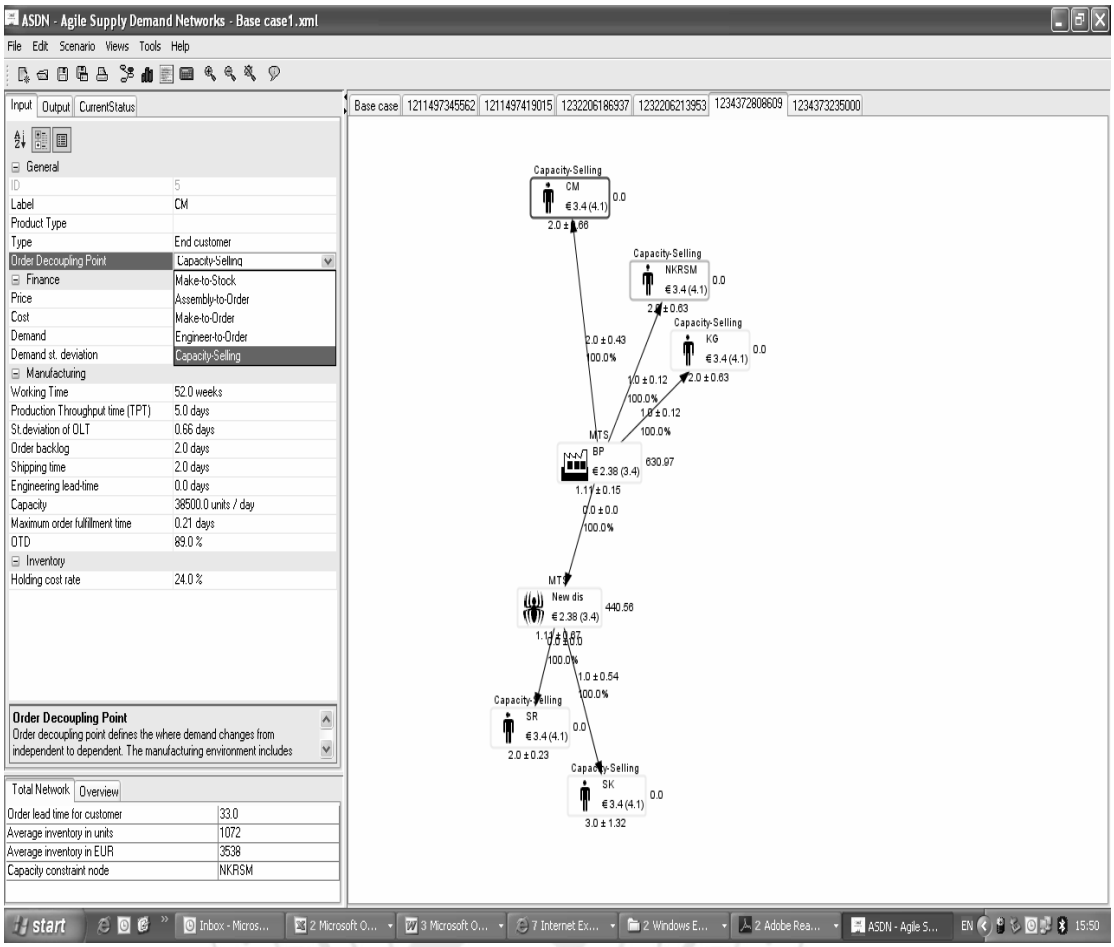
Select Order Decoupling Order

Click the Order Decoupling Order dropdown list and select the decoupling. For this case Manufacturing chooses Made-To-Stock. And Dealer selects Capacity to sell.

Make to stock



Capacity to sell

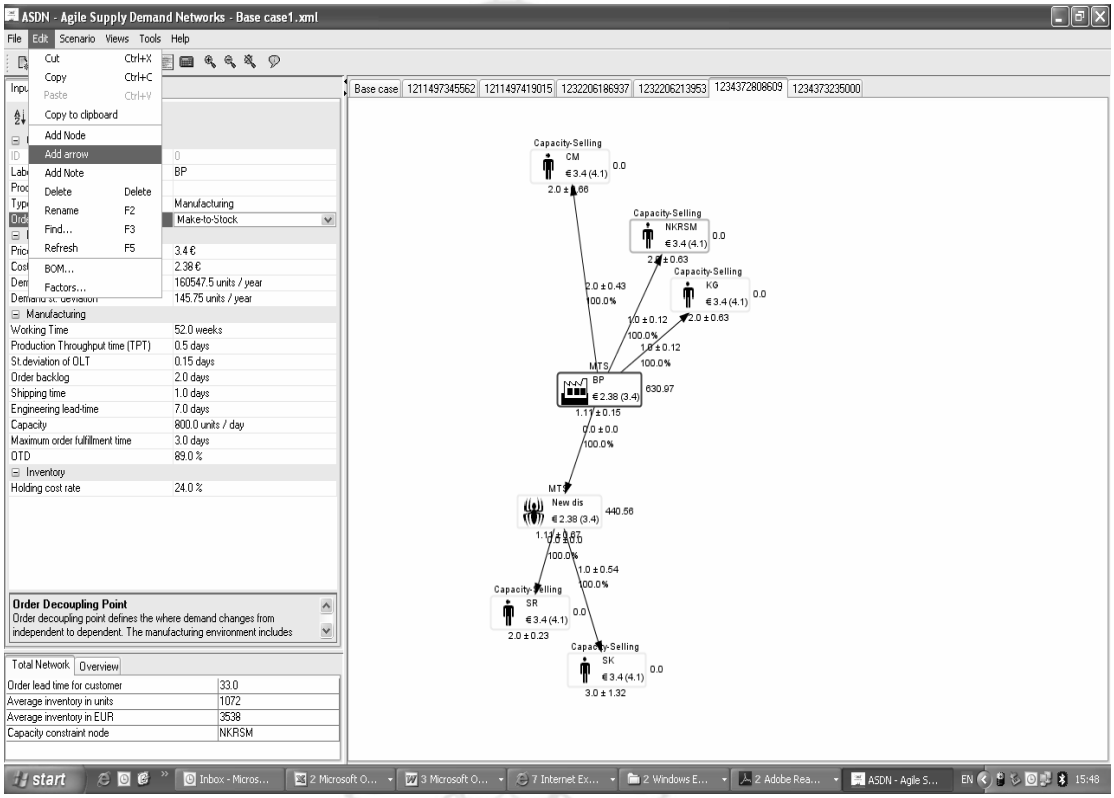


Input data

Then put the data collection into the input screen referred to table 4.1 in Chapter 4.

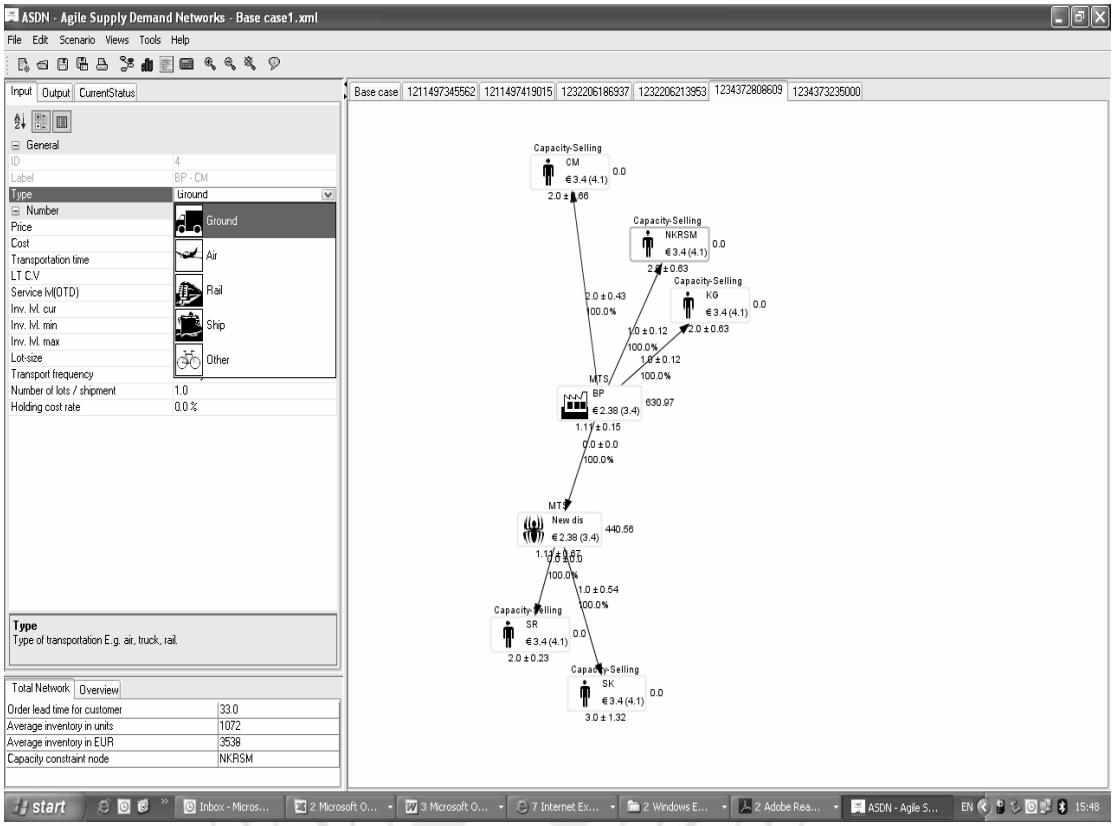
Transportation Screen

Select Edit menu>Select Network node for link BP to their customer and distribution.



Transportation input screen

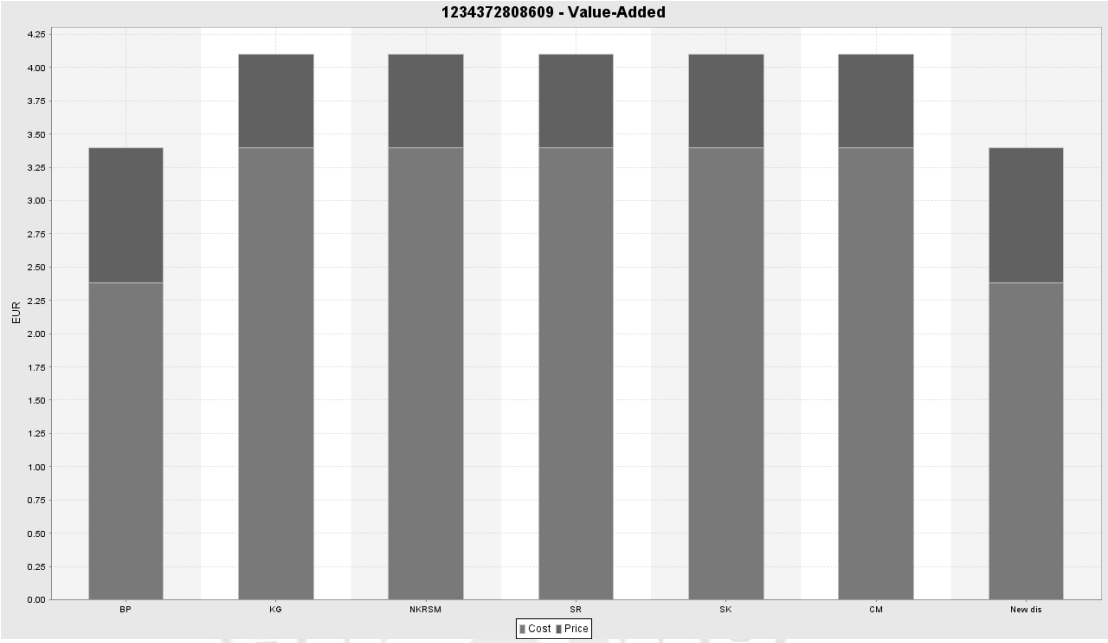
Click the select network node > Select the type > input the data that gathering in.



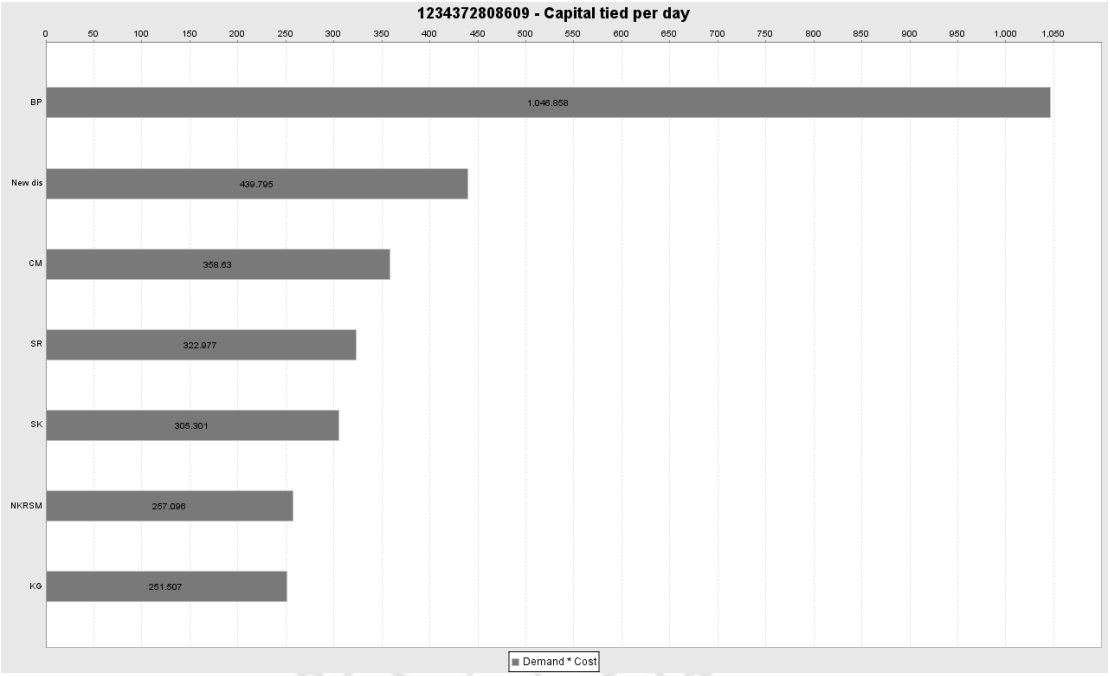
ASDN Report screen

Open View menu> select graph view> Full screen.

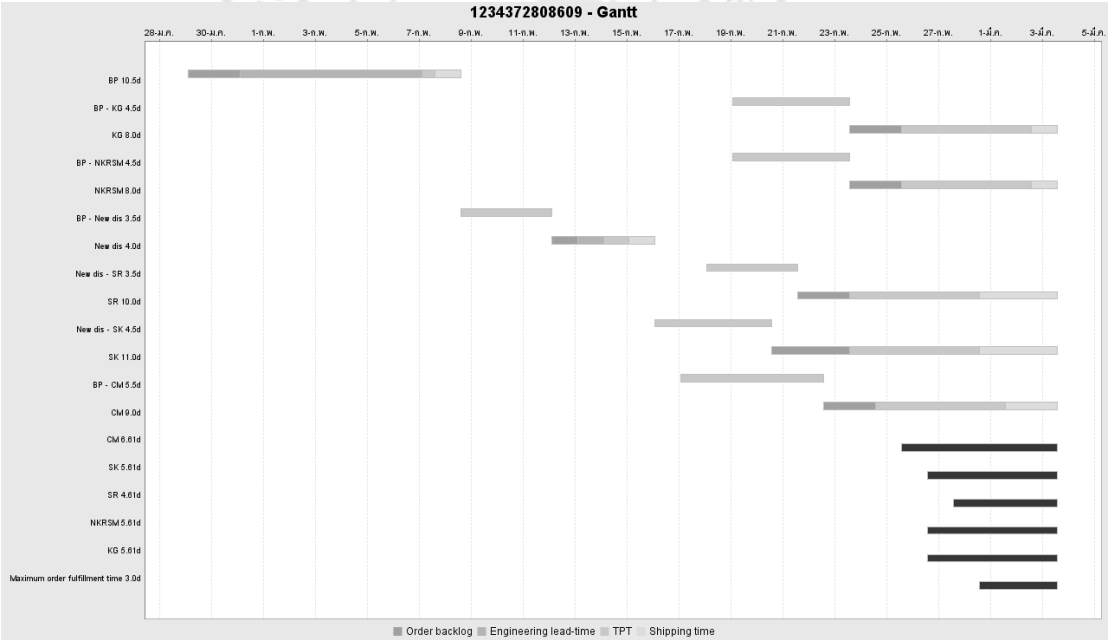
Value Added



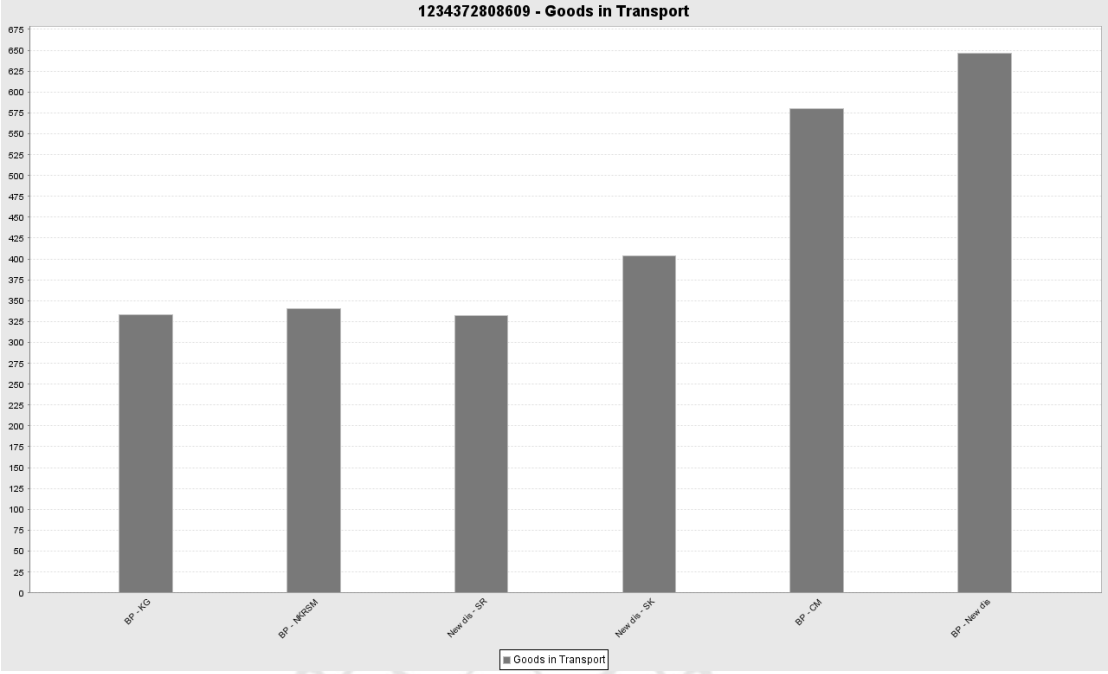
Capital tied per day



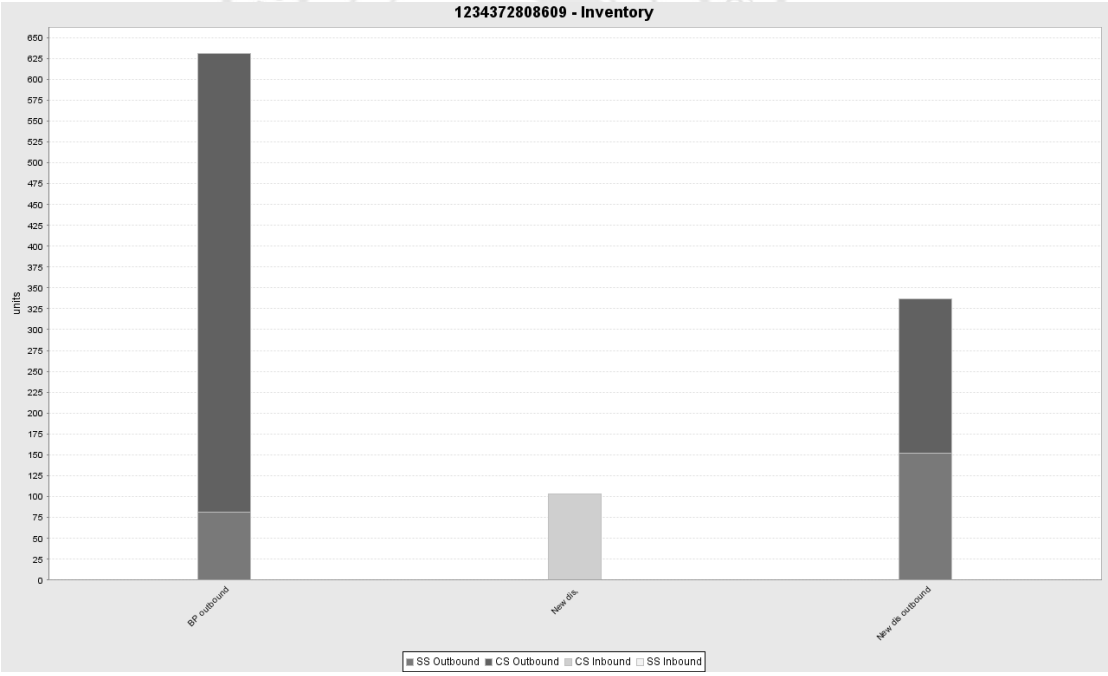
Gantt



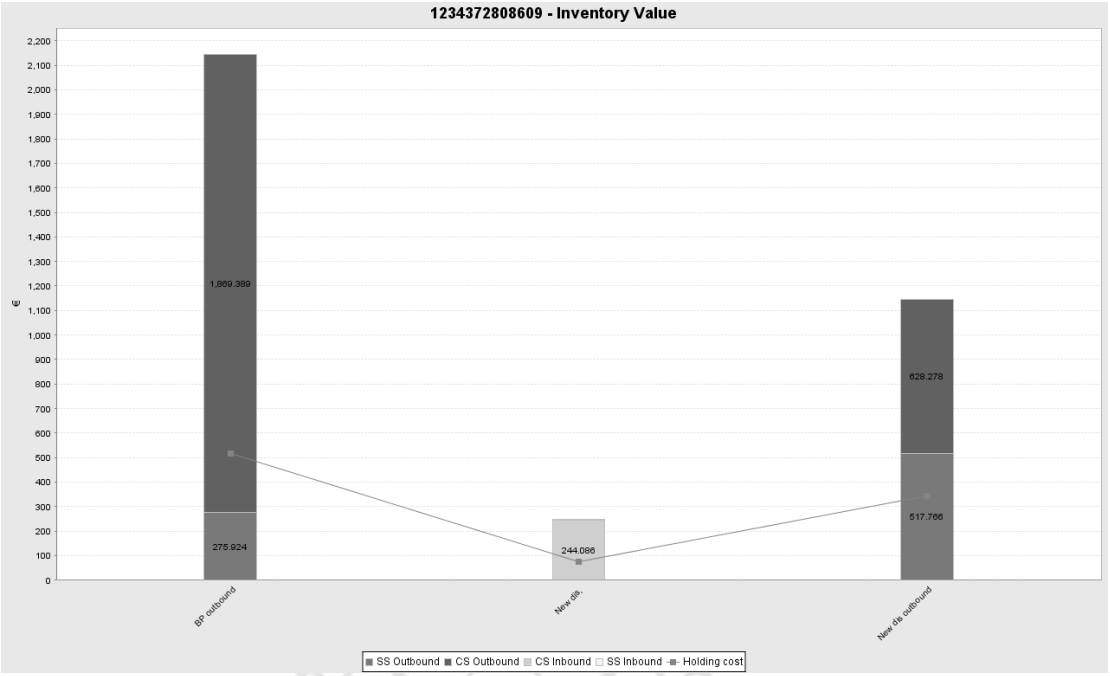
Goods in Transport



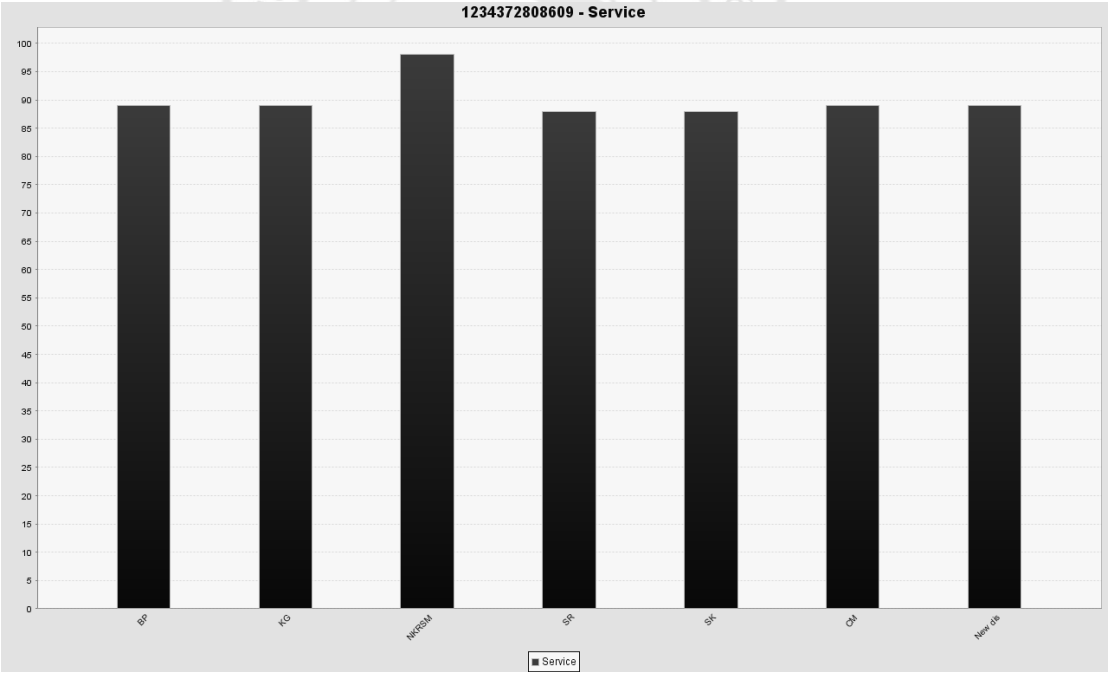
Inventory



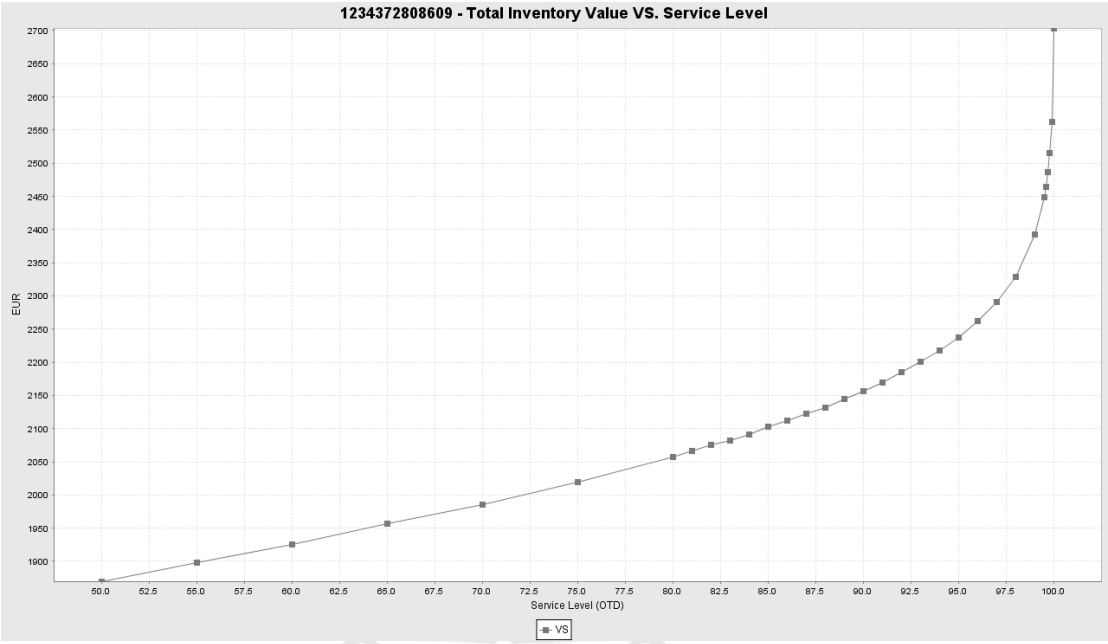
Inventory Value



Service



Total Inventory Value VS Service level

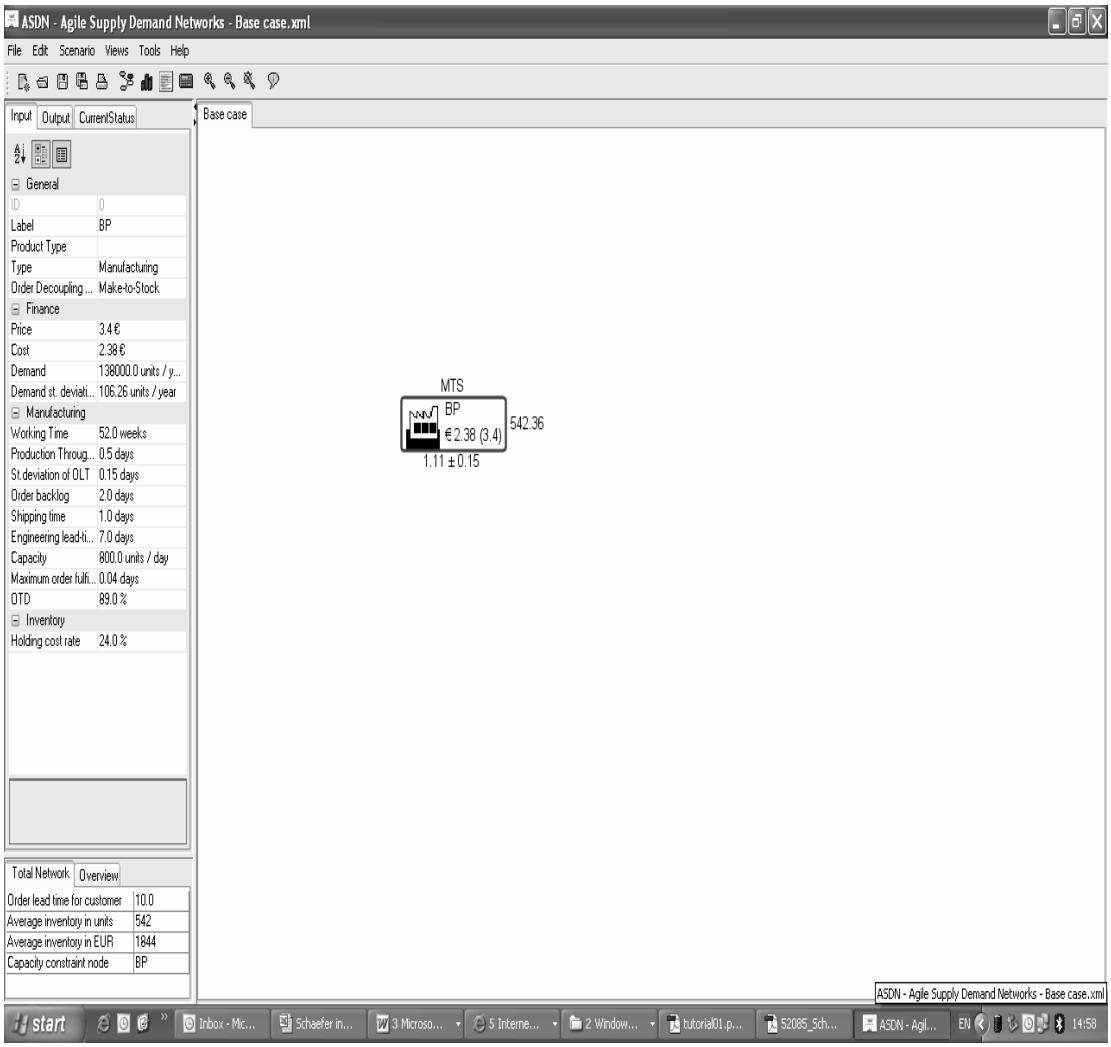


APPENDIX B

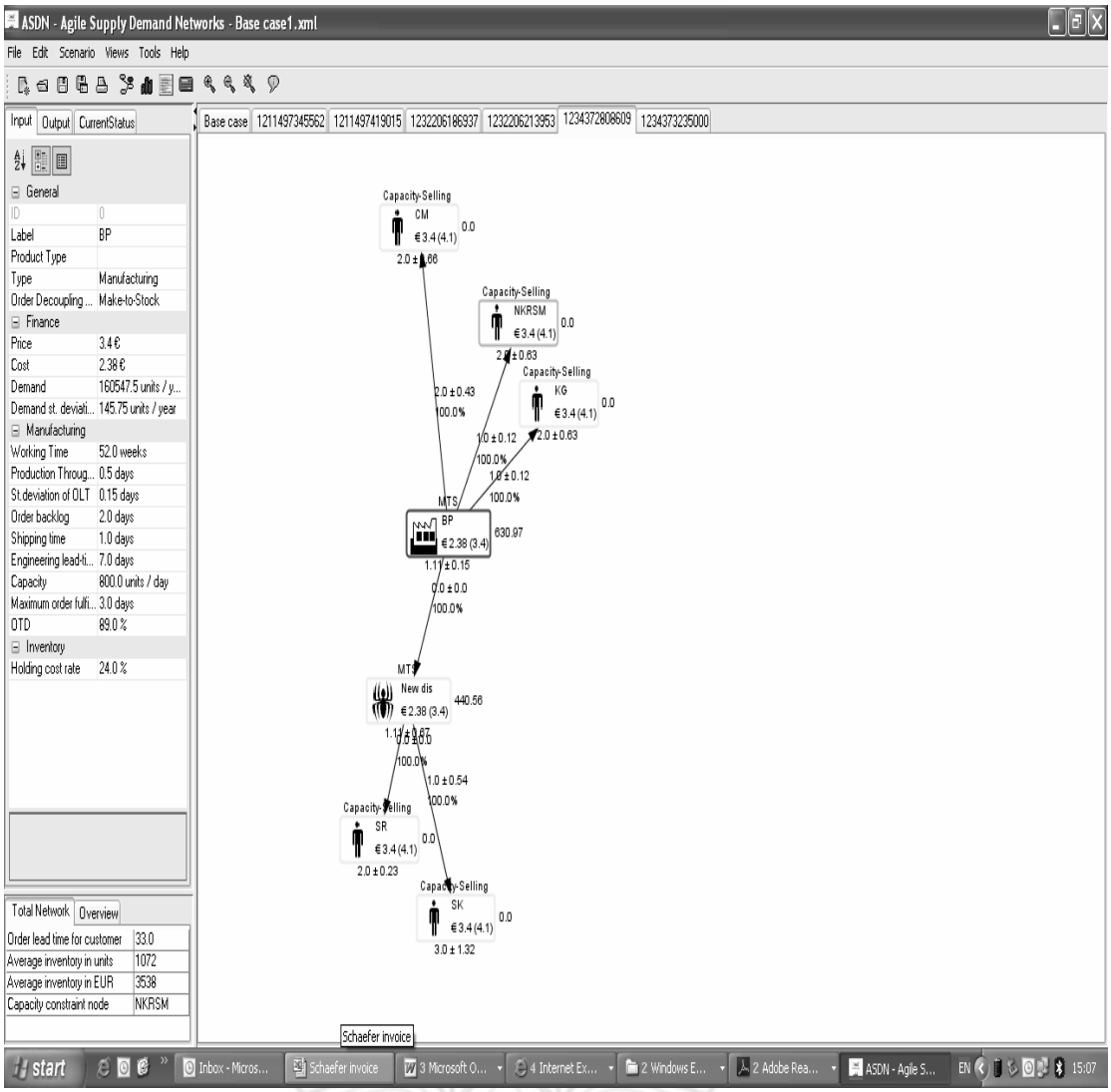
Comparing Between Warehouse Expanding Alternative and Reduce Lead Time and Increasing Inventory

Input Screen data between Warehouse Expanding and Combine reduce lead time and increase inventory.

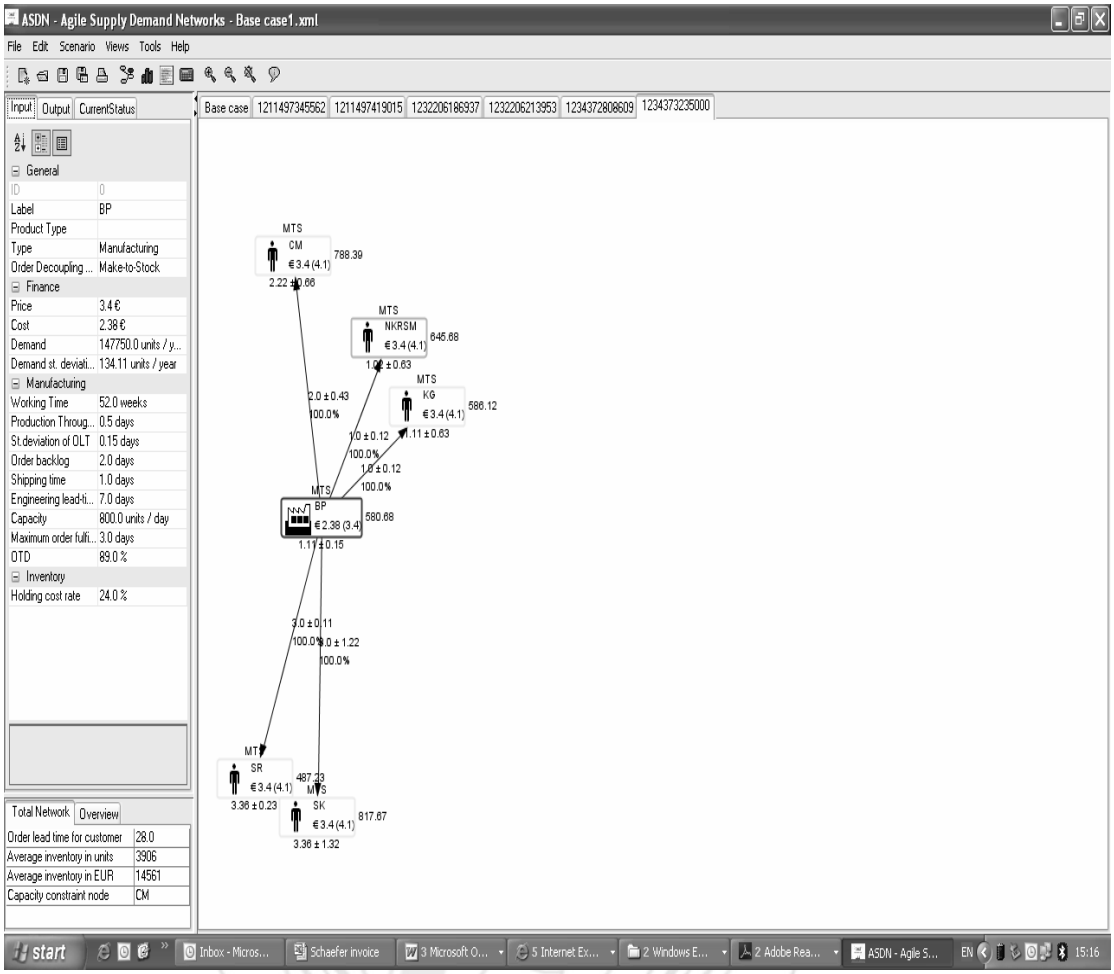
Base case (traditional way)



Warehouse Expanding Alternatives

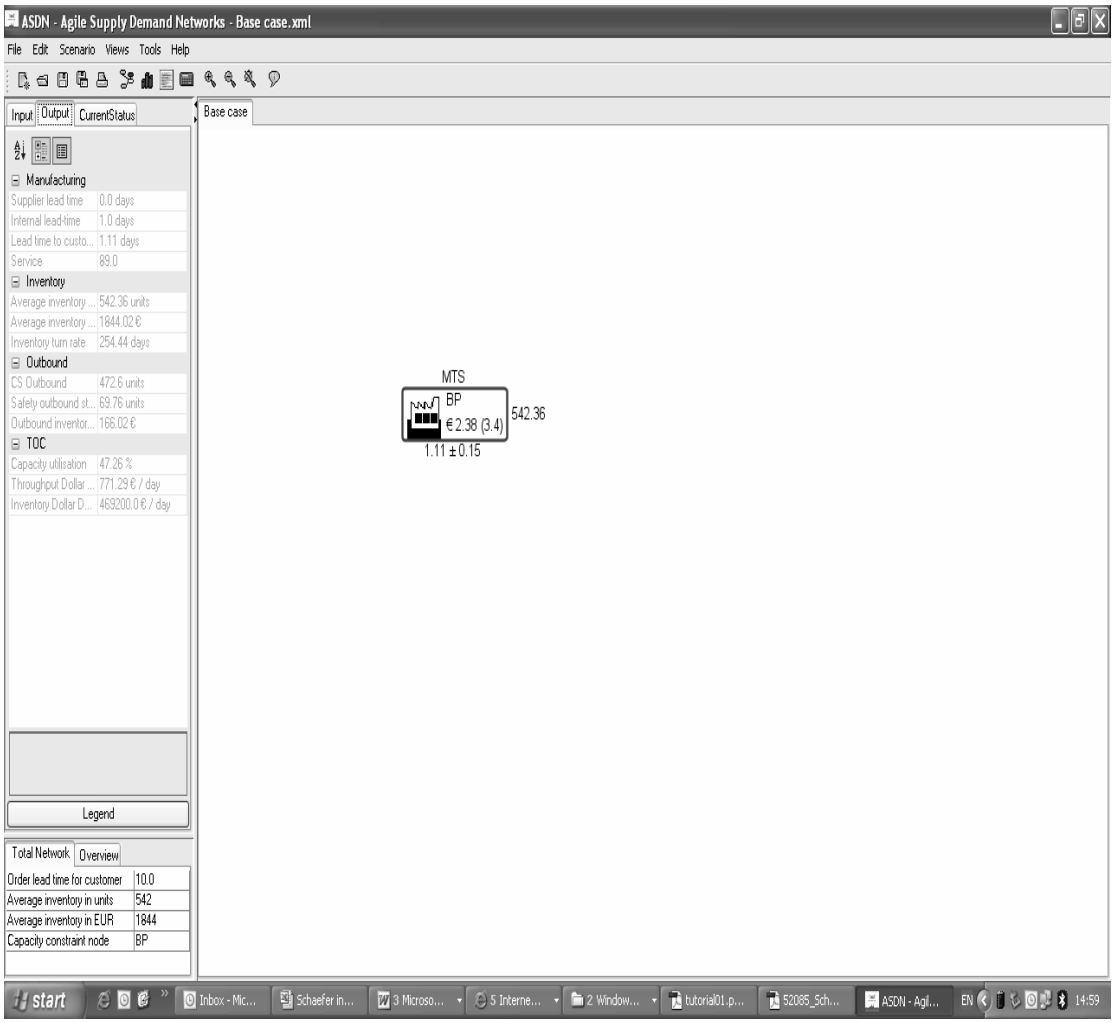


Combine alternative

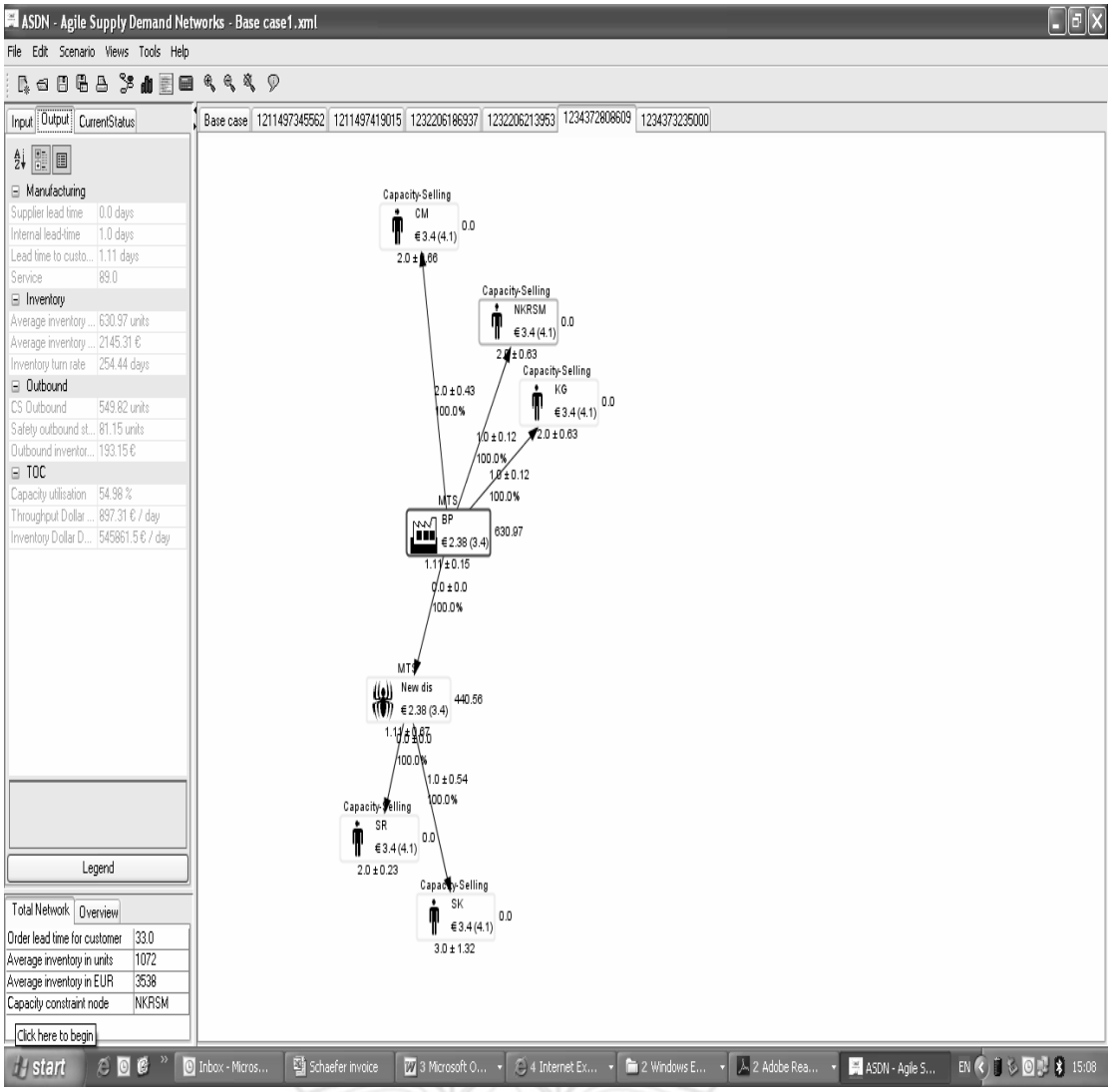


Output Screen data between Warehouse Expanding and Combine reduce lead time and increase inventory.

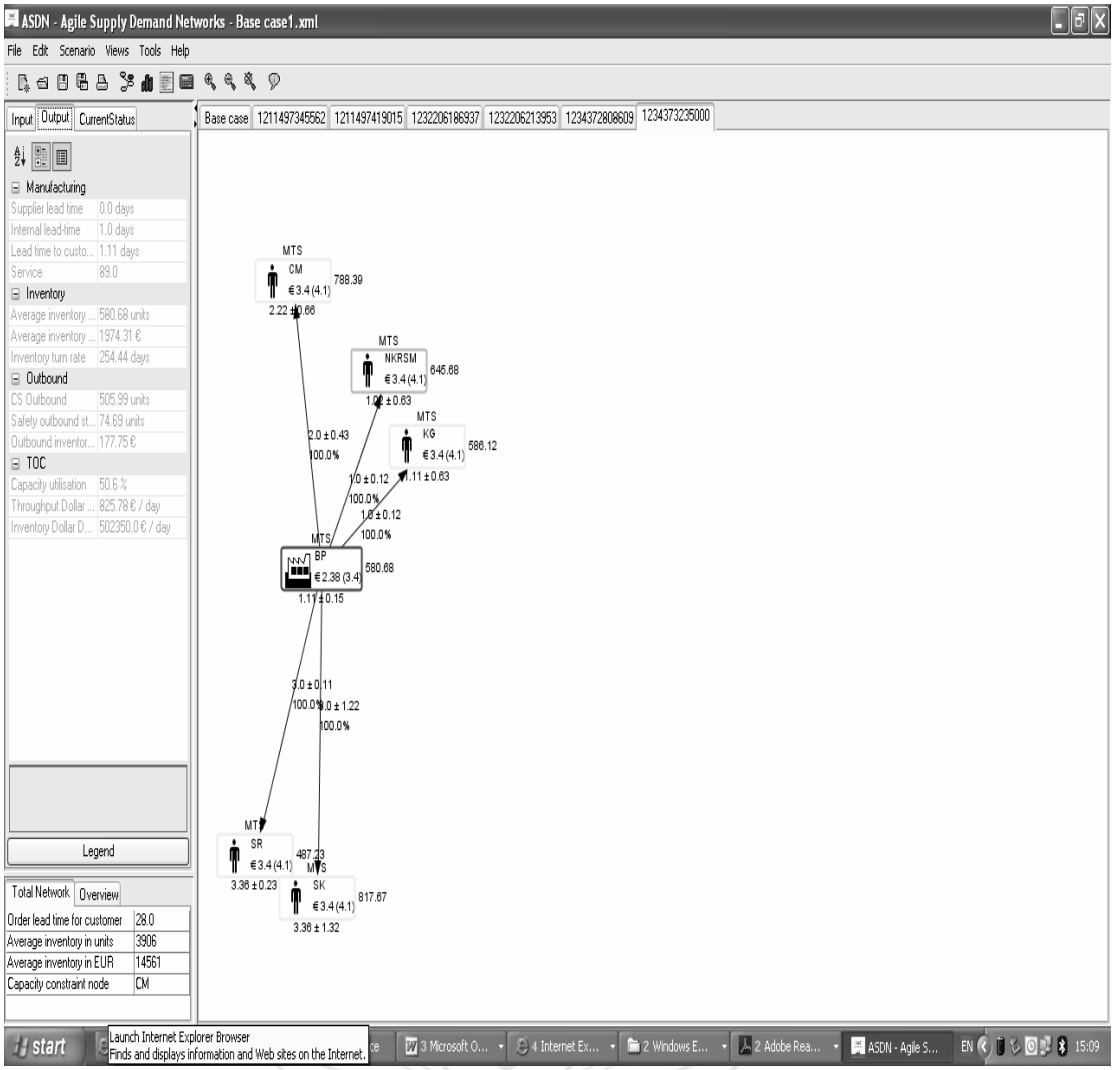
Base case (Traditional way)



Warehouse Expanding Alternative

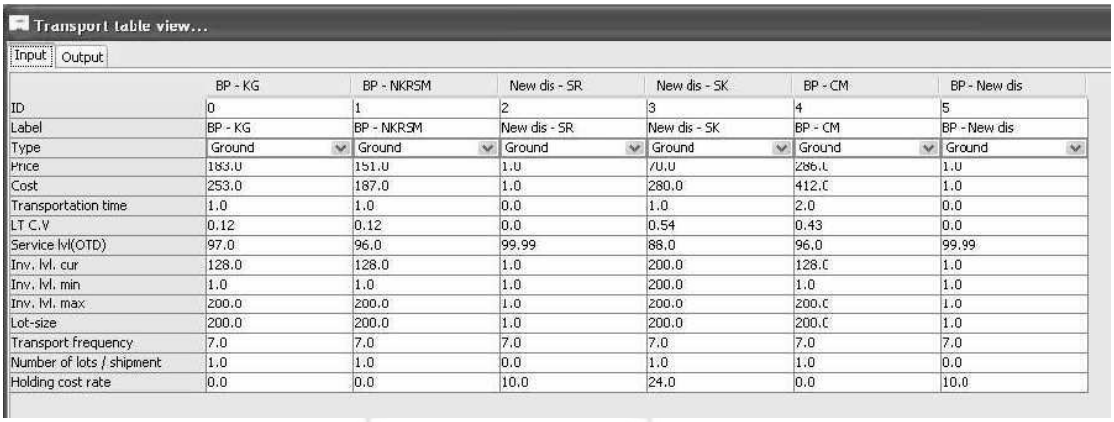


Combine alternative



Input Transportation data between Warehouse Expanding and Combine reduce lead time and increase inventory.

Warehouse expanding alternative

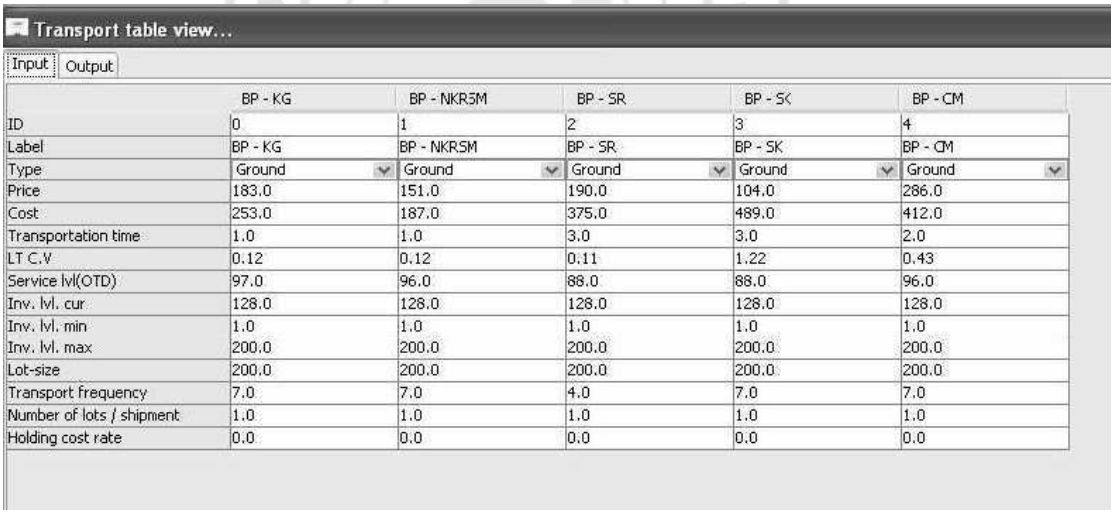


Transport table view...

Input | Output

	BP - KG	BP - NKR3M	New dis - SR	New dis - SK	BP - CM	BP - New dis
ID	0	1	2	3	4	5
Label	BP - KG	BP - NKR3M	New dis - SR	New dis - SK	BP - CM	BP - New dis
Type	Ground	Ground	Ground	Ground	Ground	Ground
Price	183.0	151.0	1.0	70.0	286.0	1.0
Cost	253.0	187.0	1.0	280.0	412.0	1.0
Transportation time	1.0	1.0	0.0	1.0	2.0	0.0
LT C.V	0.12	0.12	0.0	0.54	0.43	0.0
Service lvl(OTD)	97.0	96.0	99.99	88.0	96.0	99.99
Inv. lvl. cur	128.0	128.0	1.0	200.0	128.0	1.0
Inv. lvl. min	1.0	1.0	1.0	200.0	1.0	1.0
Inv. lvl. max	200.0	200.0	1.0	200.0	200.0	1.0
Lot-size	200.0	200.0	1.0	200.0	200.0	1.0
Transport frequency	7.0	7.0	7.0	7.0	7.0	7.0
Number of lots / shipment	1.0	1.0	0.0	1.0	1.0	0.0
Holding cost rate	0.0	0.0	10.0	24.0	0.0	10.0

Combine alternative



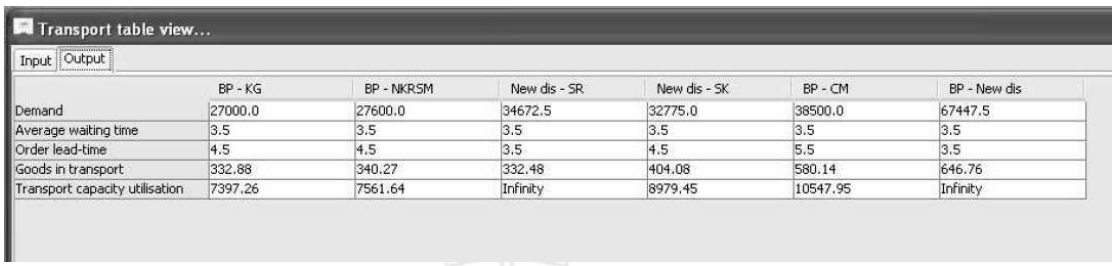
Transport table view...

Input | Output

	BP - KG	BP - NKR3M	BP - SR	BP - SK	BP - CM
ID	0	1	2	3	4
Label	BP - KG	BP - NKR3M	BP - SR	BP - SK	BP - CM
Type	Ground	Ground	Ground	Ground	Ground
Price	183.0	151.0	190.0	104.0	286.0
Cost	253.0	187.0	375.0	489.0	412.0
Transportation time	1.0	1.0	3.0	3.0	2.0
LT C.V	0.12	0.12	0.11	1.22	0.43
Service lvl(OTD)	97.0	96.0	88.0	88.0	96.0
Inv. lvl. cur	128.0	128.0	128.0	128.0	128.0
Inv. lvl. min	1.0	1.0	1.0	1.0	1.0
Inv. lvl. max	200.0	200.0	200.0	200.0	200.0
Lot-size	200.0	200.0	200.0	200.0	200.0
Transport frequency	7.0	7.0	4.0	7.0	7.0
Number of lots / shipment	1.0	1.0	1.0	1.0	1.0
Holding cost rate	0.0	0.0	0.0	0.0	0.0

Output Transportation data between Warehouse Expanding and Combine reduce lead time and increase inventory.

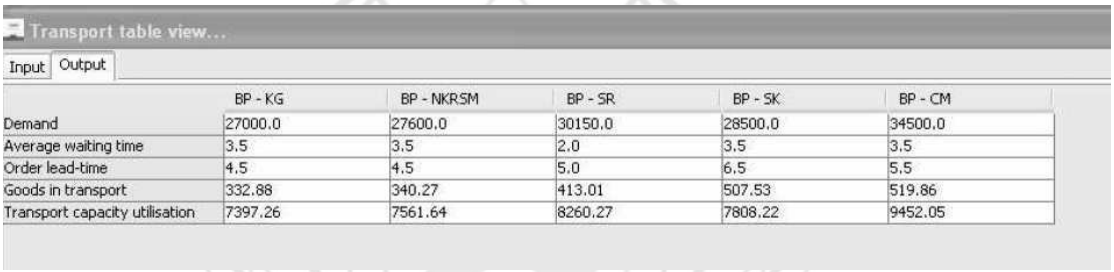
Warehouse expanding alternative


Transport table view...

Input | Output

	BP - KG	BP - NKRSM	New dis - SR	New dis - SK	BP - CM	BP - New dis
Demand	27000.0	27600.0	34672.5	32775.0	38500.0	67447.5
Average waiting time	3.5	3.5	3.5	3.5	3.5	3.5
Order lead-time	4.5	4.5	3.5	4.5	5.5	3.5
Goods in transport	332.88	340.27	332.48	404.08	580.14	646.76
Transport capacity utilisation	7397.26	7561.64	Infinity	8979.45	10547.95	Infinity

Combine alternative


Transport table view...

Input | Output

	BP - KG	BP - NKRSM	BP - SR	BP - SK	BP - CM
Demand	27000.0	27600.0	30150.0	28500.0	34500.0
Average waiting time	3.5	3.5	2.0	3.5	3.5
Order lead-time	4.5	4.5	5.0	6.5	5.5
Goods in transport	332.88	340.27	413.01	507.53	519.86
Transport capacity utilisation	7397.26	7561.64	8260.27	7808.22	9452.05

CURRICULUM VITAE

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