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Electronic Negotiation and Consortium Agents in the Plastic Market for Small and Medium Enterprises (SMEs)

By

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Abstract

With the development of the Internet and technology, the traditional market has become an electronic market, opening new horizons for trading. The Small and Medium Enterprises (SMEs) e-commerce has been growing rapidly and more businesses have used the e-commerce for selling and buying goods or services. For example, the plastic e-marketplaces allow companies to search the product and then contact with other companies electronically.

The content of this dissertation is divided into three parts. The first part designs and implements negotiation agents, which allow traders to exchange electronic messages in a multi-agent system. The negotiation agent support the Estimated Reserved Price Range (ERPR) for the buyer in decision-making, based on the buying conditions. The second part covers a consortium agent, which allows SMEs to make purchasing consortiums by applying a Modified Knapsack Problem Algorithm. The consortium agent is implemented to eliminate the broker agent in a multi-agent system. The third part combines both the consortium and the negotiation agents for SMEs. Those three parts are demonstrated by a series of simulations to show the results: 1) the efficiency difference between negotiation and non-negotiation trading, 2) the efficiency difference between the Modified knapsack Algorithm Consortium (MKPAC) and the Exactly Match Consortium (EMC), 3) the efficiency difference between the SME with negotiation and consortium combined and a market which has no negotiation nor consortium.

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Chapter 1: Introduction

Background

A market is a place where buyers and sellers meet to exchange commodities (Kirkpatrick & Dahlquist, 2010; Håkansson, 1982). In the market, there are four kinds or types of market; direct search markets, brokered markets, dealer markets, and auction markets (Kirkpatrick & Dahlquist, 2010; PF&Investing 2007; Bodie, Kane & Marcus, 2007). In the most traditional auction market, all participants meet together in one place to buy or sell a commodity where the sellers and buyers do not need to search for each other (Kirkpatrick & Dahlquist, 2010; PF&Investing 2007; Bodie et al., 2007). There are many types of auction markets such as English, Dutch, Sealed First-Price, and Vickrey auctions.

The modern market concept can be described as a group of organizational functions and processes, which search to determine the target markets' or trading partners' need, and deliver products, and/or services to customers (Houston, 1986). At the end of the last century, Internet technology has developed, and companies have started using the internet to sell more goods and services to other potential buyers (Farzamnia, Nasserzadeh & Nalchigar, 2009; Cipparrone, 2006). A trading based on the Internet has become important for companies in many different ways such as reducing operating costs, increasing productivity, and improving communications with customers' partners (Zhu, Kraemer & Xu, 2006; Kleindl, 2000). Many companies have started to implement e-commerce platforms (Dahai & Jiajia, 2010).

The electronic market is known as "online trading," "e-marketplaces," or "electronic commerce" (Quirk, 2006). An electronic trading can be described as a form of trading that uses computer software and electronic media for trading through the computer network (Quirk, 2006). In general, selling has been increased through the computer network (Feigenbaum, Parkes & Pennock, 2009). The electronic marketplace has types of e-commerce, which depends on the types of transactions: Business-to-Business (B2B), Business-to-Consumer (B2C), Consumer-to-Business (C2B) Consumer-to-Consumer (C2C), Government-to-Business (G2B), and Government-to-Consumer (G2C) (Kim, 2000).

The B2B e-marketplaces have received attention recently (Popović, 2002; Zhang & Bhattacharyya, 2010). The B2B transactions have been increased on the Internet, and e-market applications are considered decisive tools for organizations because they provide real-time trading information in the e-marketplace (Teoa & Ranganathan, 2004; Zhao, Wang & Huang, 2008). The e-marketplace model has various names such as Net Markets, e-Hubs, Fat/Thin Butterflies that connects buyers and sellers to ease communication through an online transaction (Popović, 2002; Zhao et al., 2008).

The e-commerce opens a new horizon for Small and Medium Enterprises sized (SMEs) to play more roles that are important in the modern economy (Zhu & Liang, 2009). The SMEs in the United States is defined as 500 employees or less (Shane, 2009). The SMEs in the U.S. is defined based on the field of businesses (USITC, 2010). For example, in 2012 the SMEs accounted for 97.8% of all the U.S. exporters (ITD, 2011). The SMEs need an intelligent and automated e-commerce that needs new infrastructures in order to be more efficient (Fortino, Garro & Russo, 2005). One of necessary infrastructures in e-commerce for SMEs is a software agent such as broker agent where the idea is to improve the coordination among the SMEs agent in the e-trading process

(Zhu & Liang, 2009).The software agent allows SMEs to make a better connection by exchanging communication messages with broker agents to make good purchasing consortiums. As a result, the SMEs attempt to achieve purchasing consortiums, which will help them to increase the trading with large enterprises. In addition, the SMEs have to pay a fee for the services of broker agents (USITC, 2010). However, the broker agent collects the SMEs units to achieve a seller's units without make any suggestions to the SMEs to increase their units, if the SMEs does not reach the seller's units, which is called exactly match consortium (USITC, 2010). However, the B2B starts to develop the regular e-marketplace to have new infrastructures in order to make the e-marketplace more efficient.

The B2B e-marketplace applications involve market principles with various functions and process methods such as online negotiations (online negotiation agent), making contracts, inviting tenders, bidding, purchasing and selling, settlement, distribution services, and consortium agent (Zhao et al., 2008; Zhu & Liang 2009). Especially, the online negotiation agent gets more attention in many researches recently, the idea is to improve the communication among businesses to be more automatically. As a result, it will increase the volume of trading; therefore it may reduce the product cost (Fujita, Klein & Ito, 2011). In addition, the e-marketplace applications have unique functions in e-procurement (White, Daniel, Ward & Wilson, 2007). The e-marketplace, in order to be an intelligent and automated e-commerce, needs new infrastructures (Fortino et al., 2005). One of the infrastructures that can help this e-trading is agent technology (Fortino et al., 2005).

Agent

An agent is an entity that is representative for someone and has the authority to act on behalf of the agent-owner to communicate with the third party or environment to achieve one goal (Russell, Norvig, Canny, Malik & Edwards, 1995). The agent technology is an essential part of applying the automated negotiation because its properties include autonomy, interaction, and intelligence (Hai-wen, De-yu & Bin, 2010). The e-commerce software needs to have a good structure to handle difficult and complex communication between autonomous distributed components of e-commerce (Fortino et al., 2005). One of the software agents is a negotiation agent that aids in the e-trading process; specifically, it helps to find traders more efficiently, which allows traders to negotiate by exchanging messages (Ahmadi & Charkari, 2011). Also, another software agent is a consortium agent, which assists the traders to collaborate as a one trader with large enterprises (Zhu & Liang, 2009).

The negotiation agent in the e-marketplace is a software model that can be used to communicate with other traders' agents based on the owners' requirements to carry out the negotiation (Ahmadi & Charkari, 2011). Consequently, the owner's requirement for the negotiation could hinge on a single or several variable conditions of the negotiation (Ahmadi & Charkari, 2011). The negotiation also depends on the trader's resources, which are static and dynamic (Hai-wen et al., 2010).

The consortium agent based e-marketplace can be defined two members or more are collaborating together to achieve their goal as buyer or seller, such as exchanging information or buying or selling products (Cassivi, Saives, Labzagui & Hadaya, 2009). The consortium improves the power of the buyers in the negotiation with sellers (Soh &

Markus, 2002; Local t-gov, 2007). The main goals of consortiums in e-marketplaces are to: a) reduce the price of products for a consortium of buyers, and b) increase the selling or buying of the product for a consortium of traders (Soh & Markus, 2002).

Plastic Market

In the United States, according to the Society of Plastics Industry (SPI), plastics is considered the third largest manufacturing industry in the United States. In the U.S., the plastic industry provides around $327 billion in annual shipments (SPI, n.d.). In the plastic trading market, there are two major types of plastic material; one is known as thermoplastic or primary and the other is thermosetting or secondary (Infoplease, n.d.). Thermoplastic is defined as that which “can be repeatedly softened and remolded by heat and pressure” (Infoplease, n.d., para. 2), such as polyethylene, polypropylene, polystyrene, polyvinyl chloride, and polytetrafluoroethylene (Infoplease, n.d.). Thermosetting is defined as which “cannot be re-softened after being subjected to heat and pressure”, and it has around 20,000 products (Infoplease, n.d., para. 2).

In online plastic market, the e-marketplaces allow a business in the plastic market to offer the plastic material or detailed product information (Keskinocak & Tayur, 2001). However, there are two types of plastic markets according to the material used: primary and secondary (TPEPC, 2002). Even though plastic markets are different, the infrastructure of the trading is similar (TPEPC, 2002).

Dissertation Challenges

This dissertation tries to improve the e-marketplace from the buyer's side by implementing a negotiation agent and consortium agent for SMEs. The main two challenges in the buyer application side are described below:

First challenge. The negotiation agent, in the research of Jennings, He, Rogers and Luo, (2006) focused on protocol. Others show that negotiations have been done for price or some other conditions such as delivery and maintenance of the product. Currently, the buyers and sellers negotiate in terms of trading by exchanging electronic messages. Some e-marketplace systems implement negotiation rules, negotiation strategies, and lessons learned. They implement lessons learned by using the contract's history such as an experience knowledge library to help buyers make a decision. Currently, most e-marketplace systems do not provide traders' reserved price range of a minimum, maximum, average, and expected price. However, other websites provide a full range of values of the product as a price index, which are changed every day or every week.

The first challenge in this dissertation was to set up the traders' reserved price range for products. The negotiation agent explored or probed the counterparts' reserved price, which is difficult to obtain. The reserved price is based on the market price. As a result of exploring the negotiation price range, the estimated reserved price range helped the buyers to negotiate and make successful decisions about the contract.

Second challenge. Many researchers such as Soh and Markus (2002) and Local t-gov (2007) show that the consortium agent facilitates the collaboration between the buyers to negotiate with sellers. Other researchers also show that the consortium happens in the Small and Medium Enterprises (SMEs) to negotiate with sellers in large businesses. The SMEs have a disadvantage because often the seller has Minimum Order Quantities (MOQ) of a product or offer Big Quantities (BQ) of a product. The SMEs uses the consortium to overcome the restriction barrier of MOQ or BQ by putting many SMEs of buyers together. The researchers have set up the consortium agent to negotiate with sellers to reduce the product's price without concern for the buyer's conditions or preferences in the collaboration among the buyers. This consortium agent also has a disadvantage, because it may increase the disintegration among buyers when they start to negotiate with sellers because every buyer has specific conditions about the product that will make the consortium inefficient and weak.

The second challenge in this dissertation was to build a consortium agent to reach MOQ or BQ, which improves the collaboration of the buyer of SMEs to be more efficient and more powerful. As a result, the collaboration of the buyers of SMEs increased the buyers of SMEs trading with the Large Businesses (LEs) by reaching the MOQ or BQ. On the other hand, the consortium satisfies the buyers in their collaboration, which assists them to reduce the product's price.

Dissertation Approach and Goal

This dissertation is divided into three phases. The first phase is to develop and improve negotiation agent in an on-line based e-marketplace by providing the Estimated Reserved Price Range (ERPR) of the product value based on the buyer's condition, to assist the buyer negotiating with the sellers. The second phase is to develop a consortium agent for SMEs in e-marketplace to reach MOQ or BQ by Modified the Knapsack Problem Algorithm (MKPA). The third phase is to combine both the consortium and negotiation agent to work together to make e-marketplace more efficient for SMEs to provide a lower product price and increase trading volume.

Dissertation questions. The three dissertation questions are below and are addressed in three section of the dissertation: the methodology, results and discussion, and conclusion.

Q1: Can an automated negotiation agent with Estimated Reserved Price Range (ERPR) improve the efficiency of the market for buyer's negotiation against the seller?

Q2: Can an automated consortium agent based on Modified Knapsack Problem Algorithm (MKPA) improve the trading volume for SMEs in e-marketplace?

Q3: Can the combination of an automated consortium and negotiation agents improve the market efficiency for Small and Medium Enterprises (SMEs)?

Evaluation. In this dissertation, there are three evaluation phases to evaluate the dissertation questions.

The first phase is to answer the dissertation question number one, "Can an automated negotiation agent with Estimated Reserved Price Range (ERPR) improve the efficiency of the market for buyer's negotiation against the seller?" In first phase, an evaluation is conducted by building a simulation system to compare the results of Negotiation with ERPR and Non-Negotiation.

The second phase is to answer the dissertation question number two, "Can an automated consortium agent based on Modified Knapsack Problem Algorithm (MKPA) improve the trading volume for SMEs in e-marketplace?" In second phase, an evaluation is conducted by building a simulation system to compare the results of Modified

Knapsack problem Algorithm Consortium (MKPAC) and exactly Match Consortium (EMC).

The third phase combined the consortium and negotiation agent to work together in e-marketplace to answer the dissertation question number three, “Can the combination of an automated consortium and negotiation agents improve the market efficiency for Small and Medium Enterprises (SMEs)?” In third phase, an evaluation is conducted by building a simulation system to compare the results of consortium and negotiation for SMEs, negotiation for LEs, and non-negotiation for LEs.

Chapter 2: Literature Review

This chapter explains the background of market, e-marketplaces, business, domain target, and intelligent agent. Markets can be classified by their types, which are direct search markets, brokered markets, dealer markets, and auction markets. In background of e-marketplaces, different markets are explained based on business models and organizational models. Business can be classified by the transaction participating entities: Business-to-Business (B2B), Business-to-Consumer (B2C), Consumer-to-Business (C2B), Consumer-to-Consumer (C2C), Government-to-Business (G2B), Government-to-Consumer (G2C), and the Business-to-Business for SME(Small and Medium Enterprise) and LE(Large Enterprise). A plastic market is the target domain of the negotiation and consortium agents. Automated agents negotiate trading conditions based on a plastic market's trading volume and price index. An intelligent agent is defined and explained by the types of agent. Among different types of intelligent agents, negotiation and consortium agents are discussed in detail.

Background of Market

A market is a place where buyers and sellers meet to exchange commodity for money (Kirkpatrick & Dahlquist, 2010; Håkansson, 1982). "This basic concept still works in the sophisticated world of finance, except that there are now four organizational levels depending on the nature and volume of transactions" (PF&Investing, 2007, para. 1). In the market, the buyers and sellers discuss and evaluate the commodity based on the conditions of the exchange of commodity and services from buyers and sellers and low vision (Håkansson, 1982). "The market is the place where supply meets demand.

Suppliers and customers meet, discuss and evaluate the conditions for exchange of goods and services, and exchanges take place" (Håkansson, 1982, p. 1). In the market, there are four kinds or types of market: direct search markets, brokered markets, dealer markets, and auction markets (Kirkpatrick & Dahlquist, 2010; PF&Investing, 2007; Bodie et al., 2007).

Direct search markets. In the direct search market, buyers and sellers must look for each other directly (Kirkpatrick & Dahlquist, 2010; PF&Investing, 2007; Bodie et al., 2007). The direct search is characterized by intermittent participation by the market players (Kirkpatrick & Dahlquist, 2010). For example, Mr. Mark needs to buy a used TV, so he may search in a local newspaper for markets that sell a used TV; in general, in the direct search market, often the traded commodity is low price and nonstandard goods (Kirkpatrick & Dahlquist, 2010).

Brokered market. In this type of market, brokers play the main roles (Kirkpatrick & Dahlquist, 2010). The brokers make a search service to match the buyers and the sellers for a commission fee (Kirkpatrick & Dahlquist, 2010; PF&Investing, 2007; Bodie, et al., 2007). A good example is real estate market (Kirkpatrick & Dahlquist, 2010; PF&Investing, 2007; Bodie, et al., 2007). A seller asks a broker to find a buyer who would like to buy his/her house. The broker seeks out a buyer who would like the house and who has financial assets for this house. The broker gets his commission after finding the buyer and after making a deal between the buyer and the seller (Kirkpatrick & Dahlquist, 2010; PF&Investing, 2007; Bodie, et al., 2007).

Dealer market. In a dealer market, dealers deal with a specific type of asset or commodity; they trade with these assets for their own account (Kirkpatrick & Dahlquist, 2010; PF&Investing, 2007; Bodie et al., 2007). The difference between broker and dealer markets is that "the dealers trade assets for their own accounts" (Kirkpatrick & Dahlquist, 2010, p. 58). A good example is a car dealer for used or new cars and NASDAQ for stocks (Kirkpatrick & Dahlquist, 2010). A dealer buys commodity by bidding price and offers a commodity by asking a price (Kirkpatrick & Dahlquist, 2010; PF&Investing, 2007; Bodie et al., 2007). As a result, the dealer markets in general have the "characteristics necessary to use technical analysis" (Kirkpatrick & Dahlquist, 2010, p. 59).

Auction market. In an auction market, all participants gather at one place to buy or sell a commodity where the sellers and buyers do not need to search for each other (Kirkpatrick & Dahlquist, 2010; PF&Investing, 2007; Bodie et al., 2007). The place can be a location, a clearinghouse, or a computer (Kirkpatrick & Dahlquist, 2010; PF&Investing, 2007; Bodie et al., 2007). In an auction market, the information about offers and bids is centralized where the buyer and seller can access to information anytime (Kirkpatrick & Dahlquist, 2010). For example, there is the New York Stock Exchange (NYSE) (PF&Investing, 2007). In detail, there are many types of the auction markets such as English auction, Dutch auction, Sealed First-Price auction, Vickrey auction, Double auction, and Multi-unit auction.

English auction. It is also known as an open ascending price auction (Gul & Stacchetti, 1999). This is a popular auction market type today (Gul & Stacchetti, 1999; David, Azoulay-Schwartz & Kraus, 2002). In this type, participants bid against each other where the price goes from down to up; participants bid higher than the previous participant, the participant who offers the highest price get the units (Gul & Stacchetti, 1999; David et al., 2002; Hidvégi, Wang & Whinston, 2006).

Dutch auction. It is also known as an open descending price auction (Milgrom, 1989). In this type, the auctioneer starts with a high price then goes to a lower until one of the participants is ready to accept the auctioneer's price (Milgrom, 1989; Kumar & Feldman, 1998). The winner is the first participant who can accept the lower price before any other bid for this commodity (Milgrom, 1989; Kumar & Feldman, 1998). The common market is cut flower sales market in the Netherlands; sometimes this type of auction is used for fish and tobacco market (Milgrom, 1989).

The main difference between the Dutch and English auctions is that participants in the Dutch auction depend on the participants' guess about the others decision rules (Milgrom, 1989). Meanwhile, the participants in the English auction do not depend on what they believe about their rival bids (Waehrer, 2007).

Sealed first-price auction. It is also known as a first-price sealed-bid auction (FPSB) (Engelbrecht-Wiggans & Katok, 2008; Thompson & Wright, 2004; Koc & Neilson, 2006). This type of auction is different from the English and Dutch auction; all participants submit their bids without any participants knowing the bid of any other participant (Engelbrecht-Wiggans & Katok, 2008; Haile, Hong & Shum, 2003; Thompson & Wright, 2004). The participant with the highest bid is the winner (Engelbrecht-Wiggans & Katok, 2008; Haile et al., 2003; Thompson & Wright, 2004). The participants can bid one time only (Engelbrecht-Wiggans & Katok, 2008; Haile et al., 2003; Thompson & Wright, 2004; Koc &

Neilson, 2006). This type of auction is used in tendering, specifically for government mining leases (Engelbrecht-Wiggans & Katok, 2008; Thompson & Wright, 2004).

Vickrey auction. It is also known as a sealed-bid second-price auction (Mishra & Parkes, 2008; Lucking-Reiley, 2000). This is exactly like a sealed first-price auction except that the participant's winner will pay the second highest bid rather than his or her own (Mishra & Parkes, 2008; Lucking-Reiley, 2000). An example of this type of auction can be found in eBay. Vickrey auction is rarely used (Lucking-Reiley, 2000).

Double auction. This type of auction is different from the previous auctions. The auctioneer acts as a broker and plays a main role (Deshmukh, Goldberg, Hartline & Karlin, 2002). The auctioneer's task is to match up a group of buyers with a group of sellers of the same size (Das, Hanson, Kephart & Tesauro, 2001; Gjerstad & Dickhaut, 1998; Bredin, Parkes & Duong, 2007). The auctioneer receives from each buyer and seller their bids then decides on a price paid for the commodity based on the market price (Deshmukh et al., 2002; Bredin et al., 2007). For example, the auctioneer decides the price “A” for commodity “C”, then the auctioneer match between the seller who bids the price “S” less than “A” with the buyer who bids price “B” more than “A” (Deshmukh et al., 2002; Huang, Scheller-Wolf & Sycara, 2002; Bredin et al., 2007). The commission profit of the auctioneer is the difference between the buyer's price and the seller's price (Deshmukh et al., 2002).

Multi-unit auctions. In this type of auction, the seller sells more than one item at the same time as a package rather than sell the items separately in the auction. This type can be classified into two subtypes: 1) uniform price auction, and 2) discriminatory price auction.

Uniform price auction. This type of auction depends on two variables; 1) fixed number of units of a commodity, and 2) the price of the unit (Dechenaux & Kovenock, 2005; Hudson, 2000). Each buyer bids a price and a quantity number (Dechenaux & Kovenock, 2005; Hudson, 2000; McAdams, 2002). The buyers bid the maximum price they are willing to pay per item, and the quantity number of units they need to buy. In this type of auction, the buyers' bid is sealed to others until the auction is closed (McAdams, 2002; Goldreichy, 2003). The auctioneer serves the highest bidder first by giving them the number of units requested, and then goes down to the second highest bidder until the commodity is finished (Hudson, 2000; Goldreichy, 2003; Zimmerman, 2010). In addition, the buyers who requested one unit, if the commodity does not finish by buyers who asked for more than one unit, the auctioneer gives the other buyers, who asked for a unit, the commodity by the highest price of the commodity of buyer's (Dechenaux & Kovenock, 2005; Hudson, 2000; Zimmerman, 2010).

Discriminatory price auction. This type of auction depends on three types: First degree, Second degree, Third degree (Holmes, 1989). The first degree is to charge each buyer at his or her price for units that the buyer is willing to pay (Holmes, 1989). The second degree is to charge different prices per unit depending on different quantities of a number of the same good or service

(Holmes, 1989). The third degree is to divide the buyers into two or more groups and separate those groups with demand curves then the auction charges different prices to each group (Holmes, 1989).

E-marketplaces background

The e-marketplace is a virtual place in which buyers and sellers are connected through an online market (Zhao et al., 2008). In the last century, the internet technology has developed, and companies start using the internet to sell more goods and services to more buyers (Farzamnia & Nalchigar, 2009; Cipparrone, 2006).

The Internet is a worldwide electronic network that allows many computers to connect together by using a common connection that is called an Internet Protocol (IP) (Cipparrone, 2006). According to Chaffey, Mayer, Johnston, and Ellis-Chadwick (2002), there are many benefits of the internet in trading. The benefits are as follows:

1. The Internet assists the organizational functions, processes to produce and delivers products and/or services to customers and to others.
2. The Internet is considered a communications medium that integrates different parts of the organization.
3. The Internet facilitates to exchange information of management, which is considered a support tool for marketing for strategy implementation.

Electronic market is well known as “online trading”, “e-marketplaces”, or “electronic commerce” (Quirk, 2006). An electronic trading can be described as a form of trading that uses computer software and electronic media for trading through the Internet (Quirk, 2006). The benefit of e-Marketing is to facilitate communication between traders. (Quirk, 2006). The e-Marketing includes both direct and indirect response, and it is used to help the organization to connect to their customers (Quirk, 2006). Many reports of institutions show that the e-marketplaces have grown, and the e-commerce has expanded (Kim, 2000).

The Gartner Group (2000) defined the e-marketplaces as a place that both the buyers and the sellers meet together in a specific industry, geographic region, or affinity group, for the purpose of commerce (Popović, 2002). Another definition for e-marketplace, according to Pahladsingh (2005), is a "virtual online market where buyers, suppliers, distributors and sellers find and exchange information, conduct trade, and collaborate with each other via an aggregation of information portals, trading exchanges and collaboration tools" (p. 5). The e-marketplaces model has different names such as Net Markets, e-Hubs, Fat/Thin Butterflies (Popović, 2002). There are many different types of e-marketplace based on business models (Wang, Wen-Pin, Liao, Wang, Yan & Lin, 2011). Also, there are two different types based on industry focusing (Popović, 2002).

Types of e-marketplaces based on business models. There are many types of e-market based on business models, which are independent, buyer-oriented, and supplier-oriented e-marketplace.

Independent e-marketplace. It is a business-to-business online application run by a third party, which allows the buyers or sellers to open accounts in a specific industry (Wang et al., 2011). Every registering account can access advertisement, requests for quotations, and/or bids in the same industry field (Wang et al., 2011). There will be a fee to participate (Wang et al., 2011).

Buyer-oriented e-marketplace. One of the buyer-oriented e-marketplace is a consortium market, which is run by a consortium of the buyers to create an efficient purchasing environment (Wang et al., 2011). For example, many buyers create a group then one of the buyers opens an account in Buyer-Oriented e-marketplace to reduce the administration costs and reach lower prices from the sellers (Wang et al., 2011).

Supplier-oriented e-marketplace. This type of marketplace is also well known as a supplier directory. It is run and operated by group of sellers who are looking to start an efficient sales channel through the Internet to many of buyers who are searching for the product or service (Wang et al., 2011). The sellers may use this type of marketplace to increase their potential buyers (Wang et al., 2011).

Types of e-marketplace based on an organizational model. There are two types of e-marketplace based on an organization, vertical and horizontal e-marketplace.

Vertical e-marketplaces. It provides online application which allows access to the businesses vertically (up and down) for every segment of a specific industry field such as automotive, chemical, construction, or textiles (Wang et al., 2011). The benefits of using vertical e-marketplace can make the industry's operation more efficient and assists to decrease costs of supply chain, inventories, and cycle time (Wang et al., 2011).

Horizontal e-marketplace. This type of marketplace connects the buyers and sellers across different industries, regions, or multiple vertical industries (Wang et al., 2011; Popović, 2002). It is used for an indirect product such as office equipment or stationery (Wang et al., 2011; Popović, 2002).

Background of Business

The modern marketing concept can be described as a group of organizational functions and processes which search to determine the target markets' or trading partner's need and deliver products and services to customers or to other stakeholders such as employees and financial institutions (Houston, 1986). There are various types of e-commerce, depending on the transaction: Business-to-Business (B2B), Business-to-Consumer (B2C), Consumer-to-Business (C2B), Consumer-to-Consumer (C2C), Government-to-Business (G2B) and Government-to-Consumer (G2C) (Kim, 2000; Li, 2007). Also in this section, the Business-to-Business for SME and LE background has been explained.

Business-to-Business (B2B). The B2B implies online transactions to making orders, purchasing and/or administrating task between business organizations (Kalakota & Whinston, 1997; Li, 2007). It contains trading goods, such as services, manufacturing, and wholesale dealings (Kalakota & Whinston, 1997).

Business-to-Consumer (B2C). The B2C implies transactions that connect business organizations and consumers where the business organization is the seller, and the consumer is the buyer (Kalakota & Whinston, 1997; Li, 2007). It is a form of direct selling of product or services between the business organization and consumers through the Internet (Kalakota & Whinston, 1997). The services of online banking, travel services, and health information are examples of B2C (Kalakota & Whinston, 1997).

Consumer-to-Business (C2B). The C2B model implies transactions that connect between a consumer and a business organization where the consumer is the seller, and the business organization is the buyer (Kalakota & Whinston, 1997; Li, 2007). The consumers decide the product's price rather than the business organization (Kalakota & Whinston, 1997).

Consumer -to-Consumer (C2C). The C2C model implies transaction between consumers themselves (Li, 2007).In this type of model, one consumer (not a business) sells a product to another consumer (Kalakota & Whinston, 1997). For example, eBay allows the consumers to sell their product to another (Kalakota & Whinston, 1997).

Business-to-Business for SME and LE background. In the last century, the Internet has developed and it allows the market to increase and the electronic businesses to be developed (Teoa & Ranganathan, 2004). The electronic commerce or market revenue has increased more than expected (Teoa & Ranganathan, 2004). In the last century, the B2B transactions increase on the Internet, and e-marketing application is considered a critical tool for the organization that depends on the web-based to provide real-time responding in the marketplace (Teoa & Ranganathan, 2004; Zhao et al., 2008).

The B2B's trading volume is 10 times more than the B2C market (Zhao et al, 2008). The importance of the B2B trading can be demonstrated by following example. According to Yan (2010), China's revenues in e-commerce were around 1.15280 trillion Yuan in the first quarter of 2010. In same period, the Business-to-Business (B2B) revenue was 903.6 billion Yuan, which was 89 % of the total e-commerce trading. Among the B2B revenues, B2B revenue for Small and Medium Enterprises (SME) was 52.2% of the revenue of the e-commerce trading which was 534 billion Yuan and B2B revenue for Large Enterprises (LE) was 369.6 billion Yuan that was 36.4 % of the total e-commerce trading (Yan, 2010).

Plastic Market Domain

The plastics are essential materials in our modern day life. For example, technology has changed and improved the value of our life by developing telecommunications, computers, transport, and health. In addition, these technology fields are closely related to the plastic materials (Crclarke, n.d.; EPA, n.d.). The definition of plastic is “any organic material with the ability to flow into a desired shape when heat and pressure are applied to it and to retain the shape when they are withdrawn” (Infoplease, n.d., para. 1). In our life, plastic material has been a part of almost every product, such as plastic window frames and doors, food containers, fridges, TV’s, radios, electrical cables, toys, water pipes, etc. (Crclarke, n.d.; EPA, n.d.). The plastic products start to be common as traditional materials, such as wood, ceramics, and metal. Also, there are many varieties of plastic types based on their characteristics (Crclarke, n.d.; Scheiner, 2010).

Plastics market. There are two major types of plastic material which are known as thermoplastic or primary and thermosetting or secondary. The thermoplastic is defined as that “can be repeatedly softened and remolded by heat and pressure” (Infoplease, n.d., para. 2) such as polyethylene, polypropylene, polystyrene, polyvinyl chloride, and polytetrafluoroethylene (PTFE) (Infoplease, n.d.). The thermosetting is defined as that “cannot be re-softened after being subjected to heat and pressure” (Infoplease, n.d., para. 2), and it has around 20,000 products (Infoplease, n.d.).

The plastics market can be classified into different categories. The first category is based on end-use field or appliances, for example, markets such as construction, packaging, household products, and motor vehicles. The second category is resin such as urethane, polystyrene, vinyl, engineering plastics, polypropylene, HDPE, LDPE) or plastic recycles (The Freedonia Group, 2009). Also, the resin market has a different market based on the product's characteristic such as commodity thermoplastics, high-temperature thermoplastics, engineering thermoplastics, thermosets, recycled plastics, or CME group (plasticsnews, n.d.).

Plastics market value. According to Society of Plastics Industry (SPI), in the United States, which represents plastics industries, the plastic is considered the third largest manufacturing industry in the United States. In the U.S., there are around one million employees in plastic industries, which provide around $380 billion in annual shipments (SPI, n.d.). According to Plasticsnews (n.d.), the plastic industries produce around $22.5 billion of foamed plastics. According to Barry Eisenberg, (2009), the plastic exports go above $51 billion. The U.S. plastic products in 2008 were approximately 4.4 percent of all the U.S. exports, also the plastic imports increased to be more than 3.0 percent in 2008, which were under $39 billion (Eisenberg, 2009). Also, the plastics trade surplus increased around 20 percent from $10.9 billion in 2007 to $13.0 billion in 2008 (Eisenberg, 2009). As of October 2011, the U.S. plastics industry's trade surplus reached to $14 billion, which is close to the trade surplus of 2010 ($16.2 billion) (Deligio, 2011). The plastic product price is affected by oil prices, investments in plastic industry, or events like plant closures (FFC, 2008).

Plastic trading. The plastic market is different based on the plastic products. There are many marketplaces for plastic such as exhibits, or online Internet. In the U.S., the exhibit happens based on the using of plastic such as Bioplastek and NPE 2012. The Bioplastek is yearly such as Bioplastek 2013, it is "an interactive forum on Bioplastics today and tomorrow will be an exhibition conference" (Bioplastek, 2013, para. 1). The NPE 2012 is organized by The Society of the Plastics Industry (SPI), which is one of the most important events for plastic industries, and it is a main goal to discover new plastic manufacturing technologies (Plastics Engineering Magazine, 2012).

The online plastic market depends on the e-commerce commercial websites and/or industries websites. The e-commerce market such as www.ides.com (IDES) provides the e-commerce for plastic materials to buy and sell for both buyers and sellers (plastics_marketplace, n.d.). The plastic marketplace (www.Theplasticmarketplace.com) is another e-commerce to buy and sell plastic and offers a real-time chat by contacting both buyers and sellers immediately through live chat, Skype, instant message, email, and phone (ThePlasticMarketPlace, 2009).

The industry website is another type of online market, which presents its product on a website with a description of the plastic product. M&H industry is an example of an industry website, which sells the plastic packaging product, which includes a large range of plastic bottles, plastic jars, plastic tubs, closures and flexible tubes. It sells its product by connecting directly to its buyers through its email or phone (M&H Plastics, n.d.). DAK Americas is another company which "is comprised of four business units: Polyethylene Terephthalate Resins (PET), Polyesters Staple Fibers (PSF), etc. …" (DAK Americas, n.d., para. 1).

Agent

An agent is an entity that is representative for someone and has authority to act on his behalf to communicate with a third party (Wikipedia, 2011) or environment to achieve one goal (Russell et al., 1995). The agent architecture contains two functions that are requesting agent and responding agent functions (Dijkstra, Prakken & Mestdagh, 2007). In addition, the agent uses communication language and protocol to swap information with respecting the market law (Dijkstra et al., 2007). However, “agent technology” and “software and computer agent” have the same job, but they have a different name.

Computer agent has various types, such as operating system interfaces, processing, satellite imaging data, electricity distribution management, air-traffic control, business process management, and/or electronic commerce (Luck & d'Inverno, 2001). The computer or system agent, according to Smith, Cypher, and Spohrer, (1994) is defined as “a persistent software entity dedicated to a specific purpose” (p. 60). Also, Selker (1994) defined a software agent to be “computer programs that simulate a human relationship by doing something that another person could do for you” (p. 92).

In addition, the intelligent software agent or intelligent agent is defined according to Hermans, 1996:

> A piece of software which performs a given task using information gleaned from its environment to act in a suitable manner so as to complete the task successfully. The software should be able to adapt itself based on changes occurring in its environment, so that a change in circumstances will still yield the intended result (p. 15).

One of the software or computer agents is a negotiation agent, which aids in the e-trading process; specifically, it helps to find traders more efficiently, which allows traders to negotiate by exchanging messages. Also, another one of the software agents that help SMEs to collaborate between the SMEs and improve the coordination among the SMEs agents in the e-trading process is a consortium agent (Zhu and Liang, 2009).

Computer or system negotiation agent. Negotiation is defined, according to the Western Organization of Resource Councils (WORC), (1998) as “the art of getting what you want from someone who has the power to give it to you” (p. 1). Negotiation in trading contains three parties which are buyers, negotiators, and sellers (Webb, Maughan, Maughan, Boon & Keppel-Palmer, 2011). In addition, the “Negotiation (or bargaining) is a sequence of actions in which two or more parties address demands and proposals to each other for the ostensible purposes of reaching an agreement and changing the behavior of at least one actor” (Odell, 2009, p. 4). Example: “Citizens’ groups spend great amounts of time, energy, and resources getting to the point where they can negotiate with a government agency or corporation” (WORC, 1998, p. 1). In the negotiation, the negotiator will be the entity that is responsible for the negotiation process and the result of trading between the buyer and seller (Webb et al., 2011). The negotiation agent: a) helps negotiate between the buyer’s and the seller’s opinions about the contract, b) helps the buyer and seller by providing more information of the product from old contracts, and c) helps to reduce the time for both buyers and seller by reducing the search time (Chartered Institute Of Purchasing & Supply, 2007).

Negotiation agent types. There are many different types of negotiation agents: autonomous agents, software agents, and intelligent agents (Luck & d'Inverno, 2001). The System agent according to Smith et al. (1994) is “a persistent software entity dedicated to a specific purpose” (p. 60). Also, Selker (1994) said the agent “computer programs that simulate a human relationship by doing something that another person could do for you” (p. 92). In addition, Janca (1995) defines that agent as a software entity which runs tasks instead of another.

Negotiation characteristics. The negotiation includes three parties which are buyer(s), negotiator, and seller(s) (Webb et al., 2011). In the negotiation, the negotiator takes a whole responsibility for the outcomes of trading and negotiation process (Webb et al., 2011). According to Webb et al. (2011), the following common characteristics are suggested:

- Negotiation contains two or more parties where each one needs to achieve some desired outcome.
- While parties share an interest of commodity, the parties begin with different objectives that might prevent to them of achieving an outcome.
- The parties see the negotiation as a perfect way to help them resolve the differences of their objectives.
- Each party knows that it is a possibility to modify their original opinion.
- Even the parties might reach unacceptable results of negotiations; all parties have some hope to achieve an acceptable final agreement.
- Each party has some power in negotiation that it can use to effect on the others to follow his desired outcome.
- The negotiating process itself is one of interaction between the parties, and the negotiation is influenced by emotions and attitudes.

Computer or system consortium agent. The consortium means two members or more are collaborating together to achieve their goal as buyer or seller, such as exchanging information or buying or selling products (Cassivi, Saives, Labzagui &

Hadaya, 2009). Also, the consortium definition for a local government is "an arrangement to optimize buying power and make the best use of scarce procurement skills by aggregating the requirements of more than one local government organization" (Local t-gov, 2007, p. 4). The consortium-based e-marketplace can “start with liquidity introduced by its owners, the buying power of the consortium partners can help to receive volume rebates in procurement” (Baldi, & Borgman, 2001, p. 635). The consortium improves the power of the buyers in the negotiation with sellers (Soh & Markus, 2002; Local t-gov, 2007). The main goals of consortiums in e-marketplaces are: a) to reduce the price of products for a consortium of buyers, and b) to increase the selling or buying of the product for a consortium of traders (Soh & Markus, 2002). The benefit of consortium e-marketplaces from a buyer’s side is that it integrates a group of buyers. i.e., SMEs, as one organization to negotiate with large sellers online to reduce cost or to improve their negotiation power about the product’s characteristics (Soh & Markus, 2002). In addition, the income of consortiums in e-marketplaces usually comes from membership fees, transaction fees, and consulting fees (Soh & Markus, 2002).

Consortium types. There are two consortium types to improve the power of buyer or seller based at the corporate level: 1) a joint committee, 2) collaboration with others without creating a joint organization (Local t-gov, 2007).

Joint committee: it is defined as “Local authorities pool their procurement activities in a joint committee under section 101 (5) of the Local Government Act 1972 (Local t-gov 2007). The joint committee sets policy and oversees the operations of the officers carrying out the pooled work” (Local t-gov 2007).

Collaboration without a statutory joint committee: collaboration will be occurred when “authorities agree to collaborate according to agreed protocols covering the scope for collaboration, exceptions, and sharing risks” (Local t-gov 2007).

Advantages of purchasing consortium for SMEs. The Advantage for SMEs in purchasing consortium is not only reducing the cost of goods but also services. There are other benefits such as economies of scale, economies of process, and economies of information. The detail of every advantage is as follows:

- *Economies of scale:* the companies are improving the ability to attain lower prices and increase the power of negotiating for the larger consortium (Rozemeijer, 2000).
- *Economies of process:* the companies can share the purchasing and administrative information to simplify purchasing processes (Rozemeijer, 2000). The purchasing group may also review areas that may include outside vendors or software programs to decrease workload and expenditure (Rozemeijer, 2000).
- *Economies of information:* the companies may share Information between members of the consortium (Rozemeijer, 2000). The members of groups also may share their knowledge based on their experiences, and skills within the diverse companies (Rozemeijer, 2000). This may help to improve quality of goods and services and reduce wasteful expenditure (Rozemeijer, 2000).

Disadvantages of purchasing consortium for SMEs. There are disadvantages for SMEs in purchasing consortium such as internal resistance, vendor resistance, and monitoring program design. The list of consortium disadvantage is as follows:

- *Internal resistance*: some members in the consortium feel that the large companies do not completely meet their needs (esourcingwiki, n.d.). Although, the consortium returns big benefits to them (esourcingwiki, n.d.).
- *Vendor resistance*: some vendors of consortium like to remove some members if they join in the consortium (esourcingwiki, n.d.). Those vendors do not like to work in consortium with different sizes of vendors (esourcingwiki, n.d.).
- *Monitoring program design*: the members in the consortium have different benefits in plan design. The plan design might give some members more benefit than others (esourcingwiki, n.d.). Also, the misunderstanding or changing might affect some members (esourcingwiki, n.d.).

Chapter 3: Methodology

This chapter has three parts. The first part discusses the intelligent negotiation agent in the plastic market. The second part discusses the improvement of the intelligent consortium agent for small and medium enterprises (SMEs) in the plastic market. The third part discusses the improvement of the plastic market by using consortium and negotiation agent for small and medium enterprises (SMEs). Each part discusses one of the three dissertation questions. Question 1 is “Can an automated negotiation agent with Estimated Reserved Price Range (ERPR) improve the efficiency of the market for buyer’s negotiation against the seller?” Question 2 is “Can an automated consortium agent based on Modified Knapsack Problem Algorithm (MKPA) improve the trading volume for SMEs in e-marketplace?” Question 3 “Can the combination of an automated consortium and negotiation agents improve the market efficiency for Small and Medium Enterprises (SMEs)?” Every part includes the objective, algorithms system description, and system simulation.

Part I: Intelligent Negotiation Agent in Plastic Market

This part explains the objective of intelligent negotiation, related work, negotiation model, system design, system object map, and simulation system for the plastic market.

Objective

The e-marketplace or e-commerce system was to present the online simulation trading that will answer the first dissertation question, which is “Can an automated negotiation agent with Estimated Reserved Price Range (ERPR) improve the efficiency of the market for buyer's negotiation against the seller?" In the first part, a simulation for an e-commerce system had been built to answer the dissertation questions.

The system is to improve the design of a framework for an automated negotiation agent by developing the negotiation process, which extends an existing negotiation model process (Kim & Segev, 2003). This system implements the buyer's and seller's Estimated Reserved Price Range (ERPR) and buyer's conditions. The targeted market of the negotiation agent is a plastic market.

Negotiation Related Work

Many research papers showed that the negotiation agents have been used for negotiating the product or service price in the market or for exchanging information between businesses. Also, some e-marketplace systems applied automated negotiation focusing on negotiation protocols and other resources such as negotiation rules, negotiation strategies, lessons learned or game theory (e.g., AuctionBot, Kasbah).

The Michigan Internet AuctionBot was developed under the leadership of Dr. Wurman (1998a) in 1995 in collaboration with the Department of Computer Science & Engineering at the University of Michigan (Allen, Hawkins & Sato, 2001; Fortino et al., 2005). It is a general Internet auction. The AuctionBot gives an authorization for the users to create their own auctions, which allows them to sell products, and also allows them to select the auction types based on choosing the controlling bidding protocol and auction rules (Wurman, Wellman & Walsh, 1998a; 1998b).

Kasbah was developed at MIT Media Lab (Chavez, Dreilinger, Guttman & Maes, 1997). It is an online multi-agent that allows the users to create buyer or seller agents to help in the handling of goods on their behalf, and provide some direction of negotiation strategy for agents, and send it to centralize agents of the marketplace (Chavez et al., 1997; Guttman, Moukas & Maes, 1999). Every agent has a goal, which is to complete an appropriate deal under an agent's condition such as price (Chavez & Maes, 1996). The Kasbah uses a double action mechanism; and the negotiation process in the Kasbah is straightforward (Chavez et al., 1997; Guttman et al., 1999; Chavez & Maes, 1996).

In other research papers, the automated negotiation focused on negotiation protocols. In Jennings, et al., the automated negotiations can deal with three broad topics: negotiation protocols, negotiation objects, and agents' decision-making models (Jennings, He, Rogers & Luo, 2006). The Yin, Li, and Zhi had developed a negotiation agent in a multi-agent simulation by using Netlogo (Yin, Li & Zhi, 2010). A simulation is conducted between businesses and customers (Yin et al., 2010). The simulation runs to test some components that are the number of businesses, the number of customers, the purchasing power, and the cost (Yin et al., 2010). In a paper by Jennings, et al. (2006), the authors applied the simulation of the trading agent by implementing a mix of procurement strategies and by using the market situation and its inventory level to decide the price. Also, it analyzes the buying and selling strategies in the competition and in restricted endeavors (Jennings et al., 2006).

Liang had developed a B2C e-commerce system with intelligent negotiation to reduce the responding time to the customer (Liang, 2009). The negotiation model includes four phases: information, search, negotiation, and evaluation (Liang, 2009). Liang had applied fuzzy theory and analytical hierarchy process to make the user's inputs easy by developing the system interface (Liang, 2009). Hai-wen, De-yu, and Bin had developed a multi-agent base model for the resource-oriented automated negotiation agent (Hai-wen et al., 2010). The idea of the system is that the negotiation agent relies on information from the previous experience (Hai-wen et al., 2010). Also, it changes its strategy automatically according to their resource and preferences.

Kim and Segev explained the importance of the Negotiation processes in dynamic eBusiness (Kim & Segev, 2003). Also, they explained the framework for constructing dynamic negotiation processes as follows: 1) negotiation requirements, 2) negotiation structure, 3) negotiation process, 4) negotiation protocol, and 5) negotiation strategy.

Negotiation Protocol

In the negotiation model, there are three processes, which affect the negotiation agent. The processes are Resource-Oriented Process, Estimated Reserved Price Range (ERPR) Process and Supporting Agent's Dynamic Strategy.

Resource oriented. The resource-oriented negotiation as mentioned in the introduction can be divided into two types: a) Static Resource is the basic feature (e.g., number of buyers, and sellers, and goods), and b) Dynamic Resource is the product's information (e.g., price, quality, quantity, transportation time) (Hai-wen et al., 2010). Also, the Market environment affects the product price (e.g., information of the product in market, and market index change, competition) (Hai-wen et al., 2010).

Estimated reserved price range (ERPR). A trader can have his own reserved price range. The reserved price range can affect the trader's decision when a trader bids or offers a price for plastic products. In this section of the dissertation, it is assumed that a trader's reserve price range depends on two factors: (1) the market index change (MI) which is dependent upon the fluctuation of the market; and (2) the number of participating traders' agents (NP). A trader's reserved price is generated from those two factors by ranged random in the simulation. Because this trader's reserved price is based on the market index as well as the number of competing traders, it reflects the market trend at certain point of time. One difficulty in this research is that there are no companies that publish how they really calculate their own estimated price range in real market. The implementation of the estimated reserved price range is to assist the buyer's agent in decision making in negotiation with the sellers' agent. The market conditions can be represented by five cases: fast rising, moderate rising no changes, moderate declining, and fast declining. Also, a buyer's potential trading price is calculated based on the market index (MI) by using following formula:

Buyer potential price = Market Price – Market Price * MI /scale-factor.

Now the system can calculate the estimated price range as well as the buyer's potential price. For example, if the market index moves up quickly then the system will generate a number Radom High (RH) that reflects the high estimated reserved price. Also, Random Low (RL) is represented as the number that is used to generate the percentage for low estimated reserved price. The high estimated reserved price and low estimated reserved price represent the estimated reserved price range. The formulas are described as follows:

Random High = MI * scale-factor + random (MI) – NP
High Estimated Reserved price = buyer potential price +
(Random High * buyer potential price)
Random Low = MI * scale-factor - random (MI) + NP
Low Estimated Reserved Price = buyer potential price –
(Random Low * buyer potential price)

Supporting agent's dynamic strategy. Instead of having a static negotiation strategy, the proposed system supports the buyer's agent in a dynamic strategy. When a negation is about to start, the system provides a series of different information: a list of participating sellers' agents, the estimated reserved price range, seller agents on the search list, and a filtered seller list based on buyer's search conditions at the time of negotiation. This timely and customized information will be used for buyer agent's trading negotiation, and will improve its performance in favor of the buyer's agent.

Simulation System for the Plastic Market (SSPM)

The Simulation System Plastic Market (SSPM) is to simulate the trading between the buyer's and the sellers' agents in the plastic market, based on negotiation and non-negotiation algorithms. In this section, the SSPM Description, SSPM architecture, and SSPM subsystems are explained below.

SSPM description. The e-commerce system was to represent buyer and seller agents that communicated each other by using negotiation and non-negotiation algorithms in simulation e-commerce trading module. Also, the e-commerce system takes in the buyer's trading conditions. In addition, the negotiation algorithm used the Estimated Reserved Price Range (ERPR). The proposed e-commerce system produces both negotiation trading results and non-negotiation results for the analysis.

SSPM design. In this section, not only the SSPM architecture but also SSPM subsystems architectures, which are generator, knowledge domain, negotiation, and non-negotiation, are explained.

SSPM architecture. The SSPM e-commerce system is composed of a data Generator and three subsystems, which are knowledge domain, negotiation, and non-negotiation. The Generator Subsystem (GS) takes traders' trading preferences and generates trading parameters for the subsystems. The Knowledge Domain

Subsystem (KDS) receives information from the GS and sets up product information for both the buyer and the sellers. Also, the KDS sets up the buyer's conditions and calculates the market situation for both negotiation and non-negotiation subsystems. In addition, the KDS provides the random numbers for both the buyer and the sellers to calculate their Estimated Reserved Price Range (ERPR) in negotiation subsystem. The negotiation subsystem assumes that a buyer communicates with sellers based on ERPR to choose a contract. On the contrary, in the non-negotiation subsystem, a buyer checks only the lowest seller price to check the potential sellers.

Decomposition description. Figure 1 shows SSPM components, which are generator, knowledge domain, negotiation, and non-negotiation subsystems. Also, it shows how they related to each other. Figure 1 shows only the main modules: the subsystems are explained in the following section (SSPM Subsystems Architecture).

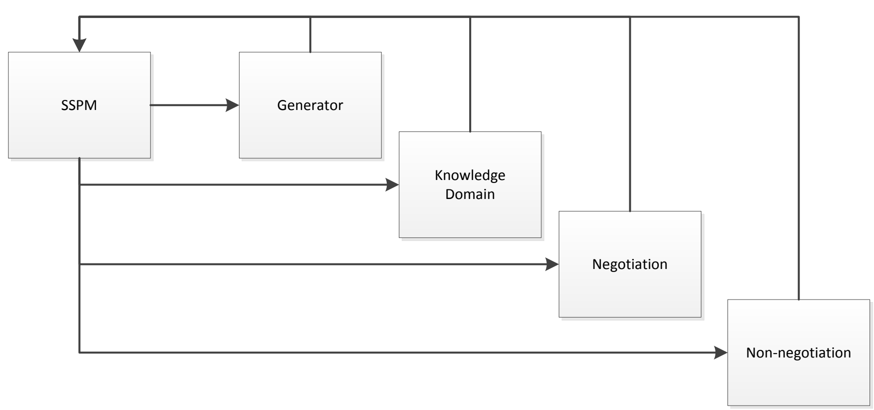

Fig. 1. SSPM Components

Functional. The Flow Chart in figure 2 shows generator, knowledge domain, negotiation, and non-negotiation subsystems. It also explains the SSPM subsystems in terms of functions. Each function in a subsystem serves the system's purpose. These functions in the Flow Chart shows how the generator works and connects to knowledge domain subsystems, negotiation, and non-negotiation subsystems together. Figure 2 also shows the algorithm of SSPM in general. The details are in SSPM Subsystems Architecture. Figure 2 explanation follows:

Generator subsystem**.** The generator has two main functions, which are to get user inputs, and build agents during the user inputs acquisition phase, information such as the number of the seller and the buyer agents and market information is gathered. After the user input, the Generator builds the agents and then sends the market information to SSPM. After that, the SSPM runs knowledge domain subsystem.

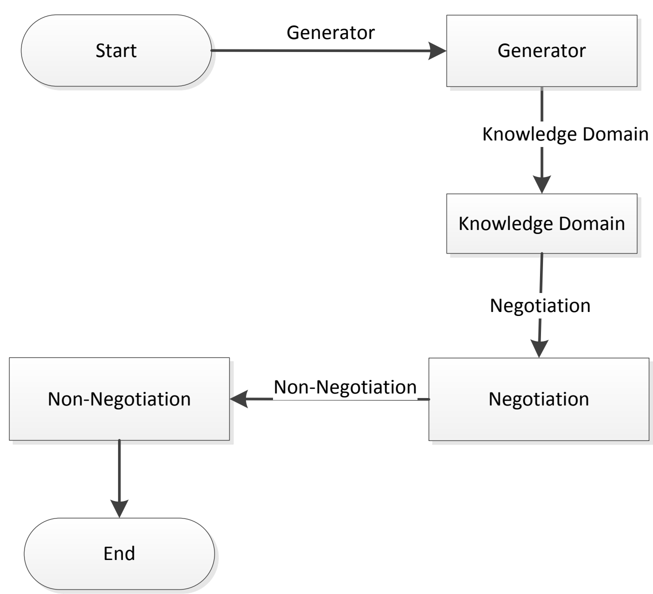

Fig. 2. SSPM Function Components

Knowledge domain subsystem. The Knowledge Domain

Subsystem (KDS) sets up the buyer's information, which is product's name, product price, date needed, and location. Also, the KDS sets up the sellers' information, which is product name, price, availability date, and location. In addition to the traders' information, the KDS calculates the random numbers, which reflect the buyer and sellers' Estimated Reserved Price Range (ERPR). The ERPR is used in the negotiation process during the simulation only for the negotiation subsystem and non-negotiation subsystem does not use it.

Negotiation subsystem. The Negotiation Subsystem (NS) allows both the buyer and the seller to communicate by sending and receiving messages to select contracts. The negotiation subsystem includes many functions which are retrieve Estimated Reserved Price Range (ERPR), start negotiation, decision reply, accept, reject (within range), reject (out of range), continue negotiation, contract, and end negotiation. All of those functions work together to make negotiation between the buyer and sellers. The details of the negotiation functions are in the negotiation subsystem architecture section.

Non-Negotiation Subsystem. The Non-Negotiation Subsystem (NNS) includes exact match and end subsystems. All those functions work together to find out the lowest selling price among potential sellers. The detail of the non-negotiation function module is in the non-negotiation subsystem architecture section.

SSPM subsystems architectures. The SSPM has four subsystems, which are Generator, Knowledge Domain, Negotiation, and Non-negotiation. In this section, the architecture for those four subsystems is explained.

Generator subsystem. The Generator Subsystem (GS) is considered the main subsystem and this module provides services to other subsystems. The GS works to get the user inputs and builds the buyer and sellers agent. After building the agents, the GS sends information to SSPM. The details of the GS are explained below:

Decomposition description. Figure 3 shows how GS works with the SSPM. The SSPM requests service from GS to get the user input and this input will be used for running the negotiation and non-negotiation simulations. The details of GS are explained in the functional section below.

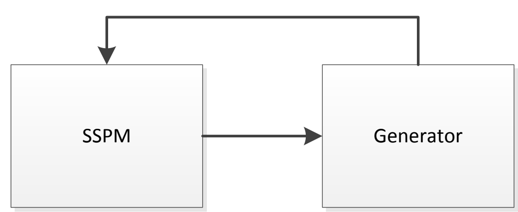

Fig. 3. Generator Subsystem Components

Functional. The Generator has two functions: one is to get user input and the other is building agents. Figure 4 shows the algorithm of Generator module.

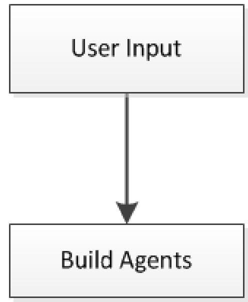

Fig. 4. Generator Function Components

User inputs. The trading related data is gathered as user input. The gathered information will be sent to other sub-modules for trading simulation parameters. The content of user input is the number of buyers and sellers, market product's price, and market index situation.

Build agents. The Generator Subsystem generates the agents. When an agent is generated, all the inputs that are gathered in user inputs sub-module will be used. At this point, the generated agent does not have knowledge domain yet and the generated agent will be sent to the knowledge domain subsystem for domain knowledge.

Knowledge domain subsystem. The Knowledge Domain Subsystem (KDS) is to set up the buyer's information which are product name, price, date need it, and location. Also, it is used to set up the sellers' information, which is product name, price, availability date, and location. In addition, the KDS calculates the numbers, which are used in Estimated Reserved Price Range (ERPR) generation for both the buyer and the sellers. The ERPR is used only for the negotiation subsystem.

Decomposition description. Figure 5 shows how KDS works with SSPM. The SSPM use KDS to set up trading information which assists to run the negotiation and non-negotiation simulations. The details of KDS are described in the functional section below.

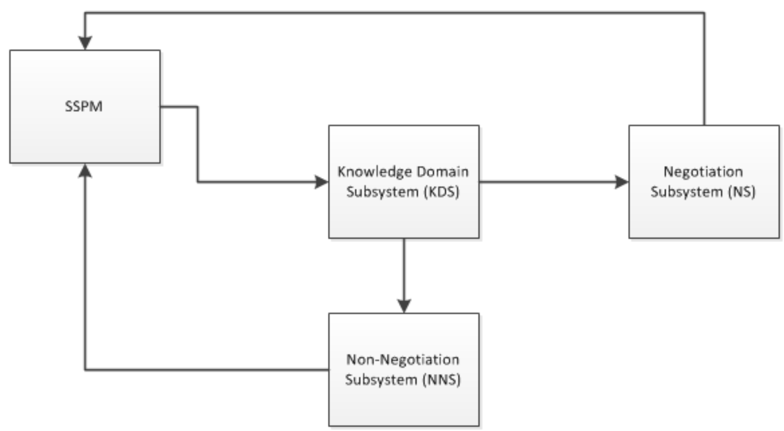

Fig. 5. Knowledge Domain Subsystem

Functional. The KDS has five functions, which are set setup product information, setup buyer conditions, search for a product, and calculate numbers for Estimated Reserved Price Range (ERPR). Figure 6 shows the algorithm of KDS in general. The KDS functions are described as follows:

Setup product information. The inputs for the KDS are the newly generated buyer's and the sellers' agents. The sub-module sets up the product information, which is the product's name, price, and availability date for the buyer and the sellers. The product information is randomly set up for both the buyer and the sellers for simulations. The outputs of this module will be the buyer and the seller agents with domain knowledge.

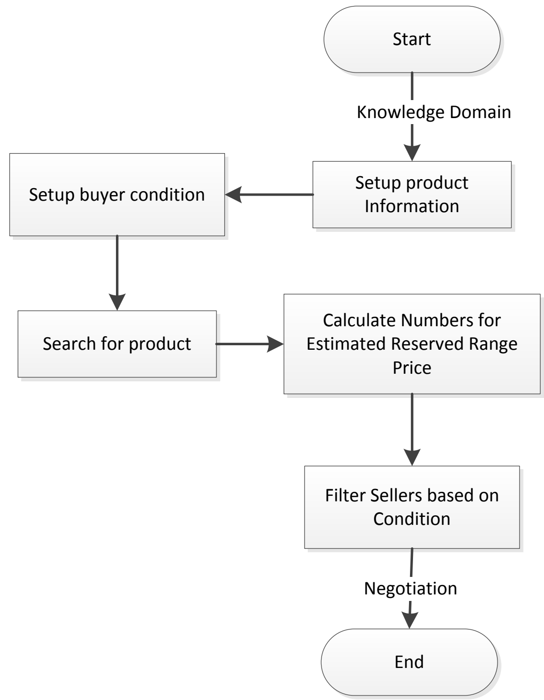

Fig. 6. Knowledge Domain Subsystem Function Components

Setup buyers' conditions. The input for the setup buyers' conditions sub-module is the buyer's agent and the product information. This sub-module makes the buyer agents ready for the given trading product. During simulations, the actual buyer's condition is randomly set up. The output from this sub-module will be the updated buyer agent with specific trading conditions for the given product.

Calculate the number for Estimated Reserved Range Price (ERPR). The sub-module calculates ERPR prices for both buyers and sellers' agents and these ERPR prices will be used for trading negotiations. The output of this sub-module is the ERPR Numbers for buyer and seller agents.

Search for product. The inputs for this sub-module are buyer's product information and the sellers' product information. The function of this sub-module is to find out the potential sellers who have the product that matches with the buyer's product description. The output of this sub-module is a list of the sellers.

Filter sellers based on the buyer's conditions. The inputs of this sub-module are buyer's conditions and the list of the sellers. The function of this sub-module is to filter out sellers based on the buyer's conditions, which are price, location, and date needed. The module will remove the sellers who do not match the buyer's search conditions. The output of this sub-module is an updated list of the sellers.

Negotiation Subsystem. The Negotiation Subsystem (NS) is composed of two subsystems, which are a negotiation subsystem and knowledge domain subsystem. The details of design, functional, and UML sequence diagram for NS is described as follows:

Negotiation subsystem design. The Negotiation Subsystem (NS) is a system for the buyer and the sellers to negotiate about the product price if the seller accepts the buyer's conditions. After the SSPM gets the user inputs from Generator Subsystem (GS), the NS starts working with

Knowledge Domain Subsystem (KDS). As the section explained earlier, the KDS is considered to get some information from Generator system to set up product information for both the buyer and the sellers. Also, KDS sets up buyer's conditions, and calculate the market situation. The KDS provides the random number to associate both the buyer and the sellers to calculate their own Estimated Reserved Price Range (ERPR). After getting the random numbers, the NS sends those numbers to every agent to calculate its own ERPR. The NS receives a new list of sellers from KDS then sends it to the buyer and allows the buyer agent to negotiate with the list of the sellers about the product's price, until a deal with one of the sellers is possible based on the buyer's own ERPR.

Decomposition description. The components for the Negotiation Subsystem (NS) are SSPM and KDS. Figure 7 shows how the negotiation subsystem works with both SSPM and KDS. The details of negotiation are in the functional section below.

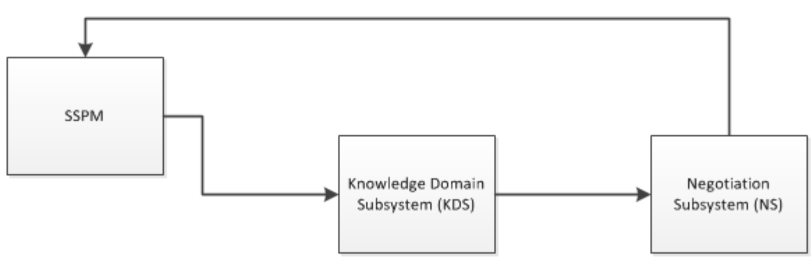

Fig. 7. Negotiation Subsystem Components.

Functional. The NS works with SSPM and knowledge domain. Figure 8 explains the Flow Chart algorithm for Negotiation subsystem.

The negotiation subsystem functions include, calculating estimated reserved price range, calculate offer price, send an offer, receive a response, decision reply, continue negotiation, modify negotiation, and end the negotiation. All those functions work together to make negotiation between the buyer and the sellers. The detail of the negotiation functions will be described below.

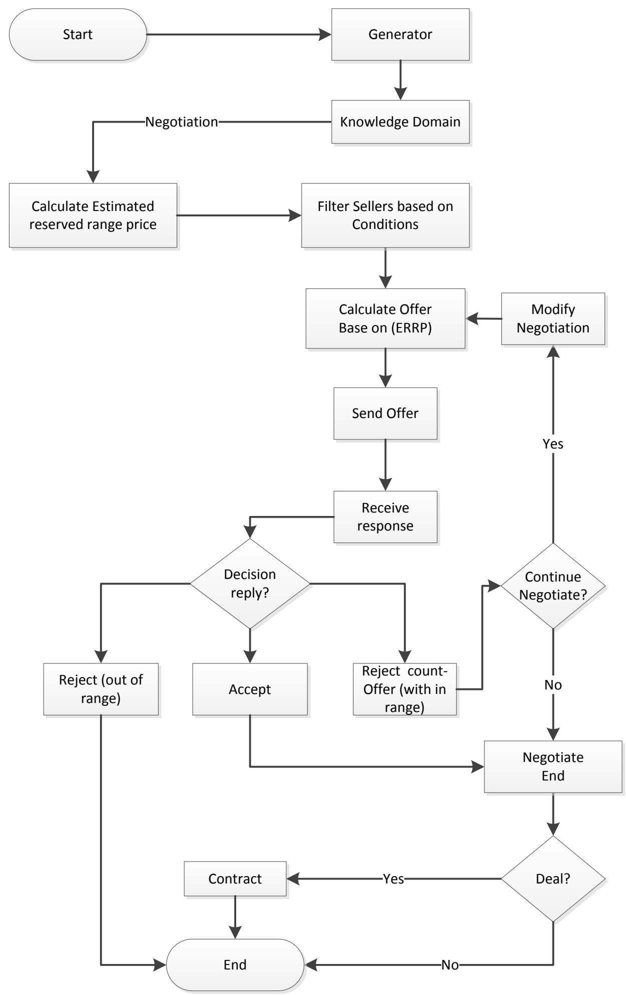

Fig. 8. Negotiation Flow Chart for Subsystem Function Components

Generator subsystem. As the section explained earlier, the Generator gets user inputs and builds the buyer's and the sellers' agents and then sends them to KDS through the SSPM.

Knowledge Domain Subsystem. As explained earlier, the Knowledge Domain Subsystem (KDS) provides numbers that both the buyer and the sellers use to calculate ERPR and provides a list of the sellers to the buyer.

Calculate reserved range price. The inputs are the market product price, and the market index change to capture the real market index: The market can change in the following five ways: 1) the market index goes up quickly; 2) the market index goes up slowly; 3) the market index will be stable; 4) the market index goes down slowly; and 5) the market situation goes down quickly. The operation is to calculate the reserved price range for the buyer, which is a price range that includes the highest and lowest price based on product's market price, market index change, and the number of sellers who sell the product. The output is estimated reserved price range.

Filter sellers based on the buyer's conditions. The inputs are buyer's conditions and the list of the sellers. The operation is to filter all sellers based on the buyer's conditions, which are price, location, and date needed, then get out the seller who does not match the buyer's conditions. The output is a new list of the sellers.

Calculate Offer. The inputs for this sub-module are the buyer's conditions, and the estimated reserved price range. The operation is to calculate the product's price offer. The output this sub-module is the buyer's offer price.

Send Offer. The inputs of this sub-module are the product's price offer, and the new list of sellers. The operation is to send the price offer to the all sellers who are on the list. The output is "waiting" for the sellers' response.

Receive response. The input of this sub-module is the sellers' response to the offer of the product. The operation is to calculate and re-sort the sellers' counter-offers from lowest price to highest price. The output is a list of the sellers' for the counter-offers.

Decision reply. The inputs of this sub-module are the buyer' offer, the product's market price, the market index change, and the sellers' response, which are either a counter-offer or an acceptance. If the seller's response is "Accept" then the operation will do nothing and the output is "Accept." If the seller's response is a "Counter-offer" then the operation is to make a decision based on the estimated reserved price range, and the buyer's conditions. In this situation, there are three possible decisions: 1) "Accept" in which the buyer accepts the count-offer; 2) “Reject Count-offer (with range)” in which the buyer does not accept the sellers’ count-offer; 3) “Reject (out of range)” in which the seller’s offer is higher than the highest price of the estimated reserved price range. The details of the three buyer’s decisions are described below:

Accept. The input of this sub-module is the buyer’s decision, which is “Accept.” The operations are to signal to finish communication with the trading seller with acceptance message and send to all other sellers with reject message. The outputs are “Deal with seller” to the selected seller and “Reject” message to all other sellers.

Reject count-offer (within range). The inputs of this sub-module are buyer’s decision, which is “Continue Negotiation”, and received sellers’ count-offer. The operation is sending “continue negotiation” signal to the seller. The output is the buyer’s message of “continue negotiation.”

Reject (out of range). The input of this sub-module is the buyer’s decision, which is “Reject”. The operation is to finish the communication with sellers. The output is “Finish communication.”

Continue Negotiation. The input of this sub-module is the buyer’s message “Continue Negotiation” and the list of sellers’ count-offers. The operation is to make the decision to continue communication with the seller or to finish negotiation, which may reach the highest of the estimated reserved price range. The output is either to continue communication, or to stop communication.

Modify Negotiation. The inputs of this sub-module are the buyer's message and the sellers' count-offers list. The operation is to make new of the buyer's offer. The outputs are new offer, and the sellers' count-offer list.

Negotiation End. The input of this sub-module is "Accept" message and seller information, or "Stop" message. The operation could be inform the seller "Accept" message, it means "Deal" or send "Stop" message to the seller, it means "No-Deal". Also, the additional operation is to finish the negotiation process.

Deal. The input of this sub-module is "Deal" or "No-Deal". If the message is "Deal" then the operation is to make a deal with the seller. If the message is "No-Deal" then the operation does not do anything but ending the negotiation process

End. The Negotiation subsystem is to finish the negotiation between the buyer and the sellers.

Sequence Diagram for Negotiation Subsystem. The sequence diagram below (figure 9) shows how negotiation subsystem communicates between a buyer and sellers. In the beginning, a buyer searches for the product by sending a broadcast message to all sellers through KDS. The seller who has the product sends a reply message back to the buyer about the product information. The buyer filters the sellers based on the buyer's condition through KDS. The negotiation process loop between buyer and sellers starts by sending one of the three options, which are send offer, accept, or reject. In the seller's side, the seller sends one option out of three, which are send count-offer, accept, or reject. The communication continues between the seller and the buyer until one of the two events happens which is "Accept" or "Reject" from the buyer or seller. In the confirmation which happens at the end, the buyer sends "Accept: true" which means the buyer accepts the offer or "Accept: false" which means the buyer rejects the offer.

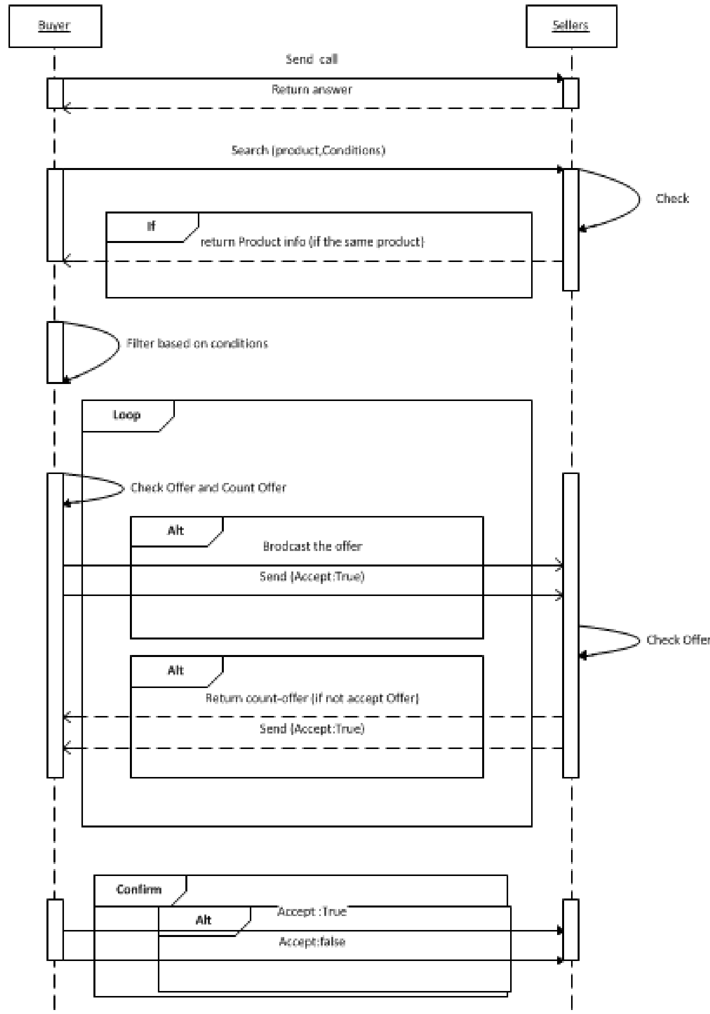

Fig. 9. Sequence Diagram for the Negotiation Subsystem

Non-negotiation subsystem. The Non-Negotiation Subsystem (NNS) has two subsystems, which are non-negotiation subsystem and knowledge domain subsystem. Detail of design, functional, and UML sequence diagram will be followed.

Design. The Non-Negotiation Subsystem (NNS) is a system for the buyer and the sellers to check that the seller product's price is suitable for the buyer. After the Generator Subsystem (GS) gets the user inputs, the

SSPM runs Negotiation Subsystem (NS) and then runs The Non-Negotiation Subsystem (NNS). The NNS starts working with Knowledge Domain Subsystem (KDS). As the section explained earlier, the KDS is considered to get some information from SSPM to set up product information for both the buyer and the sellers, buyer's conditions, and calculate the market situation. The KDS provides the random number to associate with both the buyer and the sellers to calculate their own Estimated Reserved Price Range (ERPR). The NNS allows the buyer to check the lowest product price from the sellers to see if it is suitable with the buyer's price.

Decomposition description. The Non-Negotiation Subsystem (NNS) has SSPM, and KDS. Figure 10 shows how the negotiation subsystem works with both SSPM and KDS. The details of negotiation are described in the functional section below.

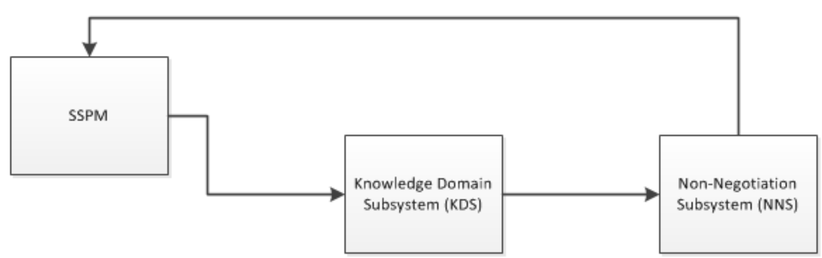

Fig. 10. Non- Negotiation System Components

Functional. The Non-Negotiation Subsystem (NNS) works with SSPM and Knowledge Domain Subsystem (KDS). Figure 11 shows the Flow Chart algorithm for the (NNS). The NNS functions include checking the lowest price, decision, contract, and end non-negotiation. All those functions work together to make a contract between the buyer and sellers. The detail of the non-negotiation functions described as follows:

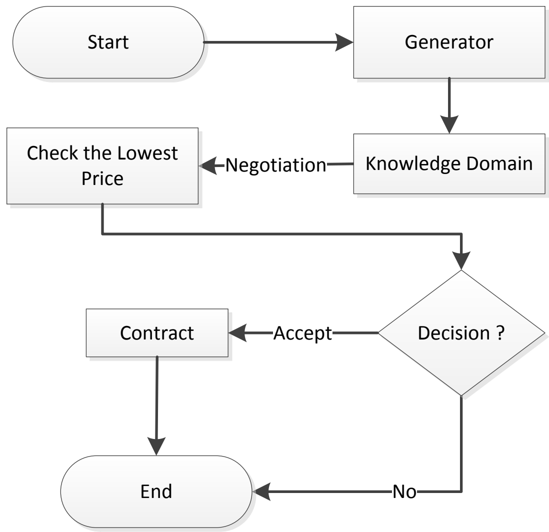

Fig. 11. The Flow Chart of Non-Negotiation Function

Check lower price. The input of this module is the list of the sellers. The operation is to get the lowest seller's product price from the given list. The output of this module is the lowest price among sellers' offer prices.

Decision. The input of this module is the lowest seller's price. A buyer makes a decision based on the lowest seller's ask price and the buyer's offer price. The output could be one of the two cases: appropriate which means "Accept," or not appropriate which means "Reject." is finished with the seller; the end should be "Deal" or "No Deal."

Sequence Diagram for Non-Negotiation Subsystem. In this function, the non-negotiation subsystem is finished with "Deal" or "No Deal."

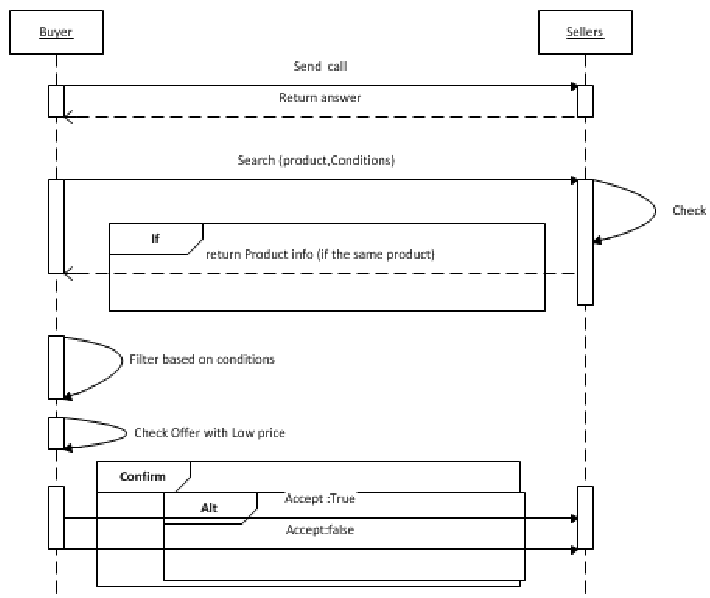

Fig. 12. Sequence Diagram for the Non-Negotiation Subsystem

In the beginning, the buyer searches for the product by sending a broadcast to all sellers. The sellers who have the product send a message to the buyer about the product's information. The buyer filtered the sellers based on the buyer's conditions. In NNS, the buyer has only one option that checks the lowest product price to see whether he can afford this product. The buyer compares prices between the buyer's reserved price and lowest price from all sellers. If the lowest price meets the buyer's reserved price then the buyer sends "Accept: true" message otherwise sends "Accept: false" message.

SSPM Class Description

The SSPM Architecture is explained in the previous section. In this section, the SSPM object classes will be explained. The SSPM object classes are Generator, Knowledge Domain, Negotiation, and Non-Negotiation subsystems. In brief, this section shows how all the object classes work together in SSPM and its subsystems. The object classes in the Generator subsystem take user inputs for setting up the buyer's and sellers' agents. The knowledge domain object classes receive user inputs from the Generator Subsystem in SSPM. The Knowledge Domain Subsystem will use the received user inputs for setting up the product information in the agents. Also, the KDS also sets up buyers' trading conditions, and both the buyer's and the sellers' price range for the product. The Negotiation object class takes inputs from SSPM through the Generator and from Knowledge Domain. In addition, it also let the negotiation subsystem calculate the Estimated Reserved Price Range (ERPR) for the buyer agent and then make the buyer to communicate with the sellers. In addition, it makes the Negotiation Subsystem send the buyer's offer to the sellers and receives the sellers' count-offers or sellers' acceptance message. Moreover, the non-negotiation object classes find trade partners in exact price matching.

SSPM classes work. The SSPM has the four subsystems, which are the Generator, Knowledge Domain, Negotiation, and Non-Negotiation. Every subsystem is explained in detail below. However, both negotiation and non-negotiation subsystems used the same data for comparison analysis. Both subsystems use the same buyer and same list of the sellers' agents for simulations, and they work sequence. Figure 13 shows how the system runs the Generator classes.

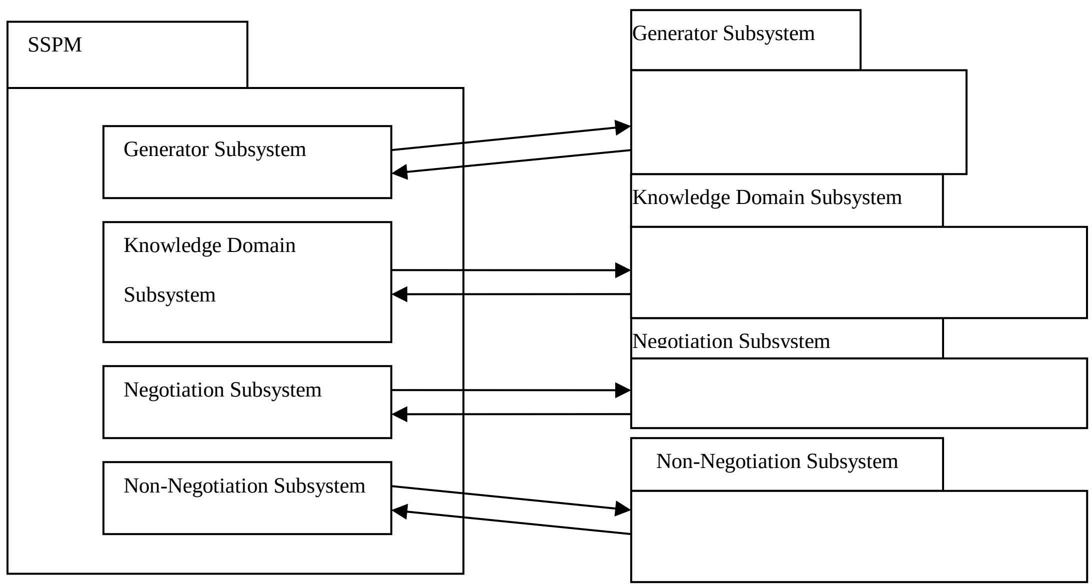

Fig. 13. The SSPM System Class Map

Generator subsystem. In the beginning, the SSPM runs the Generator Subsystem (GS) to take four different types of information from the user: 1) how many buyer agents are needed in the simulation trading, 2) how many seller agents are needed in the simulation trading, 3) e market product's price, and 4) market index trends which can be represent by numbers between 1 and 5: 1) the market goes up fast; 2) the market goes up slow; 3) the market is stable; 4) the market goes down slow; and 5) the market goes down fast. The market index range 1-5 simulates a real market plastic's price fluctuation and to capture the buyer agent behavior. The different product's prices present a real plastic market trading.

After that, the Generator builds the buyer agent and list of the sellers' agents by calling agent building object class. After the agents are built, the Generator returns a list of the buyer's and the sellers' agents with other information to the SSPM e-commerce system. The SSPM runs the Knowledge Domain Subsystem, Negotiation Subsystem and then runs the Non-Negotiation Subsystem in sequence. Figure 14 shows how the system runs the Generator classes.

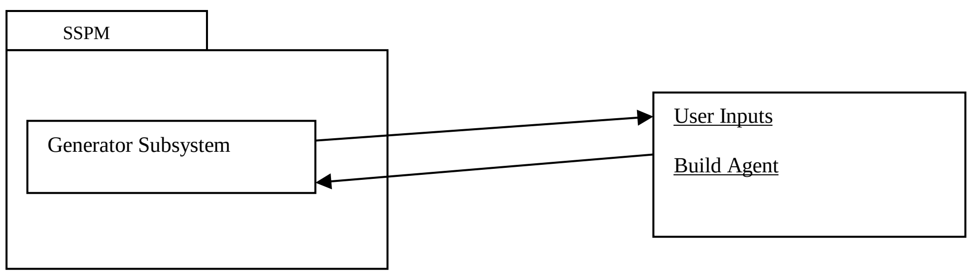

Fig. 14. The Generator Subsystem Class Map

Knowledge domain subsystem. The Knowledge Domain Subsystem (KDS) takes the list of the buyer's and the sellers' agents from the Generator. It also takes the user inputs from SSPM. Figure 15 shows how the KDS runs its object classes to setup product and other functions. The KDS randomly assigns the product's name, price, date needed, location, first condition (price, date, location), and the second condition (price, date, location) for the buyer agent by calling product information class. Also, the KDS randomly assigns the product's name, price, availability date, and location to the list of a seller's agent by calling product information class. In addition, the KDS generates a market trend, which is represented by a random number between one and five based on the user input. Later this market trend will be used for generating ERPRs for the buyer's and sellers' agents. The KDS searches sellers who has the buyer's wanted product and makes a list of the matched sellers. Then the KDS filters out the sellers who do not have the same conditions as the buyer. The KDS sends the buyer and a new list of sellers' agent to the SSPM.

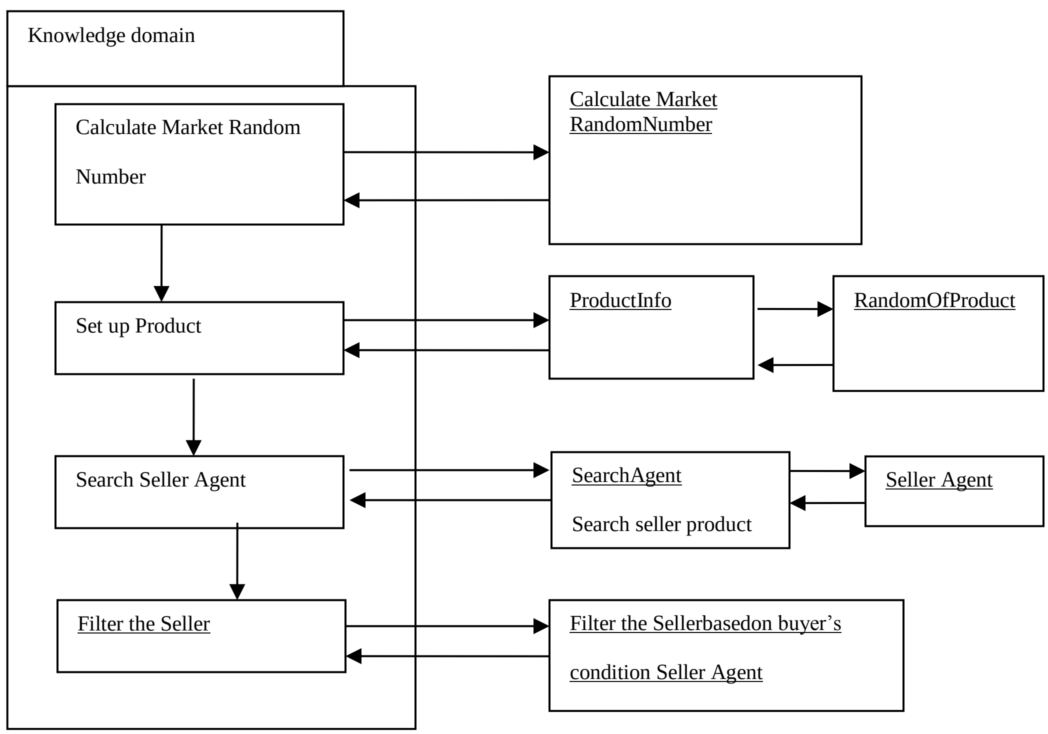

Fig. 15. Knowledge Domain Subsystem Class Map.

Negotiation subsystem. The Negotiation Subsystem (NS) works to make communication between the buyer and sellers' agent to find the best price for the buyer to buy the product from one of the sellers' agents. Figure 16 below shows how the Negotiation Subsystem object classes work with the buyer and sellers' agents.

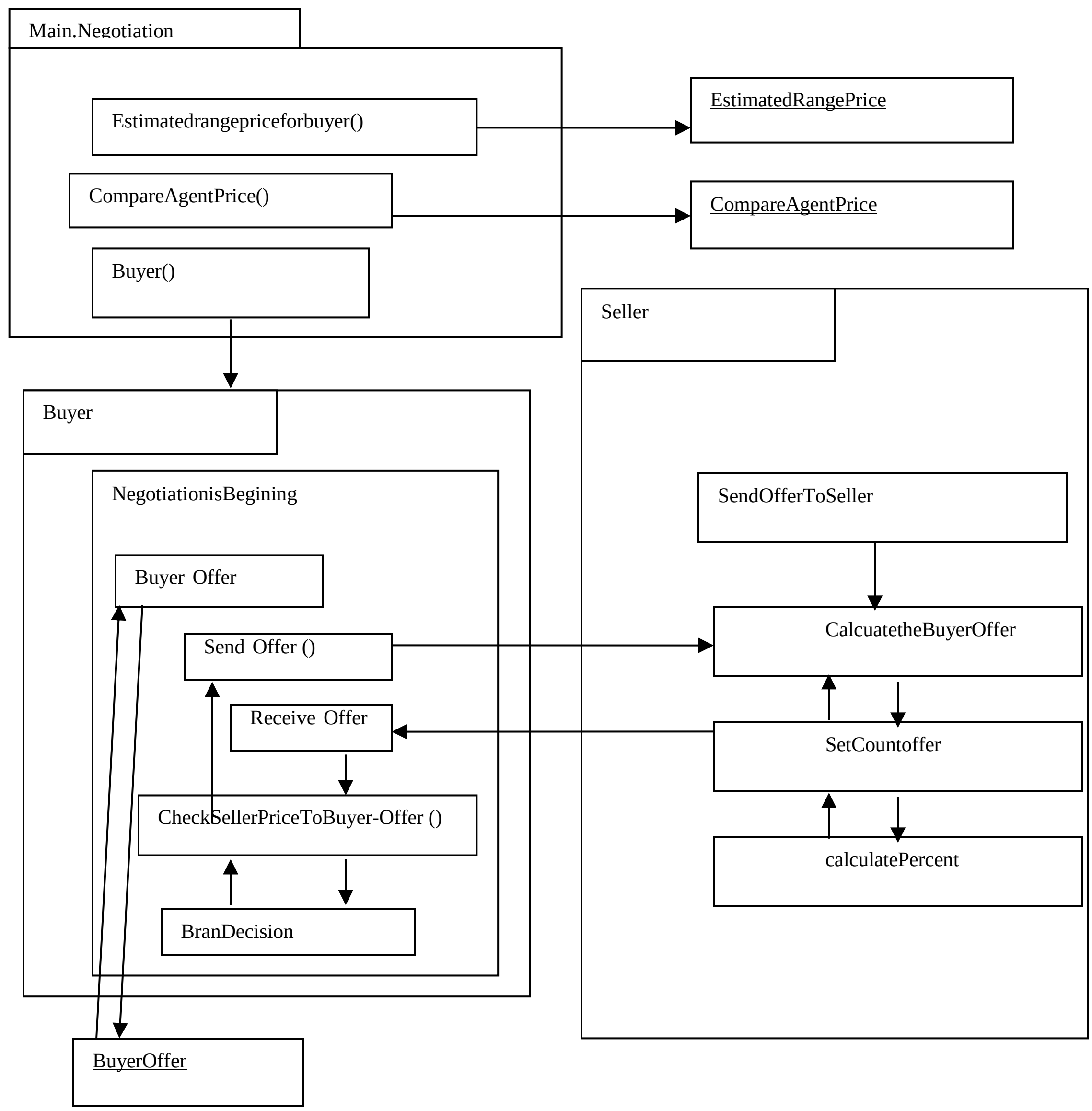

Fig. 16. Negotiation Subsystem Class Map

The negotiation subsystem allows the buyer to calculate its own ERPR by using estimated price range class. The NS uses the buyer's agent as a primary agent in communication with the sellers. The buyer communicates with all sellers as sequence communication from the lowest price up to the highest price. Every time the buyer calculates the offer-price by using buyer offer class. The buyer sends the offer price to all sellers by using message “Send-offer” and receives responses from all the sellers by using message “Receive-Offer.” The buyer uses “CheckSellerPriceToBuyer-Offer ()” to check and compare the sellers’ counter-offer against the buyer’s offer. The buyer uses “BranDecision” to make a decision about the sellers’ count-offers. In this situation, the buyer checks if none of the sellers’ counter-offers match the buyer’s offer and then the buyer increases the offer and sends this new offer to all sellers. This process continues until one of the following events happen: 1) the buyer’s price matches with one of the seller’s counter-offer, 2) one seller accepts the buyer offer, or 3) the buyer offers reach to the highest estimated reserved price.

Non-negotiation subsystem (NNS). The Non-Negotiation Subsystem (NNS) uses the buyer’s agent as a primary agent like NS. Figure 17 below shows how the NNS classes work.

In this case, a buyer will decide the seller without any communication with the seller. The NNS sorts the list of the sellers’ agents based on price by using “CompareAgentPrice” class. Then the NNS sends a list of the sellers to the buyer. The buyer looks for the lowest price from all of the sellers and then calculates the max price that the buyer can pay by using “NoncheckDeal.” The buyer checks the conditions, whether the maximum price is bigger than the lowest seller’s price. If the condition is satisfied then the buyer accepts the deal otherwise, it rejects the deal. After that matching process, the system ends.

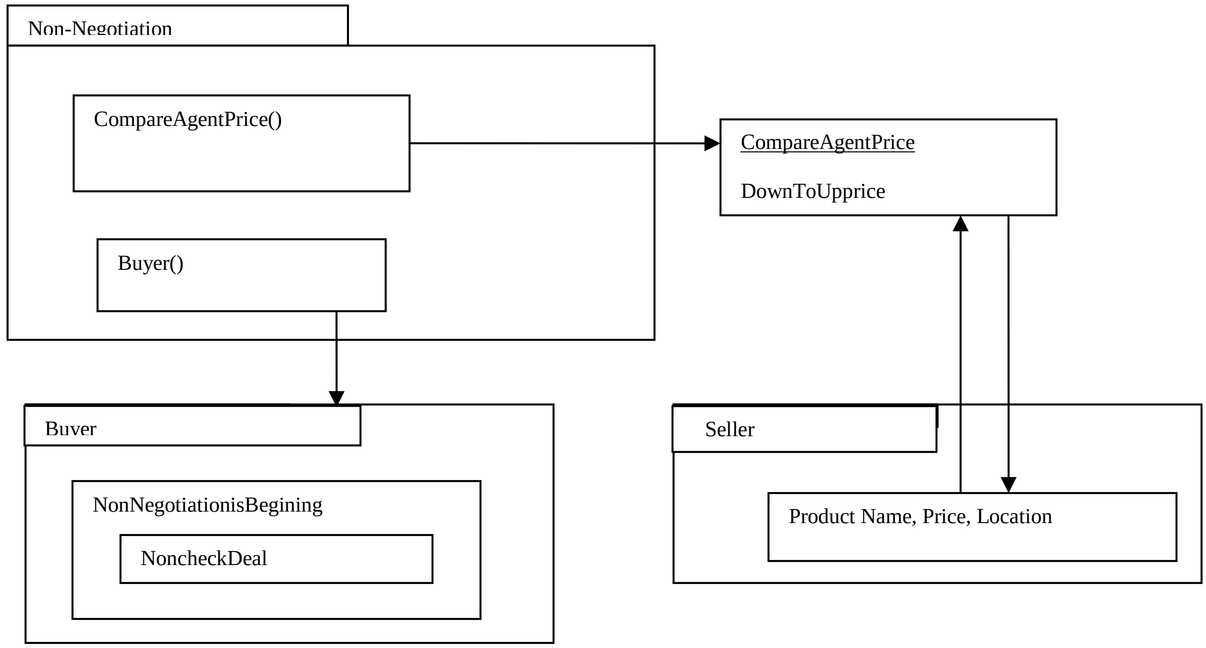

Fig. 17. Non-Negotiation Subsystem Class Map

Simulation System for a Plastic Market (SSPM)

In this section, the prototype SSPM and the SSPM simulation will be explained. The prototype SSPM system has following phases: collect and setup information phase, search, filter, and calculate Estimated Reserved Price Range (ERPR) phase, and negotiation and decision-making phase. Also, the SSPM simulation explains how the agents work with SSPM.

SSPM prototyping. A trading simulating system is developed to demonstrate the effectiveness of the negotiation process model, which simulates the negotiation process between the buyer and the sellers in a trading. Java code is used with Eclipse Indigo R Packages to program SSPM. The plastic market information is collected from a real plastic market, which is “plasticker.de” website; moreover, the product information details are used in the simulation system. The simulation system agents are divided into two groups, which are the buyer’s and the sellers’ agents. The simulation system provides the product information to the buyer's and sellers' agents randomly. Also, the simulation system provides a variety of ERPR for both the buyer's and sellers' agents. The system provides three phases for the simulation of the negotiation between the buyer and the sellers.

Collect and setup information phase. The system in this phase has two processes, which are collect and setup information with build agents. The system collects user inputs, which are the number of buyers' and sellers' agents, market product price, and market index situation. The system builds buyers' and sellers' agents based on user input. After the system builds the agents, the system sets up random product information details, which are product name, price, location, product variable date for sellers' agents, and deadlines date for buyers' agents. Also, the system sets up the buyer's condition randomly. In addition, the system provides price range for every seller.

Search, filter, and calculate ERRP Phase. The system, in this phase, has three processes which include searching, filtering, and calculating ERPR before the negotiation phase between the buyer's and the sellers' agents starts. The system searches for the buyer's product by broadcasting messages to all sellers' agents and then waits for a message from the sellers about the buyer's product, which has detailed information about it. After the system receives messages from all sellers, the system filters the seller data based on the buyer's trading conditions. It also saves the sellers in the list and re-sorts them based on the buyer's conditions. In addition, the system calculates ERPRs depending upon the number of sellers that have the buyer's product, market index change, market product price, and buyer's condition.

Negotiation and decision phase. The system had established the information for the buyer's and sellers' agents to start negotiation. In this phase, the negotiation includes a loop of send-offer, receive-response, and decision-making processes. In the beginning, the buyer checks the lowest price from the search list after it filters it by the buyer's conditions; if appropriate, then the negotiation is not needed. If not, then the negotiation starts. The negotiation begins from the buyer's side. The buyer sends a broadcast-offer message to all sellers in the search list. It is called the "Offer Price" for the product; it then waits for a message from all sellers about "Counter-offers". The sellers reply with messages to the buyer about "Counter-offer" of the product. The buyer checks if there is an "Accept" offer from any of the seller. If yes, then the "Deal" has happened and negotiation is finished; if not, the buyer re-sorts the list of the sellers based on the lowest price and checks if the next lowest price is appropriate, then meaning the "Deal" has happened and the negotiation is finished. If not, the negotiation loop continues by sending a new message of "Offer" from the buyer. The buyer agent receives a new message "Count-offers" from sellers until one of three steps happen: 1) the buyer reaches the highest of the estimated reserved price range; 2) the buyer accepts any of the sellers' count-offers; 3) there is one of the sellers' list accepts the buyer's offer. Step one means that there is "No-Deal" between the buyer and any sellers. Steps two and three mean that there is a "Deal" between the buyer and one of the sellers.

SSPM simulation description. The simulation of the SSPM has explained in the SSPM simulation map of the trading. Also, in the simulation section, the SSPM compares the agent behavior between Negotiation and Non-Negotiation Subsystems. The SSPM simulation map explains how the proposed e-commerce system works with the user and the number of agents of the buyer and the sellers.

Simulation design. The simulation map contains four parts, which enable the simulation to work efficiently. The first part is setting up the user's inputs as the main data for simulation, which include number of buyers, the number of sellers, market price, and market index situation. The second part in the proposed e-commerce is main players, which are buyer and sellers. The third part is the Negotiation Subsystem (NS), which searches for the buyer's product, sorts the sellers, and calculates the estimated reserved price range for the buyer. Also, the NS makes the buyer communicate with sellers to find the best price based on the buyer's condition. The fourth part is the Non-Negotiation Subsystem (NNS), which searches for the buyer's product, and sorts the sellers. Also, the NNS checks if the lowest price is suitable to the buyer and compare it to the buyer's price based on the buyer's conditions. Figure 18 shows the SSMP simulation map.

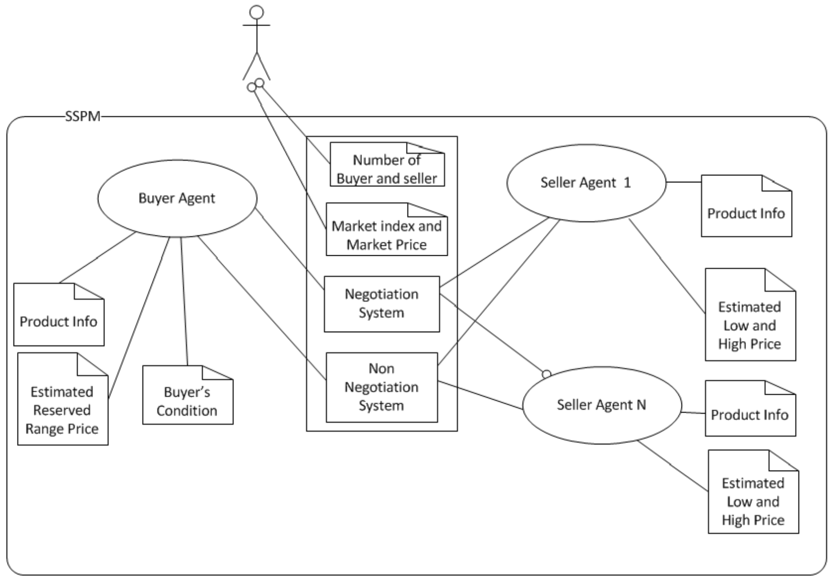

Fig. 18. SSPM Simulation Map

Simulation system plastic market. The simulation system plastic market (SSPM) is a simulation system that simulates trading among automated trading agents for the buyers and sellers in plastic market. The agents communicate with each other by sending and receiving messages. The same set of base data is used for both negotiation and non-negotiation trading simulations. As shows in figure 18, the simulation starts after the user inputs the number of buyers and sellers, market product price, and market index change. Every agent has its own detailed information about the product and Estimated Reserved Price Range (ERPR). The SSPM runs the negotiation simulation system, which is based on the exchange of messages between the buyer's and sellers' agents to reach a "Deal" or "No-Deal." In the negotiation simulation system, the first step is to search for the product from all the sellers and filter the sellers based on the buyer's conditions of the product.

The buyer negotiates with the sellers, which is dependent on the ERPR when making any offer to the sellers. Also, every seller depends on the ERPR when the seller makes any counter-offer to the buyer. After SSPM runs the negotiation simulation, the SSPM runs the non-negotiation simulation; there is no exchange message between the buyer and sellers for negotiation.

The SSPM runs the non-negotiation simulation to reach a "Deal" or "No-Deal," but the exchange message occur two times: 1) when the buyer searches for a product and then receives the sellers' response, 2) when the buyer accepts or rejects the product's price from any sellers. In the non-negotiation simulation, the first step is to search for the product from all sellers and to filter the sellers based on the buyer's conditions of the product. In the second step, the buyer has its own potential product price. The buyer makes a decision based on the lowest of the products' price that is nearest to the buyer's potential price. The answer for first question will in result and discussion chapter.

Part II: Improve the Intelligent Consortium Agent for SMEs in a Plastic Market

This section explains the objective of intelligent consortium agent, consortium algorithm model, and simulation system in the plastic market. Also, it explains the CSSPM Architecture, classes map, and simulation.

Objective

The e-marketplace or e-commerce system is to present the online simulation trading to achieve the result and answer the second dissertation question, which is "Can an automated consortium agent based on Modified Knapsack Problem Algorithm

(MKPA) improve the trading volume for SMEs in e-marketplace?" In this part, the simulation e-commerce system has been built to answer question 2.

The system purpose is to improve the design of the traders' agents to work as both a broker and trader agent. Also in the section, the system does not provide meeting service for traders as the broker; each trader can get initial trading information from the system, which allows the traders to read and write messages.

However, the first benefit of system design is mediating the broker agent by implementing an automated consortium function to eliminate consortium service costs for the traders by Leader Buyer (LB) who has the biggest units requesting. Also, the LB does not charge any cost from others because the LB has his own benefit as others, which is building a consortium to communicate with large enterprises. The second benefit is to improve a purchasing consortium among the traders by implementing a Modified Knapsack Problem Algorithm (MKPA). In addition, the efficiency of the proposed system is demonstrated by a series of simulations with the result of Modified Knapsack Problem Algorithm Consortium (MKPAC) and Exactly Match Consortium (EMC) trading.

Theoretical Reasoning for Purchasing Consortium

In this section, it explains the power of a purchasing group, purchasing in SMEs, and the advantages and disadvantage of the consortium for SMEs.

The power of purchasing groups: These days, there are groups purchasing in all industries and in many different fields. The most common of purchasing groups is in the healthcare and education industries. There are three major structures of purchasing groups are explained as followed.

Consortiums. The consortium is defined by Thomas Hendrick as "two or more independent organizations that join together, either formally or informally, or through an independent third party, for the purpose of combining their individual requirements for purchased materials, services and capital goods" (Hendrick, 1996, p. 7). The main goal is to increase the purchasing power of the group to reduce the goods or service cost (Hendrick, 1996). For example, one of the oldest established consortiums (1950s) in the U.S. were five colleges in Massachusetts which included Amherst College, Hampshire College, Mount Holyoke College, Smith College and the University of Massachusetts at Amherst to share human capital and assets (FCC, 2012).

Private equity firms. A private equity group is defined it is capital invested in the direct ownership of businesses that are not traded on public stock exchanges (Arnold, 2005). These groups simultaneously purchase and manage many companies under one umbrella (Minnesota life, 2009). These groups simultaneously purchase and manage many companies under one umbrella (Minnesota life, 2009). For example, for the short-term investment, when the private equity group buys companies, the objective is to fix or develop the companies then to sell them in three to five years at earnings (Minnesota life, 2009). For long-term investment, when the private equity group buys companies, it bring them into the group to add another layer of strength to the private equity firm's portfolio (Minnesota life, 2009).

Group purchasing organizations. It is defined as a group in healthcare in the U.S., which allows their members to get the lowest cost of goods and services

(Hovenkamp, 2002). The members in these groups pay a fee, maybe monthly or annually, to join Group purchasing organizations (GPOs) and to get access to their pre-negotiated contracts (Hu, Schwarz & Uhan, 2012). The members take advantage of the GPOs management skills and knowledge in the areas of contract negotiation, supplier management, management of direct and indirect purchasing, and proven implementation of processes (Minnesota life, 2009). For example, HealthTrust Purchasing Group which started in 1999 is GPOs, "this group has tripled in size since its inception and includes many different types of healthcare organizations" (Minnesota life, 2009, p. 3).

Purchasing small and medium sized enterprises: There are four purchasing approaches: Private Purchase approach, Supplier Based approach, Specific Purchase approach, and Source Selection approach are explained as follows.

Private purchase approach. Purchasing departments in a company implement its catalogs, which are managed by their own private gateway, which may include websites (Bartezzaghi & Ronchi, 2004). The company has its own place in web-EDI technologies, which support the exchange of information within their providers (Bartezzaghi & Ronchi, 2004). The providers manage the content of electronic catalogs by adopting the collaboration tools with their supplier base (Bartezzaghi & Ronchi, 2004).

Supplier based approach. Purchasing departments in a company mainly depend on their providers' proposals (Bartezzaghi & Ronchi, 2004). Also, most of the companies are based on electronic catalogs, which are responsibly on providers to develop and manage (Bartezzaghi & Ronchi, 2004).

Specific purchase approach. It is a vertical consortium (see figure 19) gateway which is a consortium to buy specific materials that belong to traders manufactories (Bartezzaghi & Ronchi, 2004). For example, the IDG, which is a health line network, works by expanding and targeting its advertisement stock to other traders in their sectors or fields (Bartezzaghi & Ronchi, 2004).

Source selection approach. Source selection is the procedure of making a decision, which gains the prize of a contract action (emedia, n.d.). This can be accomplished by finding the lowest price of product or formal and structured process of deciding the best assessment (Gregory, 1986). "They are based on independent horizontal marketplaces running reverse auction or virtual exchanges" (Bartezzaghi & Ronchi, 2004, p. 120). Figure 19 below shows the market theoretical framework.

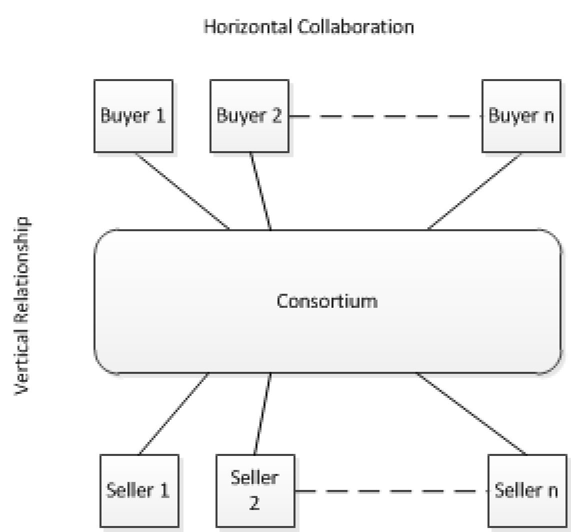

Fig. 19. Theoretical Framework

This part of the dissertation focuses on purchasing consortium because the agents are needed to connect to each other to make purchasing group, and they are not related to each other such as private equity firms or GPO. In this section, the specific purchase approach has chosen because the researcher implemented the consortium-purchasing group in a specific market, which is the plastic market for SMEs. Also, in this part, the consortium structures of purchasing groups for SMEs has been implemented by modify knapsack problem algorithm.

Advantages of purchasing consortium for SMEs. The advantage for SMEs in purchasing consortium is not only reducing the cost of goods or services but also there are other advantages. There are other advantages such as economies of scale, economies of process, and economies of information. These advantages of purchasing consortium for SMEs are explained as follows:

Economies of scale. The companies are improving the ability to attain lower prices and increase power of negotiating for the larger consortium (esourcingforum, 2007).

Economies of process. The companies can share the purchasing and administrative information to simplify purchasing processes (esourcingforum, 2007). The purchasing group may also review areas that may include outside vendors or software programs to decrease workload and expenditure (esourcingforum, 2007).

Economies of information. The companies may share Information between members of consortium (esourcingforum, 2007). The members of groups also may share their knowledge based on their experiences, and skills within the diverse companies (esourcingforum, 2007).

Disadvantages of purchasing consortium for SMEs. There are disadvantages for SMEs in purchasing consortium such as internal resistance, vendor resistance, and monitoring program design. These disadvantages of purchasing consortium for SMEs are explained as follows.

Internal resistance. Although, the consortium returns big benefits to them (esourcingwiki, n.d.) some members in the consortium feel that the large companies do not meet their needs completely (esourcingwiki, n.d.).

Vendor resistance. Some vendors of consortium like to remove some members if they join in the consortium (esourcingwiki, n.d.). Those vendors do not like to work in consortium with different sizes of vendors (esourcingwiki, n.d.).

Monitoring program design. The members in consortium have different benefits in plan design. The plan design, might give some members more benefit than others (esourcingwiki, n.d.). Also, the misunderstanding or changing might affect some members (esourcingwiki, n.d.).

Consortium Algorithm Model

The consortium model includes Knapsack Problem Algorithm (KPA) and Modified Knapsack Problem Algorithm (MKPA).

Knapsack problem algorithm. The classical 0-1 Knapsack Problem Algorithm (KPA) has many variables, which are related to each other to explain how KPA works. The KPA is that “where a subset of (n) given items has to be packed in a knapsack of capacity (c)” (Martello, Pisinger & Toth, 2000). All items have their profit (P_j) and their weight (w) (Martello et al., 2000). The KPA is to select items where a total weight does not go over (c) and where the total profit is highest or maximized (Martello et al., 2000). KPA assumes that all input numbers are positive integers (Martello et al., 2000). Also, it is used to introduce the binary decision; it uses the variables (X_j) which (X_j) = 1 if item j is selected, and (X_j) = 0 if the item j is not selected (Martello et al., 2000). The KPA model is shown below (Martello et al., 2000):

$$\begin{aligned} \text{maximize} \quad & z = \sum_{j=1}^{n} p_j x_j \\ \text{subject to} \quad & \sum_{j=1}^{n} w_j x_j \leq c \\ & x_j \in \{0, 1\}, \quad j \in \{1, \ldots, n\}. \end{aligned}$$

Modified knapsack problem algorithm. Modified Knapsack Problem Algorithm (MKPA) has developed from the knapsack problem algorithm to solve the consortium problem. The MKPA has many variables, which relate to each other to explain how the total of traders' units can be equal to seller's units. The MKPA is where a subset of n is a number of traders who request units to be equal to the Seller's Units (SU), which is a seller's offer unit. All traders have their profit (P_j) which is a different price of consortium (P_c) and retail (P_r) units and their Unit requesting (U_j). This section assumes every trader willing to buy Extra Units (E_j) up to the trader's profit (P_j) which is the largest or maximized profit. The MKPA is to select items where a total of all traders' units requested with (E_j) is equal to (SU) up to the traders' profit (P_j). The MKPA assumes that all input numbers are positive integers. Also, it is used to introduce the binary decision; it uses the variables (X_j) which (X_j) = 1 if trader j is selected, and (X_j) = 0 if trader j is not selected. The MKPA is shown below:

$$\text{Maximize} \quad M = \sum_{j=1}^{n} U_j X_j P_r - U_j X_j P_c$$

$$\text{Subject to} \quad \sum_{j=1}^{n} (U_j X_j + E_j) = SU$$

$$\text{And} \quad (U_j X_j + E_j) P_c \leq SU * P_r$$

$$j \in \{1, \ldots, n\}$$

Consortium Simulation System Plastic Market (CSSPM)

The Consortium Simulation System Plastic Market (CSSPM) is to simulate the trading between the buyers' and seller's agents and between the buyers to build a consortium in the plastic market based on Modified Knapsack Problem Algorithm Consortium (MKPAC) and Exactly Match Consortium (EMC) algorithms. In this section, the CSSPM description, CSSPM architecture, and CSSPM subsystems have been explained below.

CSSPM description. The proposed e-commerce system represents the buyers' and the seller's agents that communicate together to represent the e-commerce trading by sending and receiving information to accomplish the contract if possible. Also, the proposed e-commerce system implements the buyer's communication mechanism to build a consortium based on MKPAC and EMC. The proposed e-commerce system's purpose is to compare the trading results between MKPAC and EMC.

CSSPM design. In this section, the CSSPM architecture explained as one part and the CSSPM subsystems architecture is explained in details, which are Generator, MKPAC, and EMC.

CSSPM architecture. The CSSPM e-commerce system is composed of Generator and two subsystems. The Generator subsystem is to setup information and build agents to use with other subsystems. The MKPAC subsystem considers the LB who requests the highest units of seller's product units, communicates with other buyers to build a consortium to reach seller's product units by implementing Modified Knapsack Problem Algorithm (MKPA). The EMC subsystem makes every buyer communicate with each other to build a consortium to reach exactly the seller's product units.

Decomposition description. Figure 20 shows CSSPM components, which are Generator, MKPAC, and EMC subsystem. Also, the general information is in the functional section and the details of every subsystem are in following section (CSSPM subsystems architecture).

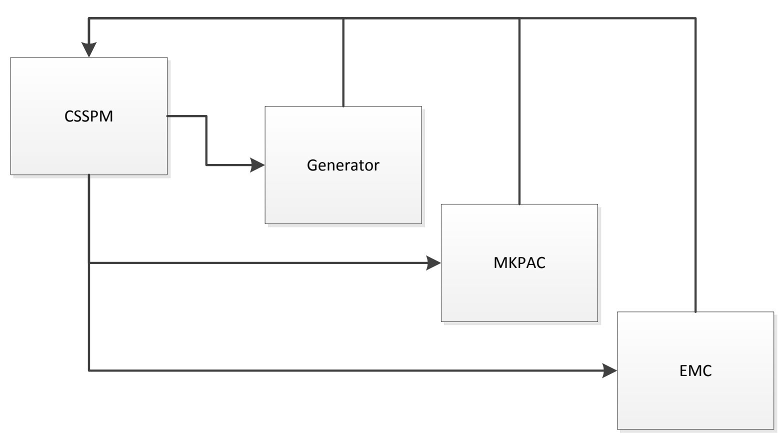

Fig. 20. CSSPM Components

Functional. The Flow Chart shows Generator, MKPAC and EMC. The Flow Chart explains the algorithm of CSSPM and the CSSPM subsystem as functions. Every function for every subsystem is based on the system's purpose. The Flow Chart also shows how the CSSPM works and connects to Generator, MKPAC, and EMC subsystems. The details are described in SSPM Subsystems Architecture. Figure 21 shows the algorithm of CSSPM.

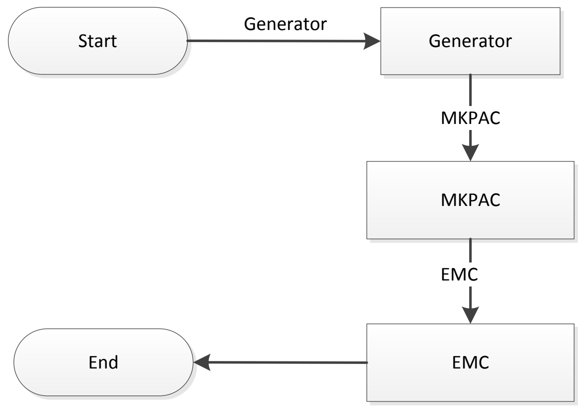

Fig. 21. CSSPM Function Components

Generator Subsystem**.** The Generator Subsystem (GS) has three functions, which are user inputs collection, build agents, and set up product information. The main function is a user input gathering which is to get the number of the seller and the buyer agents and market product information. Once the user input is gathered then the Generator Subsystem builds the agents. After the GS sets up the product information for the buyers and the seller agents, the GS returns all the information to CSSPM to run MKPAC subsystem.

MKPAC Subsystem. The MKPAC subsystem includes many functions which work together to make a consortium among the buyers by using Modified Knapsack Algorithm (MKPA). The details of the MKPAC functions are in the MKPAC subsystem section.

EMC subsystem. The EMC subsystem functions include exact matching against the seller's units. This function allows every buyer to calculate its own buying volume and price with others' to build a consortium to meet the seller's units without using any method. The details of the EMC functions are in the EMC subsystem section.

CSSPM subsystems architectures. The CSSPM has three subsystems that work together which are Generator, MKPAC, and EMC. In this section, the architecture for those three subsystems is explained below.

Generator Subsystem. The CSSPM e-commerce system uses Generator Subsystem (GS), which support MKPAC and EMC simulation to get the user's inputs and set up information for other subsystems. The GS works to get the user inputs, build the buyers' and seller's agents, and sets up the product information. After building the agent, the GS sends the produced information to CSSPM.

Decomposition Description. Generator Subsystem (GS) is a sub-component of CSSPM. Figure 22 shows how GS works with CSSPM. The CSSPM runs GS to get the user input and set up other information for MKPAC and EMC subsystem through the CSSPM. The details of GS are in the functional section below.

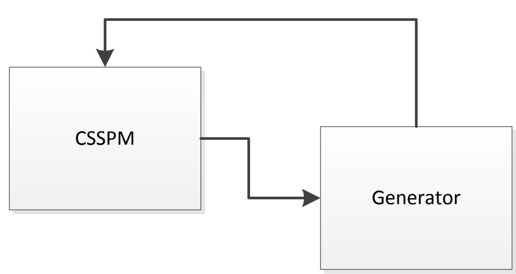

Fig. 22. CSSPM Generator Components

Functional. The CSSPM Generator has three functions, which are getting user inputs, building agents, and setting up the product's information. Figure 23 shows the algorithm of Generator Subsystem (GS). The details of its functions are described as follows.

User inputs. The input is the trader information and the product data. The gathered information will be saved by the system and will be sent to other functions as described in the Flow Chart. The content of the user input is the number of buyers and sellers, non-consortium market product's price, and consortium. The output from this function is the user data

Build agents. The input for this function is the number of buyers and sellers that gathered from the user input function. This function will build all the buyers' and seller agents. The outputs of this function are the buyers' and seller's agents to run both MKPAC and EMC subsystems.

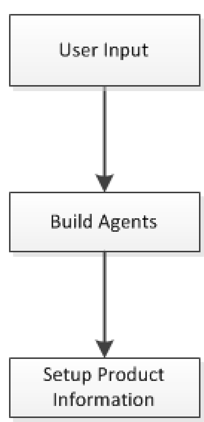

Fig. 23. CSSPM Generator Function Components

Set up product information. The inputs of this function are the buyers and the seller agents. This function sets up the product's information, which includes the product's name, and buyer's units requesting for the buyer, and the product's name, and seller's units selling for the seller. The product information will be created randomly and will be used for both the buyers and the seller's agents. The outputs of this function are the seller and a list of the buyers.

MKPAC Subsystem. The Modified Knapsack Algorithm Consortium (MKPAC) is one subsystem that uses Modified Knapsack Algorithm (MKPA). In the next steps, design, functional, and UML sequence diagram will be described.

Design: The MKPAC is a system based on finding the LB who runs the MKPA to build consortium. The consortium process has two steps and two main functions. The consortium process depends on the buyers who want to build the consortium. The LB who has the largest demand volume sends a request consortium message to other buyers and receives responses about consortium from others. For this consortium forming, a searching method is implemented in the system. The two main functions in the consortium process assist the buyers in the plastic market decision making. The first function is filtering the search list based on the buyers' product. The second is calculating the buyers' profit, which is the different between consortium and non-consortium price.

Decomposition description. MKPAC is a sub-component of CSSPM. Figure 24 shows how the MKPAC works with CSSPM and KDS. The details of negotiation are described in the functional section below

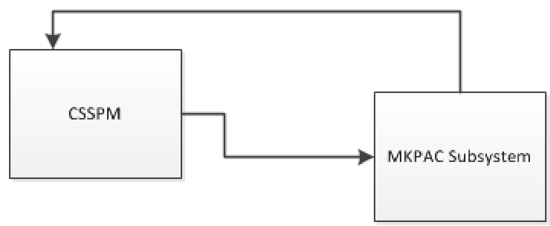

Fig. 24. MKPAC Subsystem Components.

Functional. Figure 25 explains how the Flow Chart algorithm works for MKPAC. The MKPAC subsystem has functions as follows: filter the buyers based on the seller's product, find the highest buyer unit, aggregate the buyers' buying units, find $\sum U_j = SU$ by using KPA, check if KPA ($\sum U_j =SU$), calculate the percent of remaining the seller units, send to the buyers the percent of remaining, receive the buyers' decision, use MKPA to find $\sum (U_j + E_j) = SU$, and check whether MKPA has $\sum (U_j + E_j) = SU$. All those functions work together to make consortium among the buyers and sellers. The details of MKPAC functions are as follows.

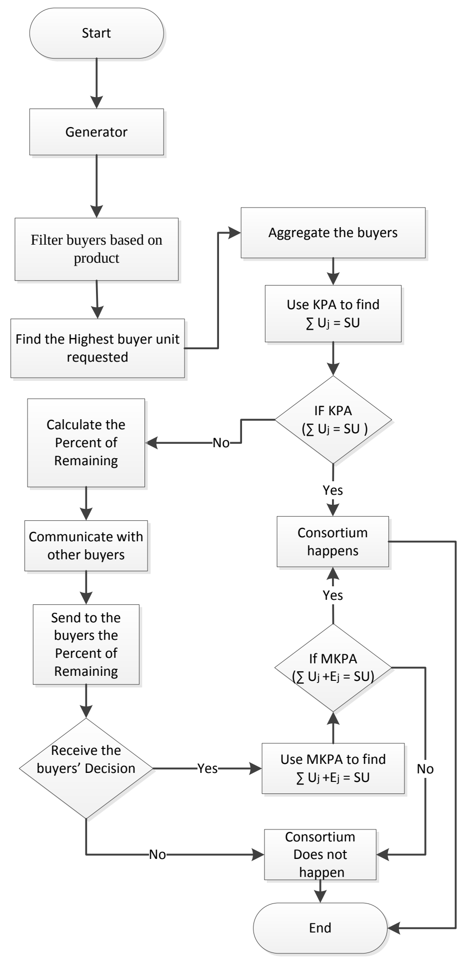

Fig. 25. Flow Chart for the MKPAC Subsystem.

Generator: The Generator Subsystem, as explained earlier, is used to get the user inputs, building agents, and set up the product's information for the buyers and seller.

Filtering buyers based on product: The inputs of this function are the name of the seller's product and a list of product information from all buyers. This function filters the list based on the product's name. The buyer who does have the seller's product will be removed from the list of the buyers. The output of this function is the new list of the buyers that can be used for the consortium process.

Find the highest buyer unit requested: The input of this function is the list of buyers. The buyers in the list communicate with the other buyers to find the Leader Buyer (LB) who has the highest purchasing units will lead the consortium process. The output of this function is the Leader Buyer (LB) who will lead the consortium process.

Aggregate the buyers: The input is the Leader Buyer (LB). In this operation, the LB begins communication with the other buyers to see whether a consortium against the seller's product is possible or not. The outputs of this function are the buyers' consortium list to start consortium, and LB.

Use KPA to find $\sum U_j = SU$*:* The inputs of this function are the Seller's Unit (SU), and the list of consortium buyers. In this operation, the LB uses KPA to check the buyers' unit ($\sum U_j$) to be equal or close to the SU. The outputs of this function are the list of consortium buyers and total of the buyers' unit requested ($\sum U_j$).

Check if KPA ($\sum U_j = SU$)*:* The inputs are the Seller's Units (SU), total of the buyers' unit requested ($\sum U_j$), and the list of consortium buyers. In this operation, the LB checks If $\sum U_j = SU$. If $\sum U_j = SU$, then the output is "Consortium Happens," which means the consortium process is finished. If $\sum U_j \not\equiv SU$ then the output is

"Consortium Does Not Happen," which means the LB continues to run other steps in the consortium process.

Calculate the percent of remaining: The inputs are seller's units (SU), $\sum U_j$, and the list of consortium buyers. In this operation, when the $\sum U_j \not\equiv SU$, the LB calculates the remaining volumes between $\sum U_j$ and SU to calculate all buyers' percent of units (E_j) based on their U_j percent to the SU. Every buyer has to add E_j to their extra units (U_j) to reach the seller's units exactly which $\sum (U_j + E_j) = SU$. The output is (E_j) for every buyer in the list of consortium buyers.

Communication with other buyers: The inputs are the LB and (E_j) for every buyer in the list of consortium buyers. The LB buyer makes the list of buyers and the percent of remaining volume for every buyer (E_j).

Send to the buyers the percent of remaining: The inputs are the list of consortium buyers, and (E_j) for every buyer in the list of consortium buyers. In this operation, the LB sends the (E_j) percent units to all buyers. The output is waiting for a response from all buyers who are in the consortium list.

Receive the buyers' decision: The inputs are all buyers' decisions, and the list of consortium buyers. In this operation, the LB collects all buyers' decisions and then updates the buyers units requested. The output is a new consortium list of buyers with updated units requested.

Yes: It means “Accept.” The LB moves to Use MKPA to find $\sum (U_j + E_j) = SU$ step if all buyers accept to increase their units.

No: It means “Reject.” The LB moves to Consortium does not happen step if one of the buyers reject to increase its units.

Use MKPA to find $\sum (U_j + E_j) = SU$*:* The inputs are the seller’s units (SU), and the new consortium list of buyers with updated units requested. In this operation, LB uses MKPA to collect all buyers’ units $\sum U_j$ with all buyers extra units (E_j) to match with the Seller’s Units (SU). The outputs are the list of consortium buyers and all buyers’ units ($\sum U_j$) with all buyers’ extra units ($\sum E_j$).

Check if MKPA, which is $\sum (U_j + E_j) = SU$*:* The inputs are Seller’s Units (SU), list of consortium buyers and all buyers’ units$\sum U_j$ with all buyers Extra units (E_j). In this operation, the LB checks if $\sum (U_j + E_j) = SU$ or not. If $\sum (U_j + E_j) = SU$ then the output is “Consortium Happens,” which means the consortium process is finished. If $\sum (U_j + E_j) \neq SU$ then the output is “Consortium Does Not Happen,” which also means the consortium process is finished without a consortium.

Sequence Diagram for MKPAC Subsystem. The sequence diagram below (figure 26) shows how MKPAC subsystem communicates between the LB, who has the highest requested of the seller's units and other buyers.

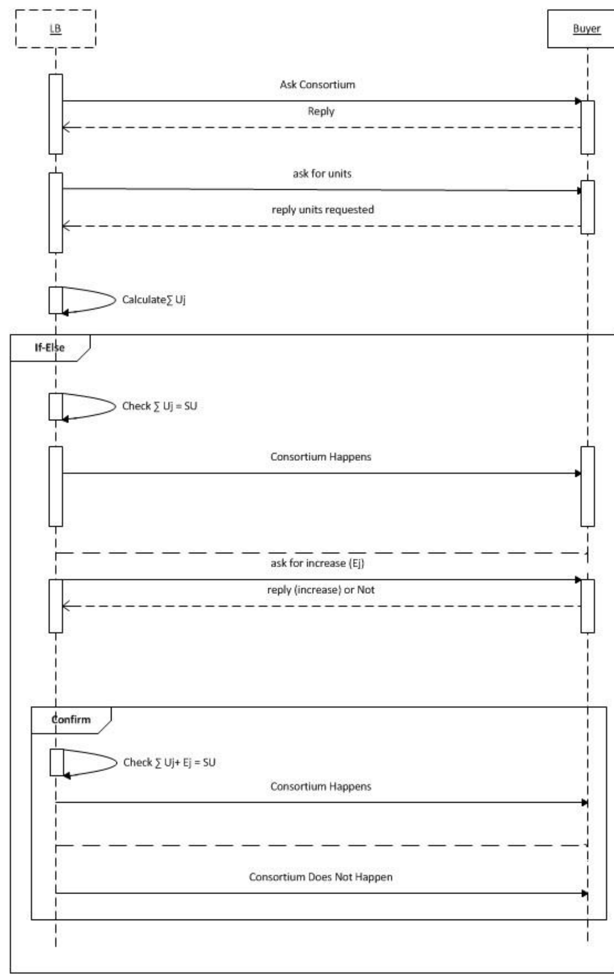

Fig. 26. Sequence for the MKPAC Subsystem.

In the beginning, MKPAC sends the list of the buyers to every buyer who wants the seller's product. The LB communicates with the list of buyers to get their units requested. The LB calculates if $\sum U_j = SU$, then the LB sends the "Consortium Happens," to the system and if not, the LB implements the MKPA to calculate their remaining and then sends a message to other buyer to ask them to increase their units based on MKPA. If all buyers accept to increase, the LB sends a message to the list of the buyers that "Consortium Happens," and if not the LB sends a message to the list of the buyers that "Consortium does Not Happen."

EMC Subsystem: The EMC is considered to find the exact match to the seller's units. Detail of design, functional, and UML sequence diagram are described as follows.

Design: The EMC is a system that allows every buyer to make match consortium exactly to the seller's units. This subsystem does not implement any method. Every buyer filters other buyers based on the seller's product. Every buyer calculates its units with others' units to reach exactly the seller's units.

Decomposition description: EMC works with CSSPM and EMC. Figure 27 shows how EMC subsystem works with CSSPM. The details of EMC are in the functional section below.

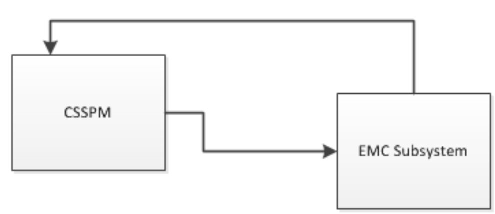

Fig. 27. EMC Subsystem Components.

Functional. The EMC works with Generator Subsystem. Figure 28 explains the Flow Chart algorithm for EMC subsystem. The EMC subsystem functions include, filter the buyer based on the seller's product, aggregate the buyer, and the buyer uses exact match. All those functions work together to make contract between the buyers and a seller. The detail of the EMC functions is described as follows.

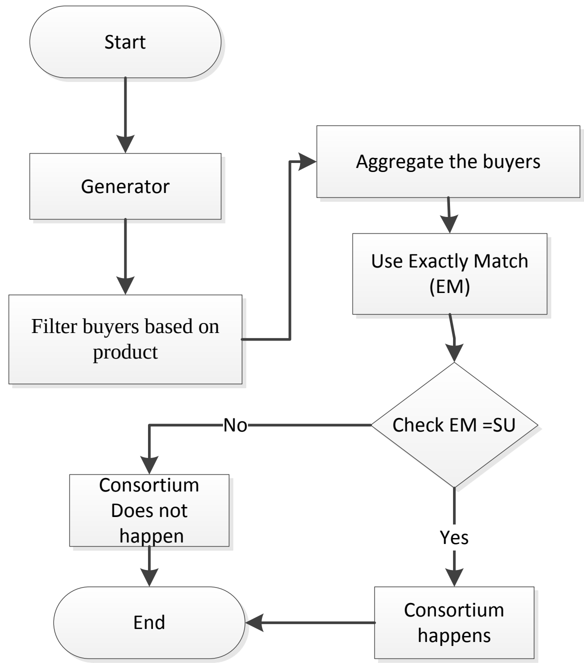

Fig. 28. Flow Chart for the EMC Subsystem.

Generator: The inputs are the buyers' number and seller, product consortium price, and non-consortium price. The operation is to build the buyers' and the seller's agent. It also sets up the product information for all buyers and the seller.

Filtering buyers based on product: The inputs are the name of seller's product and a list of product information from all buyers. The operation is that every buyer filters the list based on the product's name. The buyer who does not meet the same name of the seller's product will be removed from the list of the buyers. The output is the new list of the buyers for the consortium process.

Aggregate the buyers: The input is the list of the buyers. In this operation, every buyer communicates with the other buyers to see if they want the same the seller's product. The output is a new list of the buyers.

Use Exactly Match (EM): The input is the new list of the buyers. In this operation, every buyer uses an exact matching to calculate its units with other buyers. The output is the buyer's units with other buyers' unit information.

Check EM = SU: The input is every buyer's buying units with other buyers' buying units. In this operation, every buyer checks if the buyer units with other buyers' units by using exact matching will be equal to the seller's units for a consortium. The output is the message "Consortium Happens" or "Consortium Does not Happen," and the list of the buyers.

Consortium Happens: The input is the list of the buyers. In this operation, the buyer who has a message "consortium Happens" sends a message to other buyers who are in the list of the selected buyers. The output is the message "Consortium Happens."

Consortium Does not Happen: The input is the list of the selected buyers. During this operation, the buyer who has a message "Consortium Does Not Happen" sends a message to others in its list of the buyers. The output is the message "Consortium Does Not Happen."

Sequences diagram: The sequence of EMC operation is described in Figure 29. EMC do not use LB unlike MKPAC, which allows only the LB to build consortium. In EMC, every buyer sends out messages to other buyers for a consortium. Each buyer, who received a consortium message, replies back to the buyer who asks for the consortium. Once a buyer finds out potential consortium members then it sends out new messages again for the buyers' needed units. Every buyer replies its needed units back to original message sender. During this process, every buyer calculates not only his own units but also with other potential consortium members' units to see if consortium can be formed. If a consortium can be formed, the buyer sends "Consortium Happens" message to all buyers who are in the consortium list. Otherwise, the buyer agent sends "Consortium does Not Happen" message to all the buyers in the list. Figure 29 below shows how the sequence for EMC works

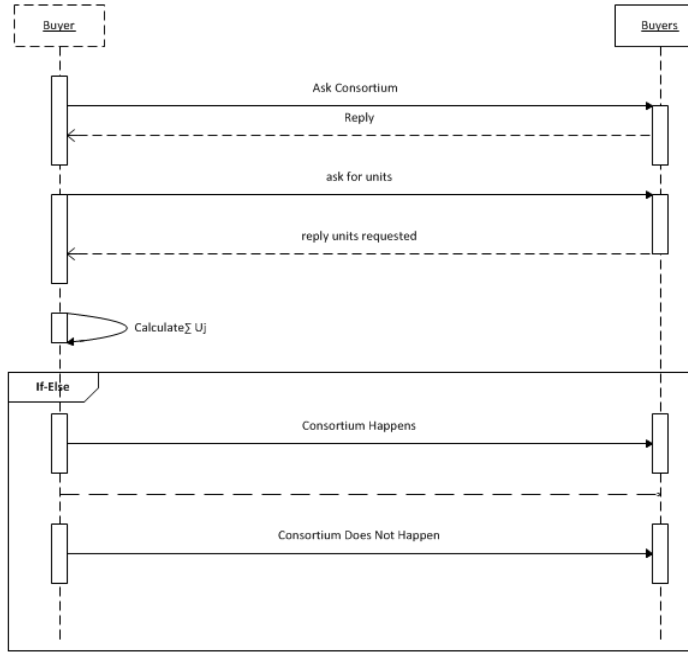

Fig. 29. Sequence for the EMC Subsystem.

CSSPM Class Description

The system architecture was explained in the previous section. In this section, the CSSPM classes will be explained. CSSPM has following subsystems: Generator, MKPAC, and EMC. This section also explains how all the classes work in CSSPM and subsystems. In the Generator classes, the user inputs are used to set up the buyers' and seller's agents. Also, the Generator sets up the product information for the buyers and the seller's agent. The LB implements MKPA to build consortium using the MKPAC classes. In addition, the MKPAC classes controls the communication between the LB and other buyers.

CSSPM classes work. The CSSPM has Generator subsystem and two other subsystems, which are MKPAC and EMC. Both MKPAC and EMC subsystems use the same list of buyers' and seller's agents to do simulation and they run those two simulations in sequence. The CSSPM uses the information that comes from the user. This user information is also used in the Generator, MKPAC and EMC to simulate the buyers' and seller's agent behavior. Figure 30 shows how the system runs the CSSPM classes.

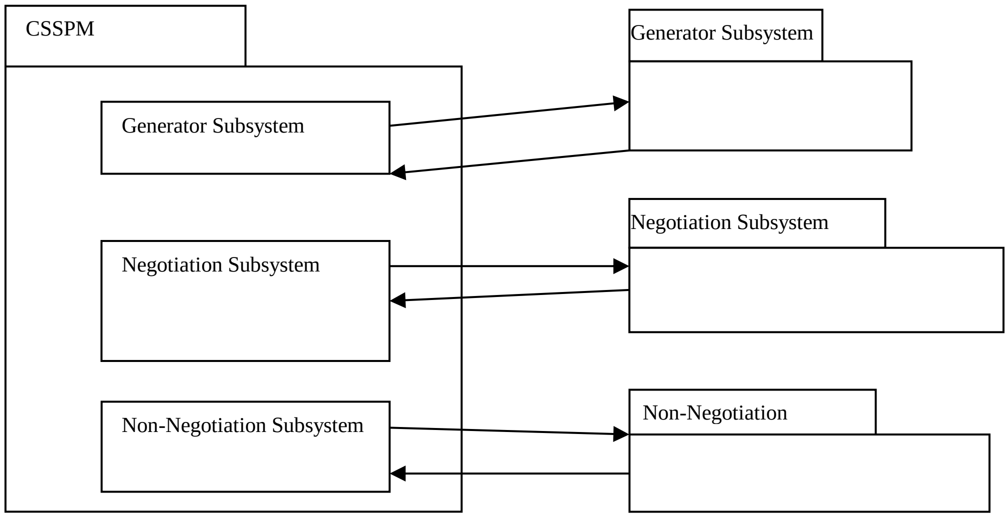

Fig. 30. The CSSPM System Class Map

Generator subsystem. In the beginning operation of this subsystem, the CSSPM runs the Generator subsystem to take four types of information from the user: 1) how many buyer agents are needed for the trading simulation, 2) how many seller agents are needed for the trading simulation, 3) what is the market product's price for the consortium, and 4) what is the market product's price for non-consortium. Also, this subsystem uses a different product's price to represent a real plastic market trading. After that, the Generator Subsystem (GS) built the list of the buyers' and seller's agents by calling build agent class. Then the agents are built by the system, and GS randomly assigns the product's name and unit to the buyers; agents will be updated by calling product information class. Also, the system randomly assigns the product's name, price, and selling units for the seller agent by calling setup product information class. The Generator Subsystem returns a list of the buyers and the seller's agents with other information to the CSSPM e-commerce system. The CSSPM runs MKPAC subsystem. Figure 31 shows how the system runs the Generator Subsystem classes.

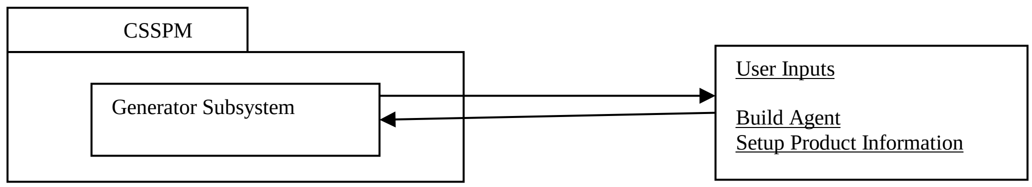

Fig. 31. The Generator Subsystem Class Map

MKPAC subsystem. The MKPAC system works to build consortium by using MKPA among the buyers. The MKPAC subsystem allows the LB who has the highest units requested to be the consortium leader. The negotiation subsystem used the LB agent as a primary agent in communication with other buyers. The LB calculates its own units (U_j) with other buyers' and compares that value with the Seller's Units (SU). After the calculation, LB checks if $\sum U_j = SU$. If $\sum U_j = SU$ then the LB does not need to run the MKPA, but if $\sum U_j \neq SU$ the LB runs the MKPA. In the MKPA process, the LB calculates the remaining (E_j) from $\sum U_j$ to the SU then divides the remaining units based on the buyer unit percentage to the seller's units. The LB sends information of remaining units to every buyer on the list asking for an increase its units E_j to reach to the SU. Every buyer calculates its remaining percentage to see if it can increase its units E_j. All buyers send the E_j to the LB. The LB calculates $\sum U_j + E_j$ then checks the $\sum U_j + E_j = SU$. If $\sum U_j + E_j = SU$ then the consortium builds and the LB sends a message "Consortium Happens." Figure 32 shows how the system runs the MKPAC classes.

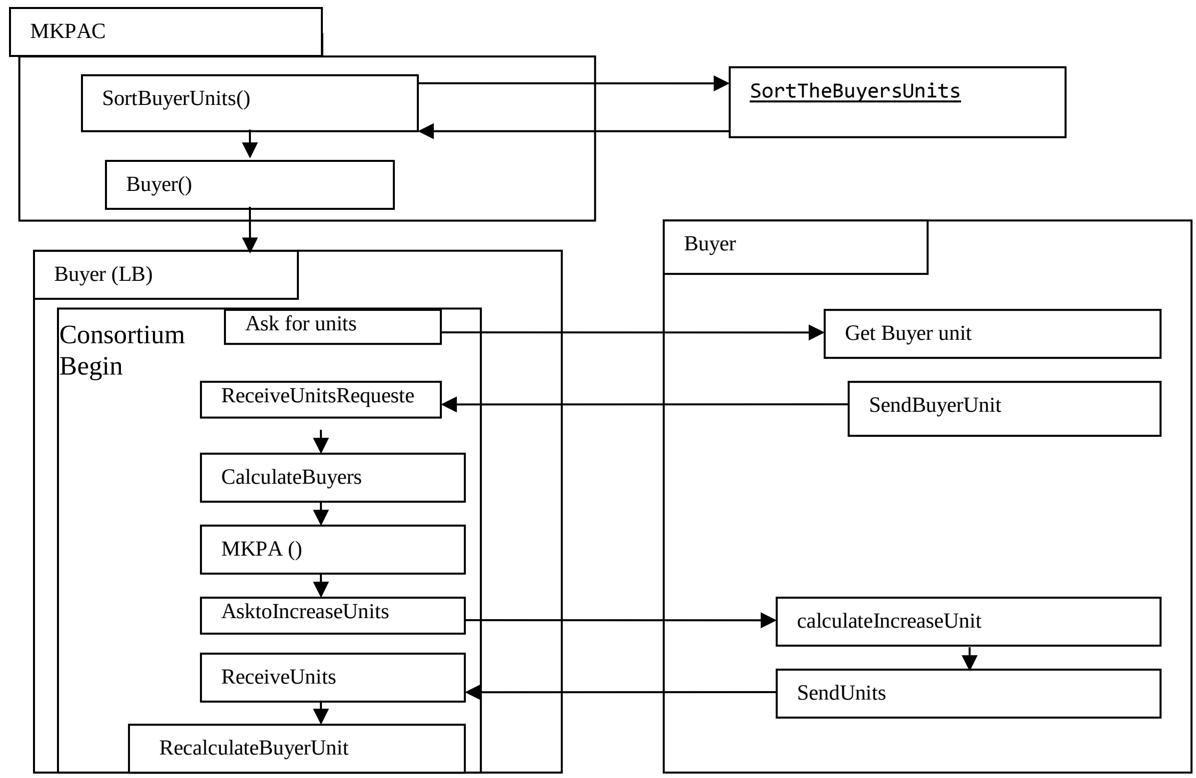

Fig. 32. Negotiation Subsystem Class Map

EMC subsystem. The EMC subsystem uses every buyer agent as a primary agent, which allows every buyer to build consortium. In the beginning, every buyer sends a broadcast message to other buyers by using "Askforunits." Every buyer receives a message from others by using "ReceiveUnits" then every buyer makes its list of the buyers. The EMC class allows every buyer to calculate his/her own units with other buyers to reach the seller's unit. If any buyer reaches the seller's units, the buyer sends a message to other buyers "Consortium Happens," and if not the buyer sends a message "Consortium Does Not happen." The system ends. Figure 33 shows how the system runs the EMC classes.

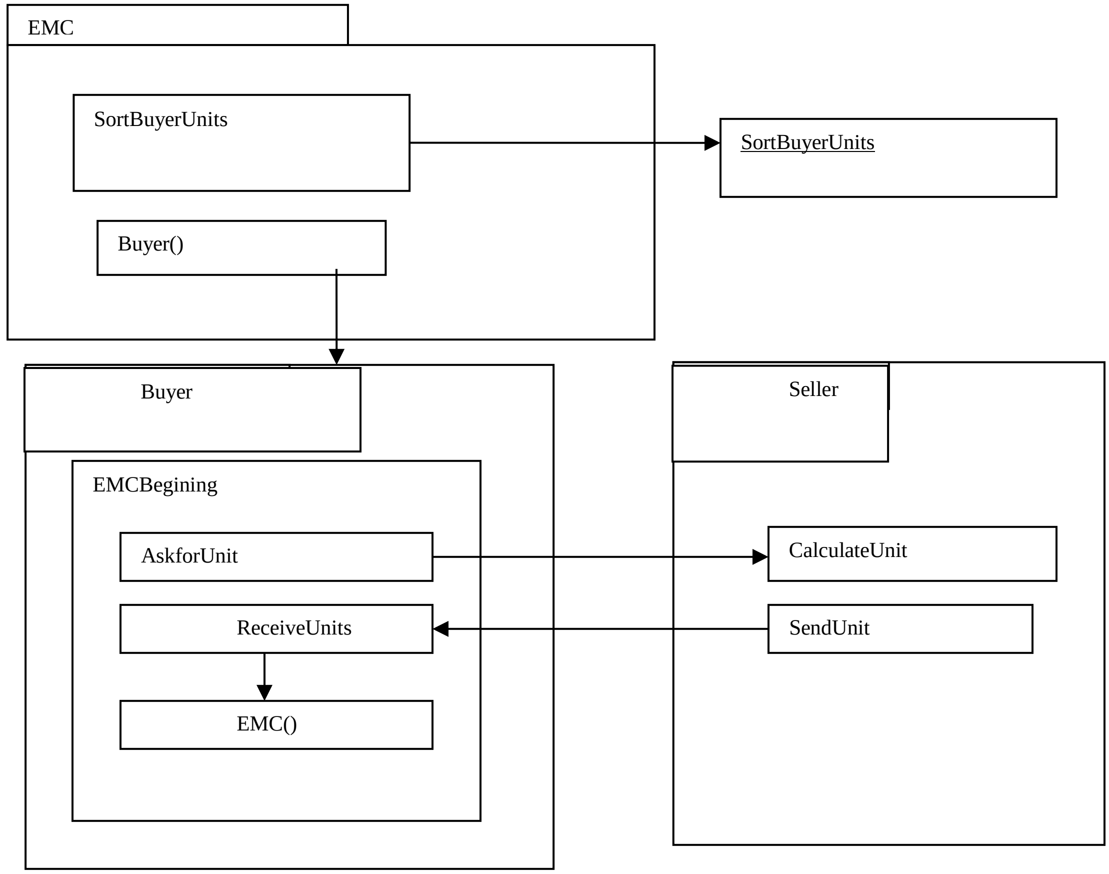

Fig. 33. EMC Subsystem Class Map

CSSPM Simulation

In this section, the CSSPM prototype and the CSSPM simulation will be explained. The CSSPM prototype system has following phases: collect user information and set up information phase, filtering and finding phase, and consortium and decision phase. The CSSPM simulation explains how the agents work with CSSPM.

CSSPM prototyping. The CSSPM has three phases and these three phases explain how the prototype is designed. Also, the CSSPM provides three phases for simulation for a consortium among the buyers.

Collect and setup information phase. The system in this phase has two processes, which are to collect information and setup information with building agents. The system collects user inputs, which are the number of buyers' and seller's agents, consortium of market product price, and non-consortium of market product price. The system also builds buyers' and seller's agents list based on user's inputs. After the system builds the agents, the system sets up random product information for both the seller and the buyers.

Searching, Filtering, and Finding Phase. The system, in this phase, has three processes, which include searching, filtering, and finding the Leader Buyer (LB). Those processes runs before the consortium phase in which a group of buyers purchases the seller's product units. The system communicates with the seller's agent by sending broadcasting seller's product information messages to all buyers' agents. In the searching process, the buyers communicate with each other to find out who needs the seller's product. The buyers filter out other buyers data based on who needs the seller's product. Buyers share the information that says who need the seller product in the list. In finding process, the buyers communicate with each other to find the LB who has the biggest units requested for the given seller's product.

Consortium and decision phase. In this phase, the system chooses the LB who has the biggest unit requested and LB runs the consortium process. The LB plays broker agent roll to build a consortium by sending consortium request and receive-response from other buyers. In the beginning, the system sends the buyers list to the LB. The LB initiates the consortium by checking the buyers list to know which buyers can join in the consortium. In the beginning of building the consortium, the LB uses the classic knapsack problem algorithm (KPA) to equal the seller's units if possible, if the total of all buyers' units and LB's units is equal to the seller's units. The LB sends messages to other buyers, which says "Consortium Happens." If the total of the buyers' units is below the seller's unit, then LB starts to use MKPA. When LB uses MKPA, the LB divides the remaining units based on every buyer's units requested to the seller's units. The LB sends messages to the buyers who are in the list of consortium, which includes every buyer units that have to increase extra units. The motivation of the consortium is based on the participants'' profit from consortium; every buyer will calculate the profit by answering this question: "if the buyer increases the unit, do I have still profit in consortium better than non-consortium?" If the answer is "Yes," then the buyer increases its units and sends a reply message to the LB which; is "I will accept units increasing." If the answer is "No," then the buyer does not increase its units and sends a reply message back to the LB, which says, "I reject increasing the units." After The LB receives all other buyers' messages, the LB checks if any buyer rejected to increase, then sends "Consortium Does Not Happen" to others, or otherwise sends "Consortium Happens."

CSSPM simulation description. The simulation of the CSSPM provides the CSSPM simulation map of the trading. Also, in the simulation section, the CSSPM runs MKPAC and EMC to compare the agents' behavior between MKPAC and EMC subsystems. The CSSPM simulation map explains how the proposed e-commerce system works with the users to set up their agents. Also, it explains how the SSPM works with MKPAC and EMC subsystems.

The CSSPM system is a trading consortium simulating system, which is developed to demonstrate the effectiveness of the consortium process model. The nature of the simulation is a trading consortium process that shows a trading between many small unit buyers and one large seller's units. This simulation was built by using Java language code. The Java code language was used with Eclipse Indigo R Packages to program Consortium Simulation System for the Plastic Market (CSSPM). The plastic market information is collected from the real plastic market, plasticker.de website; moreover, the product information details are used in the CSSPM.

Simulation design. The simulation map contains four parts. In the first part, the user's inputs are prepared for a simulation, which are a number of buyers, a number of sellers, consortium market price, and non-consortium market price. The second part of the proposed e-commerce system is the main players, which are buyers and the seller. The third part is Modified Knapsack Problem Algorithm Consortium (MKPAC) subsystem, which filters the buyer's product based on the seller's product, and then sorts the buyers. Also, it makes the buyer communicate with other buyers to find the LB, who has the highest units requested to build consortium by using MKPA. The fourth part is Exactly Match Consortium (EMC), which filters the buyers' product based on the seller's product. Also, it makes the buyer communicate with other buyers to build a consortium without using the MKPAC. Figure 34 shows the CSSMP simulation map.

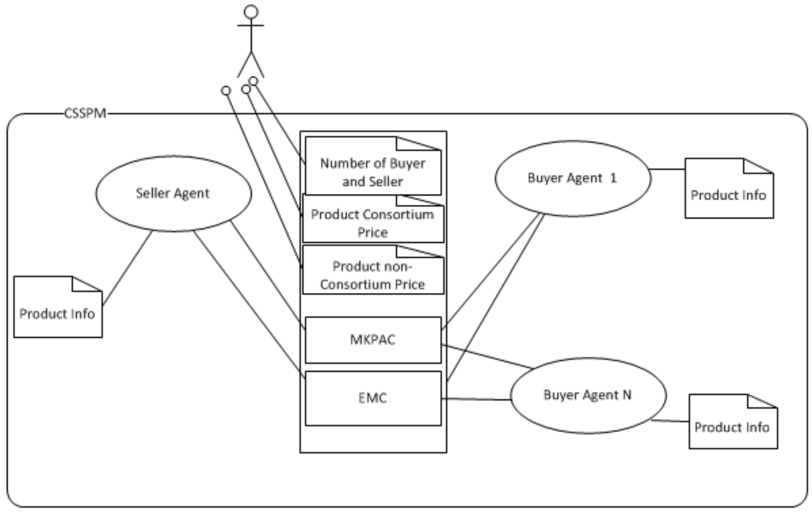

Fig. 34. CSSPM Simulation Map

The consortium simulation system agents are divided into two groups, which are the buyers' and seller's agents. The CSSPM provides the product information to the buyers' and the seller's agents randomly. The simulation starts with the user inputs: the number of buyers and sellers, consortium product price, and non-consortium product price. Every agent has its own detailed information: the product name and units requested for consortium. The CSSPM runs the Modifying Knapsack Problem Algorithm Consortium (MKPAC) in the simulation system, which is based on the exchange of messages among the buyers' agents to reach a "Consortium Happens" or "Consortium Does Not Happen."

In the MKPAC simulation system, the first step is that the system sends the seller's product information to all buyers. Then the system lets the buyers communicate with each other to find the Leader Buyer (LB) agent who requests the biggest number units to build consortium. This LB starts communication with other buyers for the possibility of forming a consortium. The LB calculates its required units with other buyers' and checks that whether the total units meet the seller's unit. If they cannot reach the seller's unit, then the LB uses the Modifying Knapsack Algorithm (MKPA) to reach the seller's unit, which calculates the difference between the total buyers' unit and seller's unit, and then the LB asks the buyers to increase their units requested. Every buyer makes its own decision to join the other buyers to build a consortium, which depends on the profit. If all buyers accept to increase their units requested then the process reaches "Consortium Happens." If any buyer rejects, this leads to "Consortium Does not Happen." After CSSPM runs the consortium simulation system based on MKPA, the CSSPM runs the Exactly Match Consortium (EMC) simulation system.

In EMC, every buyer communicates with others to build its own consortium without using any algorithm. The EMC depends on exact match consortium units requested from all buyers that equal the seller's units. The CSSPM sends the buyers list to every buyer in the list to build its own consortium. Every buyer exchanges the message with other buyers two times to reach a "Consortium Happens" or "Consortium Does not Happen." During the process, the exchange messages occur two times. It occurs when a buyer searches for product units with other buyers and then receives the buyers' product units requesting response. Every buyer, after receiving a message from all the buyers in the list, starts to calculate its units with others to check whether it reaches the seller's units. It occurs when the buyer sends an announcement message to all other buyers who are in the consortium list. The message could be either "Consortium Happens" or "Consortium Does not Happen."

Part III: Improve the Plastic Market Efficiency by Using Consortium and Negotiation Agents for Small and Medium Enterprise (SMEs)

This part explains the objective of the intelligent negotiation and consortium agent, related work, negotiation and consortium model, system design, and consortium and simulation system for a plastic market.

Objective

The proposed e-marketplace or e-commerce system is to present the online trading simulation to answer the third dissertation question, which is "Can the combination of an automated consortium and negotiation agents improve the market efficiency for Small and Medium Enterprises (SMEs)?" On third part, a simulation system for an e-commerce has been built to answer question 3.

The system is to improve the design of a framework for an automated negotiation and consortium agent. The system utilizes the combined technology of consortium and negotiation agents. The system design has two parts. The first part is the consortium agent, which allows the buyers to collaborate to act as one buyer. The second part is the negotiation agent, which allows the Lead Buyer (LB) or Large Enterprises (LEs) to communicate with a seller. Also, the system allows the buyers in the consortium to negotiate with the LB who has the biggest units requested. The negotiation between the buyers and the LB can be started only after the LB finished a negotiation with the seller.

The first part of the system will improve the performance of the traders' agents because a trade agent can be a broker as well as a trader agent. However, this system does not provide a trader meeting service as a broker. As a broker service, each trader can get initial trading information from a market posting service, which allows the traders to read and write messages to and from participating traders. In addition, one more benefit of this system design is mediating the broker agent by implementing an automated consortium function while eliminating the consortium service costs for the traders. The LB plays a broker during a consortium process. Also, the LB does not charge any fee from others because the LB has his own benefit out of a consortium. A consortium provides more trading opportunities with large volume, which is not available without a consortium.

The second part is the negotiation agent, which assists the traders in exchanging messages between the agents. In the negotiation, both the buyers and the seller implement the Estimated Reserved Price Range (ERPR) to reach "Deal" or "No Deal." The targeted implementation of the consortium and the negotiation agents are a plastic market.

Negotiation Related Work

Many research papers showed that the negotiation agents have been used for negotiating the product or service price in the market or for exchanging information between businesses. Also, some e-marketplace systems applied automated negotiation focusing on negotiation protocols and other resources such as negotiation rules, negotiation strategies, lessons learned or game theory (e.g., AuctionBot, Kasbah). As an example, The Michigan Internet AuctionBot was developed under the leadership of Dr. Wurman (1998a) in 1995 in collaboration with the Department of Computer Science & Engineering at the University of Michigan (Allen et al., 2001; Fortino et al., 2005); it is a general Internet auction. The AuctionBot gives an authorization for the users to create their own auctions, which allows them to sell products, and allows them to select the auction types based on choosing the controlling bidding protocol and auction rules (Wurman, et al., 1998).

In other research papers, the automated negotiation focused on negotiation protocols. In Jennings, et al. (2006), the automated negotiations can deal with three broad topics: negotiation protocols, negotiation objects, and agents' decision-making models (Jennings et al., 2006). The authors applied the simulation of the trading agent by implementing a mix of procurement strategies and by using the market situation and its inventory level to decide the price (Jennings, et al., 2006). The Yin, Li, and Zhi (2010) had developed a negotiation agent in a multi-agent simulation by using Netlogo. The simulation is conducted between businesses and customers (Yin, et al., 2010).

Theoretical Reason for Purchasing Consortium

In the consortium agent, this section has explained the power of a purchasing group, purchasing in Small and Medium Enterprises (SMEs).

The power of purchasing groups: These days, there are group purchasing in all industries and in many different fields. The most common form of group purchasing is in the healthcare and education industries. There are three major structures of purchasing groups: 1) The consortium which is defined by Thomas Hendrick as "two or more independent organizations that join together, either formally or informally, or through an independent third party, for the purpose of combining their individual requirements for purchased materials, services and capital goods" (Hendrick, 1996). 2) A private equity group, which is defined as "capital invested in the direct ownership of businesses that are not traded on public stock exchanges" (Arnold, 2005). 3) Group Purchasing Organizations (GPOs), which is defined as a group in healthcare in the U.S., allows their members to get the lowest cost of goods and services (Hovenkamp, 2002).

Purchasing small and medium sized enterprises: There are four purchasing approaches, which are Private Purchase Approach (PPA), Supplier Based Approach (SBA), Specific Purchase Approach (SPA), and Source Selection approach (SSA). The PPA is a purchasing department in a company that implement its own catalogs, which are managed by their own private gateway, which may include websites (Bartezzaghi & Ronchi, 2004). The SBA is a purchasing department in a company that mainly depends on their providers' proposals (Bartezzaghi & Ronchi, 2004). The SPA is a vertical consortium gateway, which is a consortium to buy specific materials that belong to traders' manufactories (Bartezzaghi & Ronchi, 2004). The SSA is a procedure of making a decision, which gains the prize of a contract action (Bartezzaghi & Ronchi, 2004).

The idea of this section of the dissertation about consortium agents is that they focus on purchasing consortium because the group of agents are needed to connect to each other to make purchasing group, and they are not related to each other similar to the private equity firms or GPO. Among the various type of the consortium, the specific purchase approach has been selected because the closeness of the consortium purchasing group in a specific market and the plastic market for SMEs.

Negotiation and Consortium Model

This section explains the resource-oriented process, Estimated Reserved Price Range (ERPR) and supporting agent's dynamic strategy of the negotiation and consortium model. Also, it explains the consortium negotiation cases and consortium and negotiation agents for both SMEs and LEs.

Resource oriented. The resource-oriented negotiation is used for building a consortium as mentioned in the introduction. The resource oriented for negotiation can be divided into two types: a) Static Resource is the basic feature (e.g., number of buyers, and sellers, and goods), b) Dynamic Resource is the product's information (e.g., price, quality, quantity, transportation time, etc.…) (Hai-wen, 2010). Also, it is assumed that the market environment will affects the product price (e.g., Information of product in market, and market price change, competition, etc...) (Hai-wen, 2010).

Estimated reserved price range (ERPR). A trader can have his own reserved price range for a product. The reserved price range can affect the trader's decision when a trader bids or offers a price for plastic products. This dissertation assumes that a trader's reserve price range depends on two factors: (1) the Wholesales Market Price (WMP), which is the average of the product price; (2) the Retail Market Price (RMP), which is the average of the retail product price. We assume that the Permissible Range Units (PRU) calculation is based on Wholesales Retail Price (WRP) that the buyer agent can increase its units without any loss of benefit of purchasing from the seller as shown below.

WMP * (Buyer Unit (U_j)+ PRU) = Buyer Unit (U_j) * RMP

Simplifying does:

WMP * Buyer Unit (U_j) + WMP * PRU = Buyer Unit (U_j) * RMP

WMP * PRU = Buyer Unit (U_j) * RMP – (WMP * Buyer Unit (U_j))

PRU = (Buyer Unit (U_j) * RMP – (WMP * Buyer Unit (U_j))) / WMP

1… j: Number of buyers

Wholesales Market Price (WMP) and the Retail Market Price (RMP) are used to generate a random number in the Estimated Reserve Price Range (ERPR) to assist both the seller and the buyers' agents in the negotiation decision making. The WMP and RMP numbers are random numbers but these numbers are based on the real trading price in the plastic market. One of the decision variables Product Random High (PRH) is represented as the number that represents the percentage of the highest estimated reserved price. Also, the Product Random Low (PRL) represents the number that is the percentage of the lowest estimated reserved price. The highest and lowest estimated reserved prices represent the estimated reserved price range.

PRH = random of WRP

PRL = random of WRP

High ERPR = buyer potential price + (random of PRH * buyer potential price)

Low ERPR = buyer potential price - (random of PRH * buyer potential price)

Supporting agent's dynamic strategy. The system supports the buyer's agent in consortium by providing following services: providing a list of buyers' agents and the estimated reserved price range, analyzing every buyer agent on the buyers list, and filtering the list of buyers based on seller's product information. The system also provides different resource knowledge to trader agents to enhance the agents' trading strategies. Those resources are static, dynamic, and market environment information and it allows the agent to achieve a better performance in forming a consortium and doing a negotiation. This information also allows the buyers to negotiate with each other and to build a consortium as well as the LB to negotiate with the seller.

Consortium negotiation cases. There are many methods to build a consortium among buyers. Example of consortiums are Local Network and Volunteer Confederation (Aylesworth, 2003). The Local Network is defined as "one or more institutions join together to obtain better pricing, share information, and in some cases, share resources" (Aylesworth, 2003, p.3). The Volunteer Confederation is defined as "a confederation is the most common model of collaboration noted in the study whereby purchasing managers carry out competitive sourcing based on needs defined by the participating institutions" (Aylesworth, 2003, p.3). In this section, the Leader Buyer who has the largest volume requested against the seller's unit is used as an agent, which tries to do exact volume matching by collaborating with other buyers. Also, Consortium Negotiation is used to calculate the appropriate offer-price between a group of buyers and a seller's product. There could be many methods to calculate offer-price: 1) average offer-price without considering the buyer's volume requested, 2) average offer-price with considering the buyer's volume requested, and 3) average offer-price for a trader who needs more than a quarter of the seller's units. In this section, the first case has implemented to calculate the average because of the realistic and practical reason. Also, if the LB ignores any buyer that might affect the performance of forming a consortium. In addition, the option two is also realistic but it will make the consortium to fail too frequent.

Consortium and Negotiation Simulation System in a Plastic Market (CNSSPM)

The Consortium and Negotiation Simulation System Plastic Market (CNSSPM) is to simulate the trading between the buyers and the seller's agents in the plastic market based on consortium and negotiation for SMEs, negotiation for LEs, and non-negotiation for LEs. In this section, the CNSSPM description, CNSSPM architecture, and CNSSPM subsystems have been explained below.

CNSSPM description. The e-commerce system is to represent the buyers' and the seller's agents that communicate together using consortium and negotiation for SMEs, negotiation for LEs, and non-negotiation for LEs by sending and receiving information to accomplish the contract if possible. Also, the CNSSPM implements the buyer's and the seller's Estimated Reserved Price Range (ERPR) in the negotiation. In addition, CNSSPM implements consortium for SMEs that use exactly match. Moreover, the CNSSPM implements non-negotiation for LEs. The e-commerce system purpose is to compare the results for the Consortium and Negotiation for SMEs with ERPR, Negotiation for LE with ERPR, and Non-Negotiation for LE.

CNSSPM design. In this section, the CNSSPM design is explained as one part and the CNSSPM subsystems design is explained in detail, which include Generator, Knowledge Domain, Consortium and Negotiation for SMEs with ERPR, Negotiation for LEs with ERPR, and Non-Negotiation for LEs.

CNSSPM architecture. The CNSSPM e-commerce system is considered as Generator Subsystem and four subsystems, which are Knowledge Domain, Consortium and Negotiation for SMEs, Negotiation for LEs, and Non-Negotiation for LEs. The Generator Subsystem (GS) is to get the user inputs to use in other subsystems. The Knowledge Domain Subsystem (KDS) is considered to get some information from GS to set up product information for both buyers and the seller. Also, KDS provides the random number to associate with both the buyer and the sellers to calculate their Estimated Reserved Price Range (ERPR) in negotiation for SMEs and LEs. The Consortium and Negotiation for SMEs subsystem (CNSMEs) considers that the buyer communicates to find the Lead Buyer (LB), which has the highest units requested to build consortium. Also, CNSMEs allows the LB to negotiate with the seller based on ERPR to make a contract, if possible. The Negotiation for LEs Subsystem (NLEs) considers that the LE negotiates with the seller based on ERPR to make a contract, if possible. The Non-Negotiation for LEs Subsystem (NNLEs) considers that LE checks if the seller's product price is suitable to make a contract or not.

Decomposition description. Figure 35 shows CNSSPM components, which are Generator, Knowledge Domain, Consortium and Negotiation for SMEs, Negotiation for LEs, and Non-Negotiation for LEs subsystems. Also, it shows how they are related to each other. The general information is in the functional section, and the details of every subsystem are in the following section (CNSSPM subsystems architecture).

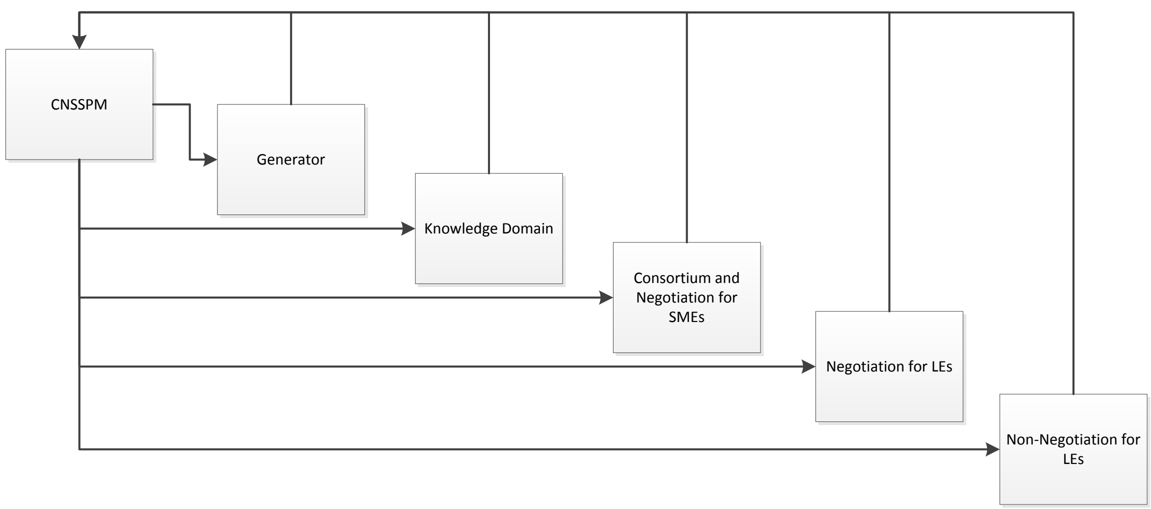

Fig. 35. CNSSPM Components

Functional. The Flow Chart shows the major subsystems: Generator, Knowledge Domain, Consortium and Negotiation for SMEs, Negotiation for LEs, and Non-Negotiation for LEs subsystems. The Flow Chart also explains the CNSSPM subsystem as functions. The Flow Chart shows how the Generator subsystem works and connects to Generator, Knowledge Domain, Consortium and Negotiation for SMEs, Negotiation for LEs, and Non-Negotiation for LEs subsystems. Figure 36 shows the algorithm of CNSSPM. The details of the subsystems are in the CNSSPM Subsystems Architecture. Figure 36 explains subsystems as follows.

Generator subsystem**.** The Generator Subsystem (GS) has two main functions: collecting user inputs and building agents. The main function of the collecting user's inputs module is to get the number of the sellers, the number of buyer agents, and market information. Based on the collected information, the GS builds the agents and then sends them with market information to CNSSPM. After that the CNSSPM run the Knowledge Domain Subsystem.

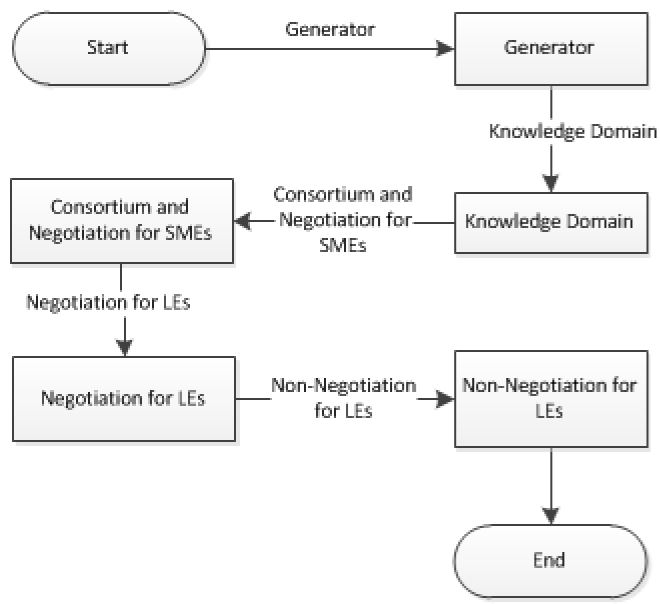

Fig. 36. Flow Chart for the CNSSPM Function Components

Knowledge domain subsystem. The function of Knowledge Domain Subsystem (KDS) is to set up the buyers' information, which include are the product's name and product units. Also, it sets up the seller's information, which includes the product's name and product units. In addition, KDS calculates the random numbers for both the buyers and the seller, which are used to calculate the agents' own Estimated Reserved Price Range (ERPR). The ERPR is used in e-marketplace simulation trading. Also, the ERPR will be used only in negotiation for SMEs and LE agents.

Consortium and negotiation for SMEs subsystem (CNSMEs). CNSMEs allows the SME agents to communicate together to find the LB who is responsible for building a consortium among the SMEs. Also, the LB negotiates with the seller, instead of the individual SMEs, based on ERPR to make a contact by sending and receiving messages. The consortium and negotiation for SMEs subsystem has many functions that work together to build consortium among the buyers and later the LB from the consortium negotiates with the seller. The details of the consortium and negotiation functions for SMEs are in the consortium and negotiation for SMEs subsystem architecture section.

Negotiation for LEs subsystem**.** Negotiation for LEs Subsystem (NLEs) allows the LE agents to negotiate with the seller instead of the SMEs based on ERPR to make a contract. The negotiation for LEs subsystem has many functions and those functions try to make a deal in a negotiation with the seller. The detail of the negotiation for LEs functions is in the negotiation for LEs subsystem architecture section.

Non-Negotiation for LEs Subsystem**.** Non-Negotiation for LEs Subsystem (NNLEs) allows the LE agents to check whether the lowest seller's price is suitable to make a contract. The NNLEs subsystem has many functions that work together to make a contract between the LEs and the seller. The detail of the NNLEs functions is in non-negotiation for LEs subsystem architecture section.

CNSSPM subsystems architectures. The CNSSPM has five subsystems: Generator, Knowledge Domain, Consortium and Negotiation for SMEs, Negotiation for LEs, and Non-Negotiation for LEs. In this section, the architecture for those five subsystems are explained below.

Generator subsystem. The Generator Subsystem (GS) gets the user's inputs that are used in other subsystems and then the GS builds the buyers' and seller's agents. After GS builds the agents, the GS sends the relevant information to CNSSPM.

Decomposition description. The GS works with CNSSPM closely. Figure 37 shows how GS works with CNSSPM. The details of GS are described in the functional section below.

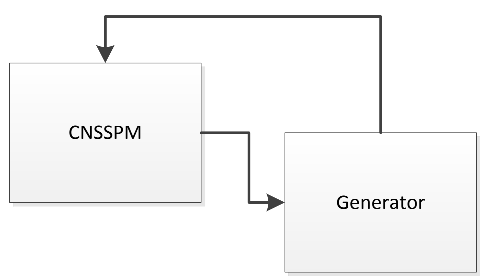

Fig. 37. Genertor Subsystem Components

Functional. The GS has two functions, which are to get the user inputs and build agents. Figure 38 shows the algorithm of Generator Subsystem. The details of every function is described as follows.

User inputs. The input of this function is the user data. This function collects user data and then it saves the collected user input to its storage after the data saving it sends the collected data to other functions in the system. The content of the user inputs is the number of buyers and seller, non-consortium market product's price, and list of buyers in a consortium. The output of this function is the user data.

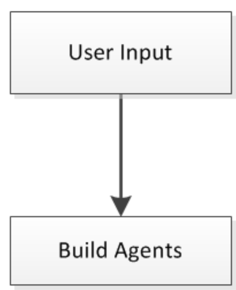

Fig. 38. Generator Function Components

Build agents. The input of this function is the number of buyers and sellers that is received from the user inputs function. All the buyers' and seller's agents will be built in this function. The output is the buyer and sellers agents to run Consortium and Negotiation for SMEs, Negotiation for LEs, and Non-Negotiation for LEs subsystems.

Knowledge domain subsystem. The Knowledge Domain

Subsystem (KDS) is used to set up the buyers' information, which includes product name and units requested. Also, KDS is used to set up the seller's information, which includes the product name and units for sale. In addition, KDS generates some numbers that will be used in the Estimated Reserved Price Range (ERPR) for both the buyer and the sellers. The ERPR will be used only for the Consortium and Negotiation for SMEs and Negotiation for LEs subsystems.

Decomposition description. KDS is working with CNSSPM. Figure 39 shows how KDS works with CNSSPM. The CNSSPM runs KDS to set up the information, which assists to run the Consortium and Negotiation for SMEs, Negotiation for LEs, and Non-Negotiation for LEs subsystems. The details of KDS are described in the functional section below.

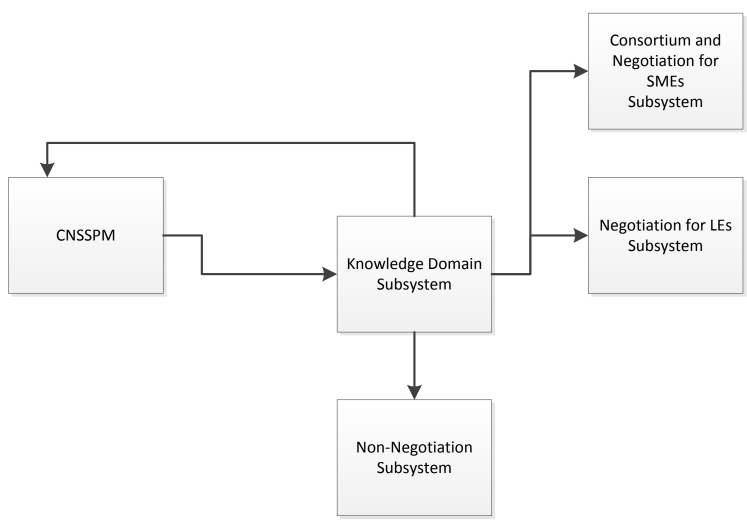

Fig. 39. Knowledge Domain Subsystem

Functional. The KDS function has three sub-functions, which are set up product information, search for product for other subsystems, and filter buyers based on the seller product. Also, KDS generates some numbers for the buyers and the seller to calculate their own Estimated Reserved Price Range (ERPR). This number will be used for Consortium and Negotiation for SMEs and Negotiation for LEs subsystems later. Figure 40 shows the algorithm of KDS. The detail of every function is described as follows.

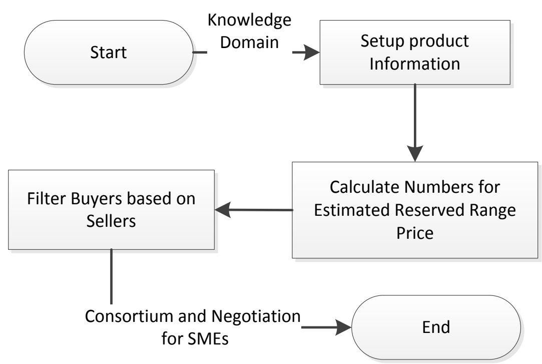

Fig. 40. Knowledge Domain Subsystem Function Components

Setup product information. The inputs are the buyers and the seller's agents, which is received from Generator Subsystem. This function sets up the product information, which includes the product's name, unit's price for the buyers and the seller. The product information is randomly generated for both the buyers and the seller. The outputs are the buyer name and the new list of the sellers.

Calculate the number for Estimated Reserved Range Price. The subsystem calculates the numbers that allow both the buyers and the seller to calculate their own ERPR. The output of this subsystem is the ERPR's numbers.

Filter buyers based on the Seller. The inputs are the seller's product information and the list of the buyers. This function filters out buyers who do not have the seller's product. The output of this function is a new list of the buyers.

Consortium and negotiation for SMEs subsystem. Consortium and Negotiation for SMEs Subsystem (CNSMEs) has two subsystems, which are CNSMEs, and Knowledge Domain subsystems. The detail of design, functional, and UML sequence diagram will be described as follows.

Design: The CNSMEs is a system that will find the LB who builds a consortium and negotiates with the seller to make a contract. The CNSMEs has two main processes. The first main process depends on the LB, who will build a consortium by communicating with other buyers. During the process, the LB sends a consortium request message to other buyers and receives responses from others. In the second main process, the LB negotiates with the seller over the product price to make a contract. Also, the LB negotiates with other buyers about the seller's counter offer, making offer for the seller, or rejecting the seller's counter offer.

Decomposition description. The CNSMEs subsystem works with CNSSPM. Figure 41 shows how the CNSMEs works with CNSSPM and KDS. The details of negotiation are described in the functional section below.

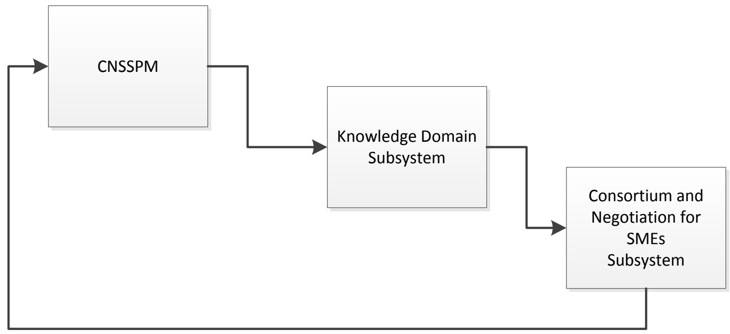

Fig. 41. CNSMEs Subsystem Components.

Functional. Figure 42 explains the Flow Chart algorithm for Consortium and Negotiation for SMEs (CNSMEs). The MKPAC subsystem function finds the highest buyer unit requested, and then it aggregates the buyers' units ($\sum U_j$). After the aggregation, it checks if $\sum U_j$ >, =, or < to the Seller Units (SU). Next, it starts a negotiation with the seller (Units) by sending a message to the seller. When the system receives the seller's decision, it checks out whether ($\sum U_j + PRU_j$) equals to the Seller Units (SU). If the two trading units are equal then a consortium will be formed and following procedures will be initiated. The procedures are: the system starts negotiation with the seller (Price), calculate the offer price base on (ERPR), send a message to the seller, receive a message from the seller, send messages to the buyers, receive the buyers' decisions, check the type of responses which is rejection, continue negotiation, update the buyers' offer base on (ERPR), end negotiation, contract, and end the procedure. The detail of CNSMEs functions are described as follows: (See figure 42).

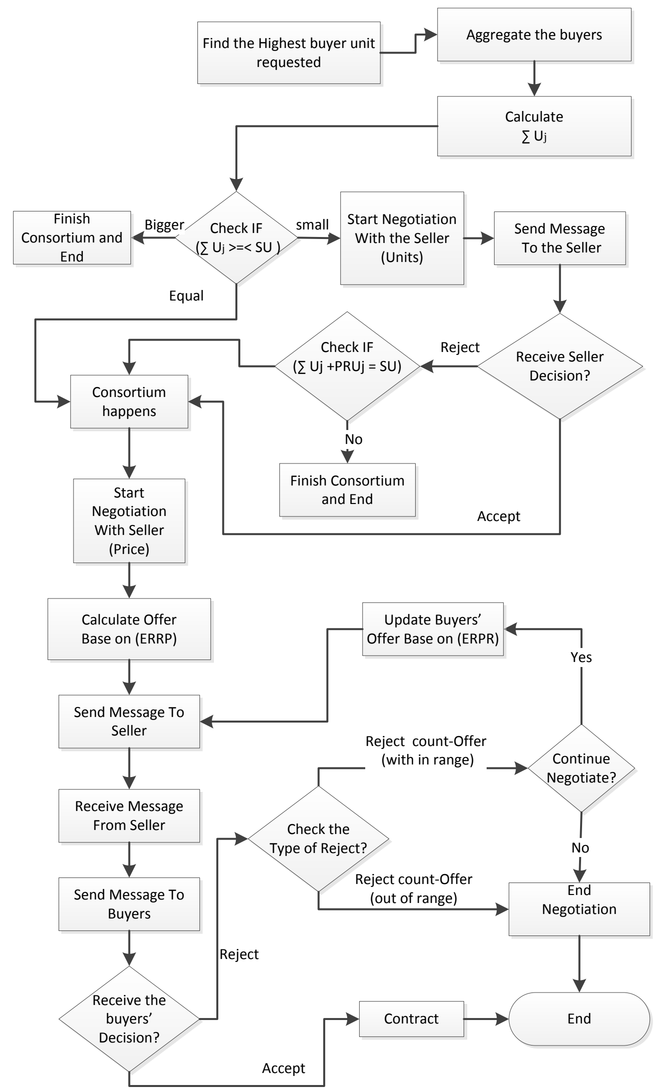

Fig. 42. Consortium and Negotiation for SMEs

Find the highest buyer unit requested: The input is the list of buyers. The buyers communicate with other buyers to find the Leader Buyer (LB) who has the highest purchasing unit requested will lead the consortium process. The output is the Leader Buyer (LB).

Aggregate the buyers: The input is the Leader Buyer (LB). The LB communicates with the other buyers who need the seller's product to see if forming a consortium is possible or not. The outputs are the buyers' consortium list and LB.

Calculate $\sum U_j$*:* The inputs are the LB and buyers' consortium list. In his operation, the LB communicates with the other buyers to get their unit requested (U) to calculate $\sum U_j$. The outputs are $\sum U_j$, buyers' consortium list, and LB.

Check if $\sum U_j$ *>, =, or < to the Seller Units (SU):* The inputs are the LB, buyers' consortium list, $\sum U_j$, and Seller Units (SU). During this operation, the LB checks that the $\sum U_j$ is bigger, equal, or smaller than SU:

- If $\sum U_j = SU$, then the output will be "Consortium Happens," which means the consortium process can be started.
- If $\sum U_j > SU$, then the output will be "Consortium Does Not Happen," which means that the Finish Consortium and The End subsystems will be initiated.
- If $\sum U_j < SU$, then the output will be "Consortium Does Not Happen," which means the LB will start a negotiation with the Seller based on the trading units.

Start negotiation with the seller (Units): The inputs are the LB, buyers' $\sum U_j$, and Seller Units (SU). In this operation, the LB starts a negotiation with the seller about "Can the seller accept their units requested?" The outputs are $\sum U_j$ and LB.

Send message to the seller: The inputs are the LB, buyers' $\sum U_j$, and the seller's decision. In his operation, the LB sends a message to the seller about "can the seller accept the buyers' units requested which is less than the seller's units?" The outputs are seller's responding message and LB's waiting.

Receive the seller's decision? The inputs are the LB and the seller's message. In his operation, the LB checks out the seller's message: "Accept" which means "Consortium Happens," then the outputs are LB and $\sum U_j$, or "Reject", then the outputs are LB and $\sum U_j$.

Check if ($\sum U_j + PRU_j = SU$): the inputs are the LB and $\sum U_j$. The LB gets PR from each buyer and checks if $U_j + PRU_j = SU$. If $\sum U_j + PRU_j = SU$ then the system outputs LB and a consortium will start. If $\sum U_j + PRU_j \not\equiv SU$ then the outputs are Finish Consortium and End processes.

Consortium Happens: the inputs are the LB and buyers' consortium list. In his operation, the LB sends out a confirmation "Consortium Happens" message to buyers who are in the consortium list. The outputs are buyers' consortium list and the LB.

Start negotiation with the seller (Price): the input is the LB. The operation is that the LB organizes itself to negotiate with the seller. The output is the reorganized LB.

Calculate price offer base on (ERPR): The inputs are the buyers' consortium list, and LB. The operation is that LB communicates with the buyers who are in the consortium list to calculate the Product's Offer Price (POP). The outputs are POP and the LB.

Send message to the seller: The inputs are POP and the LB. The operation is that the LB sends the POP to the seller. The output is "Waiting" for the seller's response.

Receive message from the seller: The input is the seller's response to the POP. The operation is that the LB receives the seller message, which is "Accept" or "Count-Offer." The outputs are LB and the seller's message.

Send messages to the buyers: The inputs are LB, the seller message, and buyers' consortium list. The operation is that the LB sends a message to the seller, which is "Accept" or "Count-Offer" to other buyers. The output is "Waiting" for the buyers' response.

Receive the buyers' decisions? The input is the buyers' responses, which are either a count-offer or an acceptance message. The operation is that the LB checks all the buyers' decisions. In this situation, there are two possible outcomes: 1) "Accept" which means all the buyers accept the seller's counter offer, which means the process, can go to "Accept Contract", 2) "Reject" which means the buyers reject the count-offer from the seller. In this case, the system checks out the type of the rejection. The outputs are LB and Buyers' decision, which is "Accept," or "Reject."

Check the type of rejection? The inputs are the LB, the LB's decision "Reject," and the buyers' responses. LB checks all the buyers' decisions. This decision could be one of the following: 1) "Reject Count-offer (with range)" which means one or more buyers does not accept the seller's counter offer but they still want to go to "Continue Negotiation"; 2) "Reject (out of range)" which means one or more buyers see the seller's offer is bigger than the buyer's highest price of the estimated reserved price range. In this case, the process will go to "End Negotiation." The outputs are LB and Buyers' decision which is "Reject Count-offer (with range)," or "Reject Count-offer out of range."

Continue Negotiation: the inputs are LB and the buyers' message "Continue Negotiation" and the sellers' counter offer. The operation is to continue the negotiation with the seller or to finish the negotiation to finish the negotiation, the seller's counter offer may reach the highest of the LB or any buyer's ERPR. The output is either to continue negotiation or to stop negotiation, which means the negotiation is the end.

Update the buyers' offer base on (ERPR): The inputs are the buyers' consortium list and LB. The operation is that LB communicates with the buyers who are in the consortium list to update the Product's Offer Price (POP). The outputs are POP and the LB.

End Negotiation: The input is "Stop Communication" message from the system. The operation is "Stop Negotiation" which it means "No-Deal." The output is "No Deal."

Contract: The input is the combined buyers' decision "Accept." The operation is to make a deal with the seller.

End: In this process, the system kills all the processes and agents.

Sequence diagram. The CNSMEs sequence has two components: 1) process sequences for the building a consortium, and 2) process sequences for a negotiation. The first sequence shows how the LB builds a consortium with other buyers. The second sequence shows how the LB negotiates with other buyers, and how the LB negotiates with the seller.

Consortium sequence. The sequence below (figure 43) explains Consortium process. In the beginning, the LB asks for a consortium by sending a broadcast message. Every buyer who needs the seller's product sends back a reply. The LB builds the consortium list of the potential buyers. The LB sends a "waiting" message to other buyers who are on the consortium list. Every buyer calculates its own buyer unit and sends it back to the LB. The LB adding up all the buyers' units, checks out that the aggregated buyers' units reaches the seller's units, and builds a consortium list. If the total of the buyers' units is equal to the seller's units then the LB starts negotiation right away. However in case the total of the buyers' units is less than the seller's units then the LB sends another message to all buyers who are on the consortium list and asks the buyers to increase their units to reach the seller's units. If the buyers increase their units, the LB starts negotiation again with the seller. If any buyer rejects to increase its own units, the LB stops doing consortium activity.

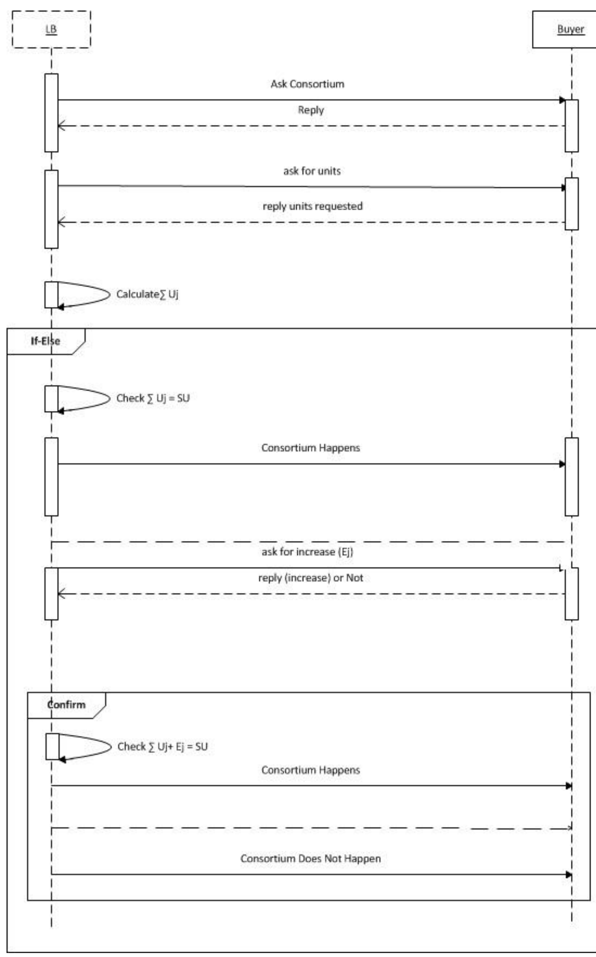

Fig. 43. CNSMEs Sequence for a Consortium.

Negotiation Sequence. In the beginning, the LB has two negotiation processes: 1) the negotiation between the LB and the buyers who are on the consortium list, and 2) negotiation between the LB and the seller.

In the sequence diagram below (figure 44), the negotiation between the LB and the buyers who are on the consortium list of the buyers starts sending and receiving a message which includes offer, count-offer, accept, or reject. The LB calculates the offer from the consortium list of buyers after it receives the other buyers' messages. The buyer starts negotiation with the seller.

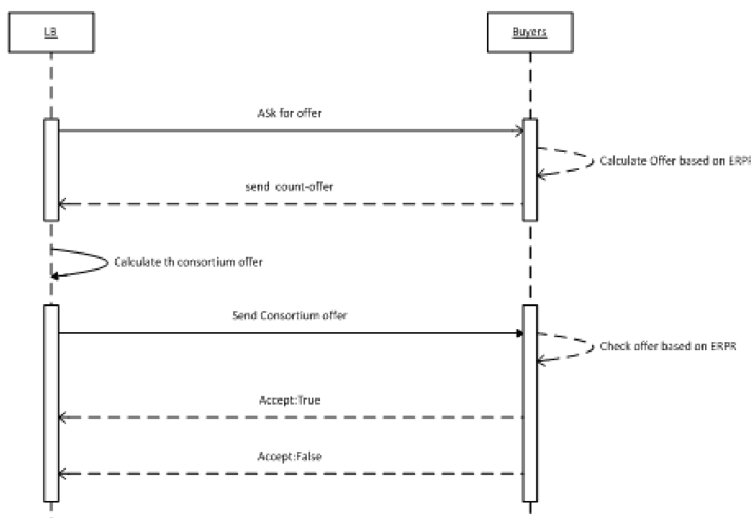

Fig. 44. CNSMEs Sequence for Negotiation with the Sellers.

In the sequence diagram below (figure 45), the negotiation between the LB and the seller starts by sending and receiving a message which includes offer, count-offer, accept, or reject. After the LB calculates the offer from the buyers on the consortium list, the LB sends the offer to the seller. The seller checks the LB's offer and replies to the LB by count-offer. This sending and receiving messages between the LB and the seller form a loop until one of them accepts, rejects, or offers another price.

Negotiation for LEs subsystem. The Negotiation for LEs Subsystem (NLEs) has two subsystems, which are NLEs, and knowledge domain subsystems. In the next steps, the detail of design, functional, and UML sequence diagram will be described.

Design: The NLEs is a system, which negotiates with the seller to make a contract. The negotiation subsystem is one of the NLE's sub-process. The NLE allows the LEs to negotiate with the seller by sending and receiving messages.

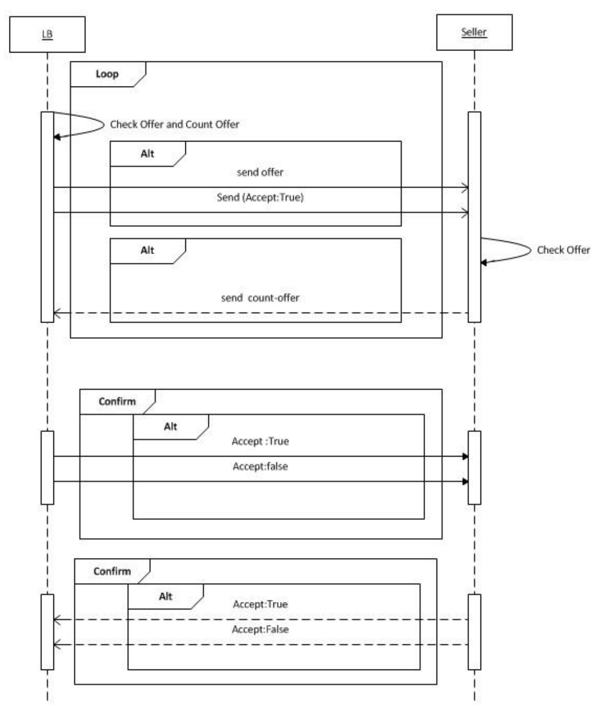

Fig. 45. CNSMEs Sequence for Negotiation with the Sellers.

The LEs have to accept the seller's count-offer, make another offer-price for the seller, or reject the seller's counter offer.

Decomposition description. The LEs works with the CNSSPM system. Figure 46 shows how the NLEs works with CNSSPM and KDS subsystems. The details of negotiation are described in the functional section below.

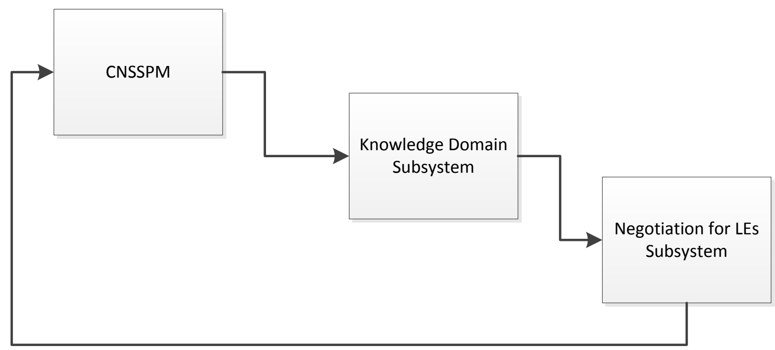

Fig. 46. NLEs Subsystem Components.

Functional. Figure 47 explains how the Flow Chart algorithm for negotiation for SMEs (NLEs) works. The NLEs subsystem functions has functions as follows: LE buyer calculates units (U_j), check If U_j >, =, or < SU, start negotiation with the seller (Units), send Message to the seller, receive the seller's decision, check if LE's (U_j +PRU_j = SU), finish and end, start negotiation with the seller (Price), calculate offer price base on (ERPR), end message to the seller, receive message from the seller, check the buyer's decision, check the type of rejection, continue negotiation, negotiation end, contract, and end. All those functions work together to make a negotiation between buyers and a seller. The detail of CNSMEs functions are described as follows.

LE buyer calculates units (U_j): The input is the LE. In his operation, the LE calculates how many units are needed for the seller's units. The outputs is LE's units requested (U_j).

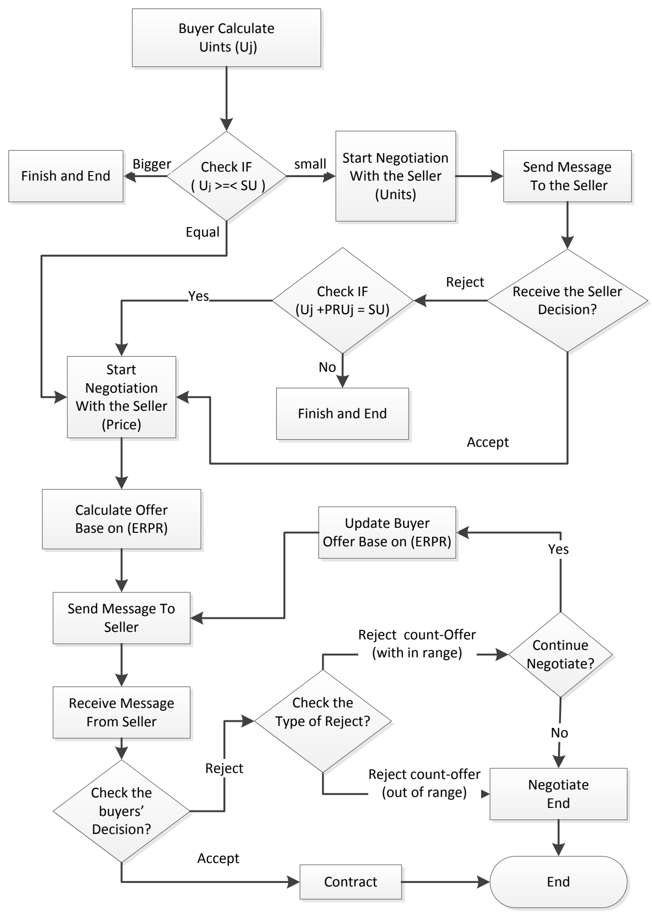

Fig. 47. Flow Chart for LEs' Negotiation.

Check If U_j >, =, or < SU: The input is the LE's U_j. During this operation, the LE checks out that U_j is bigger, equal, or smaller than SU.

If $U_j = SU$, the output will be "Start Negotiation (Price)," which means the LE can start negotiation with the seller.

If $U_j > SU$, the output will be "Finish and End Process" which means the LE will not do any negotiation with the Seller.

If $U_j < SU$, the output is "Start Negotiation (Units)," which means the LE will communicate with the seller about the units

Start negotiation with the seller (Units): The input is the LE's U_j. In his operation, the LE starts to negotiate with the seller about "can the seller accept the LE's U_j to sell". The output is LE's U_j.

Send Message to the Seller: The input is LE's U_j. In his operation, the LE sends a message to the seller about "Can accept the LE's U_j." The outputs are message and LE's "Waiting."

Receive the seller's decision? The inputs are the LE and the seller's decision. In his operation, the LE checks the seller's message; if the seller message is "Accept" then the output is LE, or "Reject", then the output is LE's U_j.

Check if LE's ($U_j + PRU_j = SU$): the input is the LE's U_j. The LE calculates the PRU and checks if $U_j + PRU_j = SU$, if $U_j + PRU_j = SU$ then the output is LE's new U_j, if $U_j + PRU_j \neq SU$ then the output will be "Nothing" and end job.

Finish and End. The system kills all the LEs agents.

Start Negotiation with the seller (Price): the input is LE. In this operation, the LE organizes itself to start a negotiation with the seller. The output is the LE.

Calculate offer price base on (ERPR): The input is LE. The operation is that LE calculates Product's Offer Price (POP) based on the ERPR. The outputs are the POP and LB.

Send message to the seller: The inputs are POP and the LE. The operation is that the LE sends a message, which includes the POP to the seller. The output is "Waiting" for the seller's response.

Receive message from the seller: The input is the seller's response to the POP. The operation is that the LE receives the seller message, which is "Accept" or "Count-Offer." The outputs are LE and the seller's message.

Check the buyer's decision? The inputs are the LE and seller's message. The operation is that the LE checks the seller's decision. In this situation, there are two decisions are possible: 1) "Accept" which means all the buyers accept the counter offer which is "Accept Contract"; 2) "Reject" which means that the buyer rejects the counter offer. The system identifies the type of the rejection. The outputs are LE and LE's decision, which is "Accept," or "Reject."

Check the type of rejection? The inputs are the LE, and the LE's decision "Reject." In this situation, there are two decisions are possible: 1) “Reject Count-offer (with range)” which means LE does not accept the sellers’ counter offer but still want to “Continue Negotiation”; 2) “Reject (out of range)” which means LE sees the seller’s offer is bigger than the buyer’s highest price of the estimated reserved price range and this condition leads the process to the “End Negotiation.” The outputs are LE and LE’s decision which is “Reject Count-offer (with range),” or “Reject Count-offer (out of range).”

Update Buyer Offer based On ERPR: The input is LE. The operation is that LE calculates another Product’s Offer Price (POP) based on the ERPR. The outputs are the POP and the LB.

Continue Negotiation: the inputs are LE, the LE’s decision “Continue Negotiation,” and the seller’s counter offer. The operation has to make a decision whether it continues the negotiation with the seller or to finish the negotiation if the seller’s offer reaches the highest of the LE’s ERPR. The output is either to continue the negotiation or to stop the current negotiation.

Negotiation End. The input is “Stop Communication” message. The operation is “Stop Negotiation” which it means “No-Deal.” The output is “No Deal.”

Contract: The inputs are LE and LE’s decision “Accept”. The operation is to make a deal with the seller.

End: In this process, the system kills all the processes and the agents.

Sequence diagram. In the sequence diagram below (figure 48), the negotiation between the LE and the seller starts by sending and receiving messages which includes offer, count-offer, accept, or reject. After the LE calculates the offer price based on the consortium list of the buyers, the LE sends an offer to the seller. The seller checks the LE's offer and replies to the LE by Counter offer. This sending and receiving messages between the LE and the seller forms a loop until one of them accepts, rejects, or offer a new price.

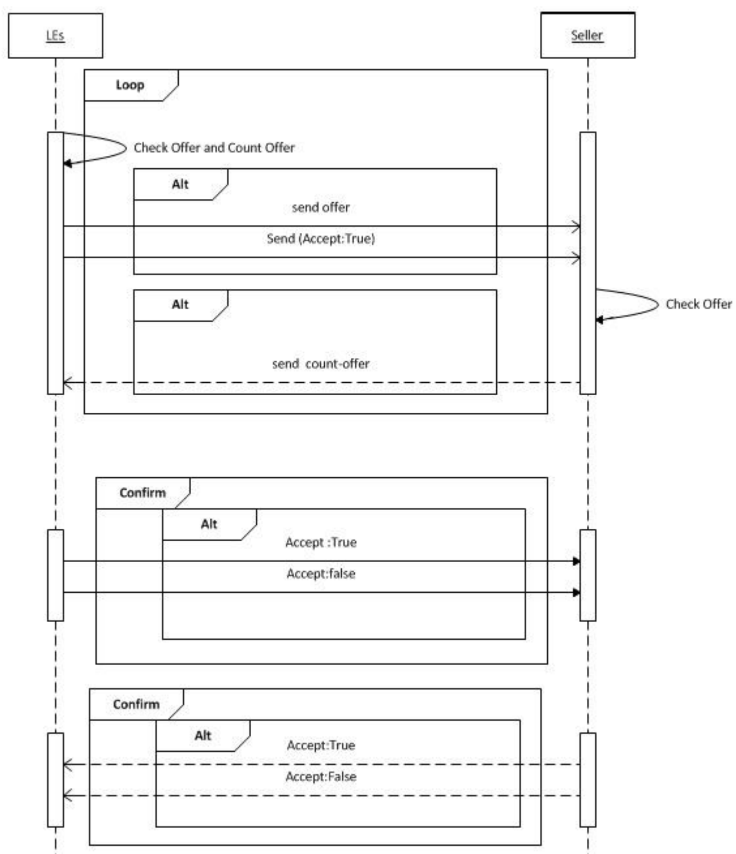

Fig. 48. Sequence for NLEs' Subsystem.

Non-Negotiation for LEs Subsystem. The Non-Negotiation for LEs Subsystem (NNLEs) is a subsystem that does perform a trade matching without doing any negotiation. In the next steps, the details of design, functional, and UML sequence diagram will be described.

Design: The NNLEs is a system that checks the sellers for a product whether the seller's price is suitable for the LE's or not. This process can initiate a contract if necessary. The LEs has two options, which are, accept or reject the seller's price.

Decomposition description. The NNLE works with the CNSSPM subsystem. Figure 49 shows how NNLEs works with CNSSPM and Knowledge Domain Subsystem. The details of the negotiation are described in the functional section below.

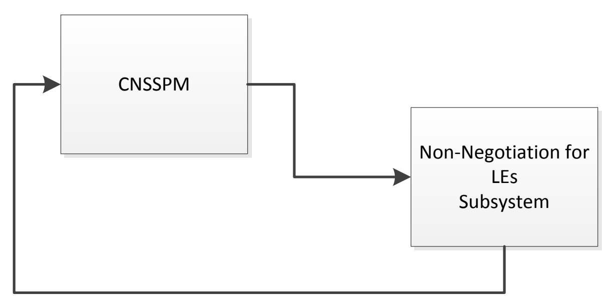

Fig. 49. NNLEs Subsystem Components.

Functional. Figure 50 explains how the Flow Chart algorithm works for SMEs (NNLEs) without any negotiation. The NNLEs subsystem functions include Generator, Knowledge Domain to check the seller's price, LEs decision, contract, and end. The detail of NNLEs functions are described as follows.

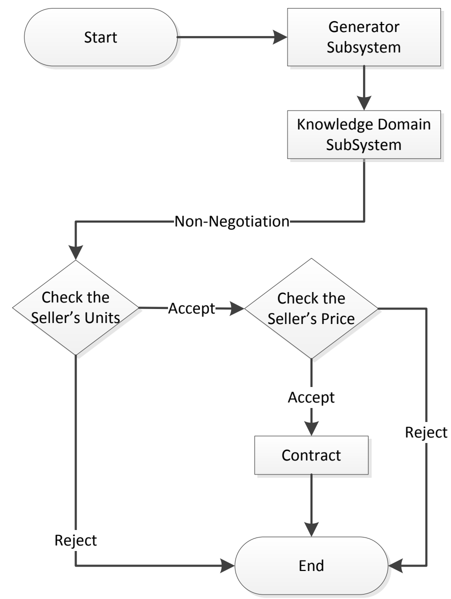

Fig. 50. NNLEs Flow Chart Components.

Generator subsystem. The Generator Subsystem (GS) gets the user's inputs and then this gathered user inputs are used in other subsystems. The GS collects the user's inputs, and then build the buyers' and seller's agents. After GS builds the agents, the GS sends information to CNSSPM.

Knowledge Domain Subsystem (KDS). The KDS is used to set up the buyers' information, which include product name and units requested. Also, KDS is used to set up the seller's information, which includes the product name and units for sale. However, the KDS does not provide ERPR to NNLEs. It only provide the seller information to the NNLEs.

Check the Seller's Units: The inputs are the seller's units and the LEs. In this operation, the LEs check the seller's units whether it is matched with its own trading condition. The output is the LE's decision, which is "Accept" or "Reject."

"Accept": The LE continues to check the Seller's Price.

"Reject.": The LE stops and ends the system process.

*Check the Seller's Price**:*** The inputs are the seller's price and the LEs. In this operation, the LEs check that the seller's price is acceptable or not. The output is the LEs decision, which is "Accept" or "Reject."

"Accept": The LE continues to contract with the seller.

"Reject.": The LEs stops and end the system process.

Contract: The LE makes a contract with the seller.

End: The System stops.

Sequence diagram: The sequence diagram below (figure 51) describes the Non-Negotiation trading for LEs. First, the buyer (LE) receives a message that has the seller's price information for the product trading. The buyer (LE) checks whether the seller's ask price is suitable or not. If the seller's price is suitable then the buyer sends an "Accept" message; if not, the buyer sends a "Reject" message.

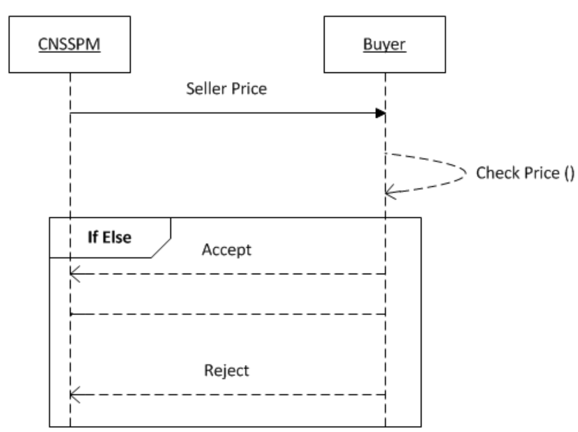

Fig. 51. Sequence for NN LEs

CNSSPM Simulation

In this section, the CSSPM prototype and the CSSPM simulation will be explained. The CSSPM prototype system has following phases: collect and set up information phase, filtering and finding phase, consortium and decision phase, and negotiation and decision phase. The SSPM simulation explains how the agents work with CSSPM.

System prototyping. This section describes the process of forming a trading consortium and the negotiation simulating system that uses the consortium and a negotiation process model. The prototype of the CNSSPM has four phases and these four phases are described as follows.

Collect and set up information phase. The system in this phase has two processes, which are to collect and set up information for agents. The system collects user inputs, which are the number of buyers' and seller's agents, the Wholesales Market Price (WMP), and Retail Market Price (RMP) for the product. The WMP and RMP allow the LB and the LEs to generate their Estimated Reserved Price Range (ERPR). The system also creates both the buyers' agent list and the seller's agent based on the user's inputs. The system sets up random product information for the seller and the buyers. In addition, every agent creates its own ERPR.

Searching, filtering, and finding phase. The system, in this phase, has three processes, which include searching, filtering, and sorting of the buyers list. The system allows the seller to communicate with buyers by sending broadcast messages to all buyers' agents. In the searching process, the buyers communicate with each other to know who needs the seller's product by sending broadcast messages. Every buyer who needs the seller's product responds back to the messages. Then, every buyer filters the buyers' response and saves the buyers who need the same seller product in the list. In this finding process, the buyers communicate with each other to find the LB who has the biggest units requested to lead the negotiation process with the seller and to start consortium and decision phase. In addition, the buyer's agent who needs the seller's product in large volume that is big enough for direct trading will become a LE and this LE's agent can initiate a trading without a consortium.

Consortium and decision phase. In this phase, the system lets the Lead Buyer (LB) run the consortium and start the negotiation processes between the buyers. The LB plays as a broker agent in the consortium building process. The LB forms a consortium by sending a consortium message to other buyers and receiving responses from them. In the beginning of this process, the LB initiates a consortium by checking the buyers list to find out which buyers can join the consortium group. In a consortium, the combined buyers' requested units should be equal to the seller's units. If the total of all buyers' and LB's units is equal to the seller's units, then the LB sends the "Consortium Happens" message to other buyers. If the total of all buyers' units is below than the seller's unit, then the LB communicates with the seller to see "Can the seller accept the total of SMEs units requested?" If the seller's answer is "Yes" then the LB sends the "Consortium Happens" message to other buyers. If the answer is "No", then the LB asks Permissible Range Units (PRU) to each buyer on the consortium list. The sum of all the buyers' units with PRU should be equal to the seller's units. If it is equal to the seller, the LB sends the “Consortium Happens” message to other buyers. Otherwise, the LB sends the “Consortium Does not Happen” message to other buyers in the consortium list.

Negotiation and decision phase. In this phase, the negotiation process has following functions: a loop of send-offer, receive-response, and decision-making. The negotiation agent will be activated under two conditions: 1) it will be activated by SMEs when they try to build a consortium and to find an appropriate offer price for the product; and 2) it will be activated when the LB and/or the LE are negotiating with the seller. The buyers and the seller make their own decision based on the ERPR value. The negotiation process will go through the negotiation between the seller and LB and/or the LEs by sending-offer, receiving-response to reach “Deal,” or “No Deal.” Using a negotiation, the SMEs can find a good ask price from the seller.

CNSSPM simulation description. The Consortium and Negotiation Simulation System Plastic Market (CNSSPM) is a simulation system that simulates trading among automated trading agents for the buyers and sellers in the plastic market. The negotiation agent is used to communicate by the buyers and the seller to send and receive messages. Also, the consortium agent is used to build a consortium among the buyers. The same set of information is used for both negotiation and consortium trading simulations. Figure (52) shows the simulation steps.

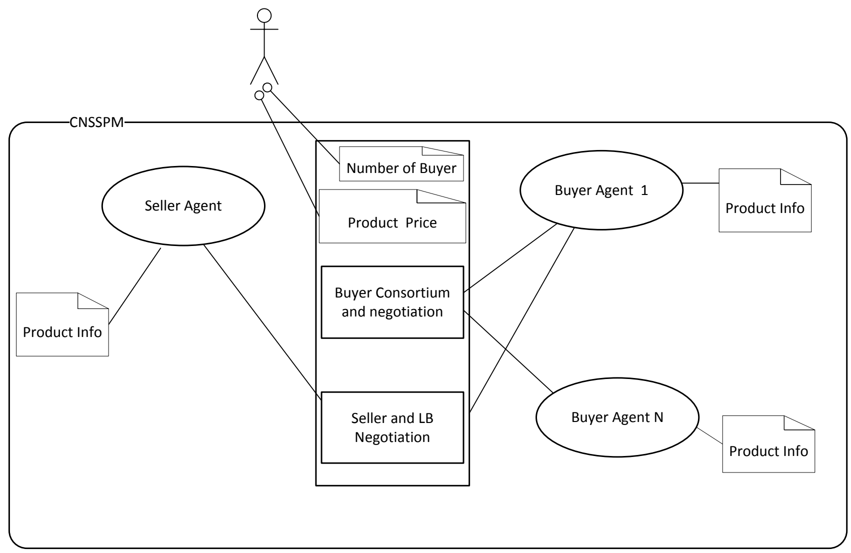

Fig. 52. Simulation for CNSSPM

In the CNSSPM, the first step is gathering user inputs, which are number of buyer, product price. After the user inputs, the system allows the consortium agent to build the consortium, which filters the buyers, based on the seller product information. The buyers negotiate with each other to find a Leader Buyer (LB) who wants the biggest requested units. The LB starts calculating all the buyers' requested units to match the seller units. After the consortium builds, the first step, the LB starts negotiation with other buyers to make a "Price-Offer" to the sellers, which is dependent on every buyer's Estimated Reserved Price Range (ERPR). In addition, the Large Enterprises (LEs) who has enough trading units for a direct trading participates the trading. The second step, the LB and/or LEs start negotiation with the seller. The seller, based on the ERPR, will make "Count-Offer" or "Accept" the LB's and/or LE's offer. The CNSSPM runs to reach a "Deal" or "No-Deal" by exchanging messages.

The simulation has two parts, which are trading consortium process among the SMEs to purchase the seller units, and trading negotiation process for the LEs and/or the

LB who represents multiple SMEs to negotiate with the seller. The negotiation for the SMEs happens in two ways; 1) the buyers find an appropriate product price offer, 2) the LB and the seller find the deal price. Also, the negotiation for the LEs happens only with the seller. This simulation system is built by using Java language code. The Java code language is used with Eclipse Indigo R Packages to program Consortium and Negotiation Simulation System for the Plastic Market (CNSSPM). The plastic market information is collected from the real plastic market, plasticker.de (2011) website. Also, the details of the product information are used in the consortium and negotiation simulation systems for the SMEs and the LEs. The consortium and negotiation simulation system agents are divided into two groups, which are buyers' and seller's agents. The CNSSPM provides the product information to the buyers' and sellers' agents randomly.

Chapter 4: Results and Discussions

This chapter has three parts. The first part shows and discusses the results from the intelligent negotiation agent in plastic market. The second part shows the results from the improving the intelligent consortium agent for small and medium enterprises (SMEs) in the plastic market. The third part shows the results from the improving the plastic market by using consortium and negotiation agent for small and medium enterprises (SMEs). Every part has several figures to show the results and discusses them to answer three dissertation questions. The first part answers the question1 which is "Can an automated negotiation agent with Estimated Reserved Price Range (ERPR) improve the efficiency of the market for buyer's negotiation against the seller?" The second part answers the question 2 which is "Can an automated consortium agent based on Modified Knapsack Problem Algorithm (MKPA) improve the trading volume for SMEs in e-marketplace?" The third part answers the question3 which is "Can the combination of an automated consortium and negotiation agents improve the market efficiency for Small and Medium Enterprises (SMEs)?" Every part includes the objective, algorithms, system description, and system simulation results.

Part I: Intelligent Negotiation Agent in Plastic Market

Within the scope of this dissertation, this section discusses the result data that is the output of simulation of intelligent agents via electronic communication in trading. The input data for the simulation is not come from the real market. However, using a statistical data distribution, the simulation system tries to capture the trading agents' behavior in e-commerce trading.

Result Part I: Data Analysis and Reporting

This section analyses the output data from the first simulation system and the outputs are summarized in different charts. Every chart is related to its own data, explanation, and to a dissertation question. The e-commerce data depends on five levels of the market trends, which are level 1, level 2, level 3, level 4, and level 5. Every level represents the market trend of price index changes in the same day. Level1 represents that the market index goes up quickly; level 2 represents that the market index goes up slowly; level3 represents the stable market index; level 4 represents that the market index goes down slowly; level 5 represents that the market index goes down quickly.

Total of trading number. Figure 53 below shows that the total number of trades for all the levels was 35. When a trade starts, one trading level is decided by random. Level 1 occurred 8 times in total during trading simulation, which was 23% out of 35 tradings. Level 2 occurred 7 times and which represents 20% of all the tradings. Level 3 occurred 6 times, which represents 17% of all the tradings. Level 4 occurred 8 times and which represents 23% of all the tradings. Level 5 occurred 6 times and which represents 17% of all the tradings.

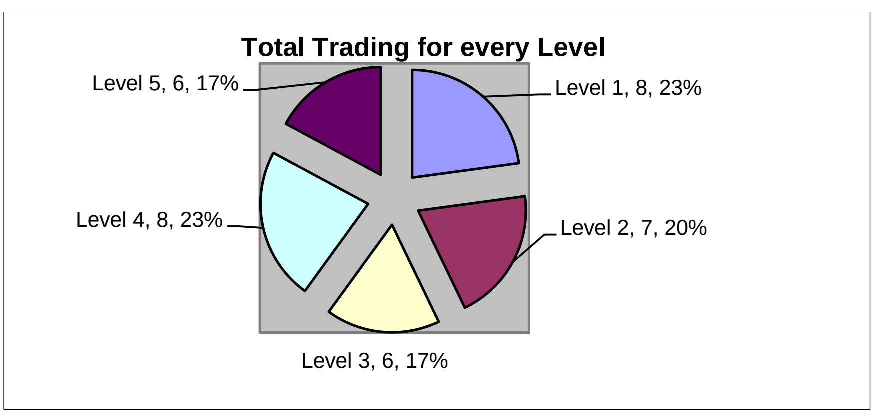

Fig. 53. The Total Number of Trading Simulation.

All Levels: negotiation and non-negotiation contract. Figure 54 below shows the simulation results. The simulation with negotiation had made 25 deals out of 35 tradings, and had made 10 no deals out of 35 tradings. Also, figure 54 shows the results of the Non-Negotiation which made 18 deals out of 35 tradings, and had made 17 no deals out of 35 tradings. As a result, the Negotiation with Estimated Reserved Price Range (ERPR) shows better performance than the Non-negotiation in the market simulations.

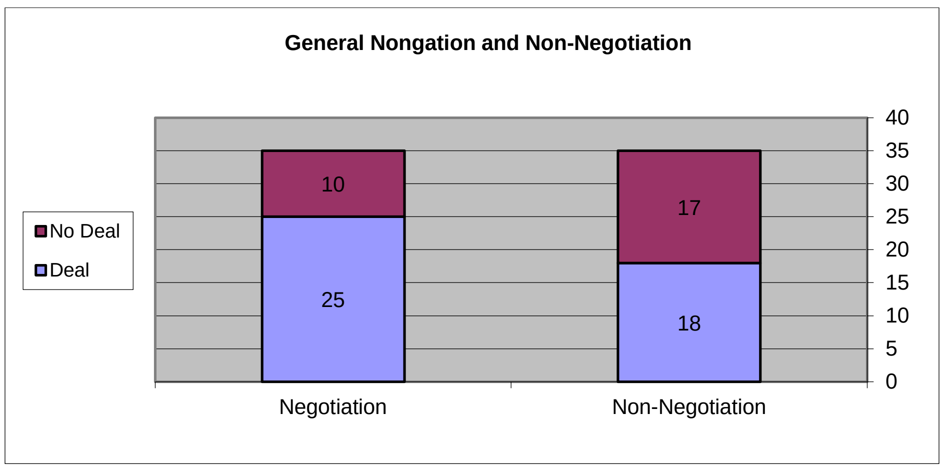

Fig. 54. Negotiation and Non-Negotiation in all Market Levels.

Level 1: negotiation and non-negotiation contract. Figure 53 shows the number of different market trends. The number 1 market trend happened 8 times. Figure 55 below shows the Negotiation with number 1 market trend had made 6 deals out of 8 tradings, and had made 2 no deals out of 8 tradings. Also, it shows the Non-Negotiation had made 2 deals out of 8 tradings, and had made 6 no deals out of 8 tradings. As a result, the Negotiation with ERPR demonstrated better performance in e-commerce simulation than the Non-Negotiation in the market simulation when the market trend goes up fast.

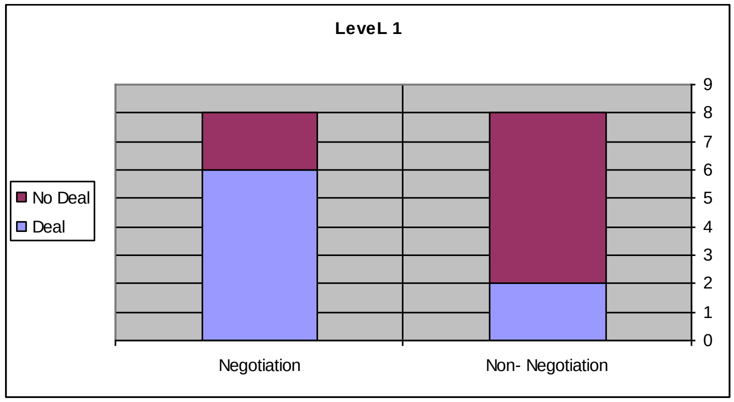

Fig. 55. Negotiation and Non-Negotiation in Level 1.

Level 2: negotiation and non-negotiation contract. Figure 56 below shows the Negotiation with the number 2 market trend had made a "Deal" 5 times out of 7 tradings, and had made "No Deal" 2 times out of 7 tradings. Also, it showed that the Non-Negotiation had made a "Deal" 4 times out of 7 tradings and had made "No Deal" 3 times out of 7 tradings. As a result, the Negotiation with ERPR demonstrated better performance in e-commerce simulation than the Non-Negotiation in the market simulation, when the market was going up slow.

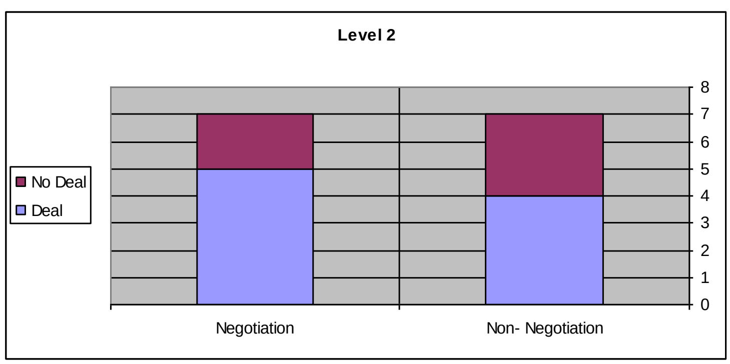

Fig. 56. Negotiation and Non-Negotiation in Level 2.

Level 3: negotiation and non-negotiation contract. Figure 57 below shows the Negotiation with the number 3 market condition had made a "Deal" 6 times out of 6 tradings, and had made “No Deal” 0 times out of 6 tradings. Also, it showed the Non-Negotiation had made a “Deal” 6 times out of 6 tradings, and had made “No Deal” 0 times out of 6 tradings. As a result, the Negotiation with ERPR was the same as the Non-Negotiation in the market, when the market trend was stable because the traders can predict the product price to match the market price.

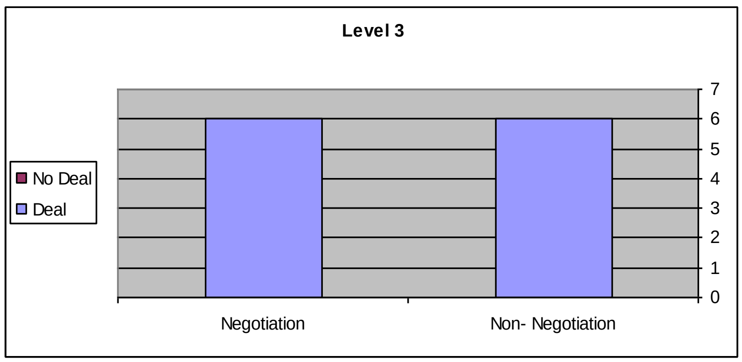

Fig. 57. Negotiation and Non-Negotiation in Level 3.

Level 4: negotiation and non-negotiation contract. Figure 58 below shows the Negotiation with the number 4 market trend had made a “Deal” 4 times out of 8 tradings, and had made “No Deal” 4 times out of 8 tradings. Also, it showed the Non-Negotiation had made a “Deal” 3 times out of 8 tradings, and had made “No Deal” 5 times out of 8 tradings. As a result, the Negotiation with ERPR demonstrated better performance in e-commerce simulation than Non-Negotiation in the market simulation, when the market was going down slowly.

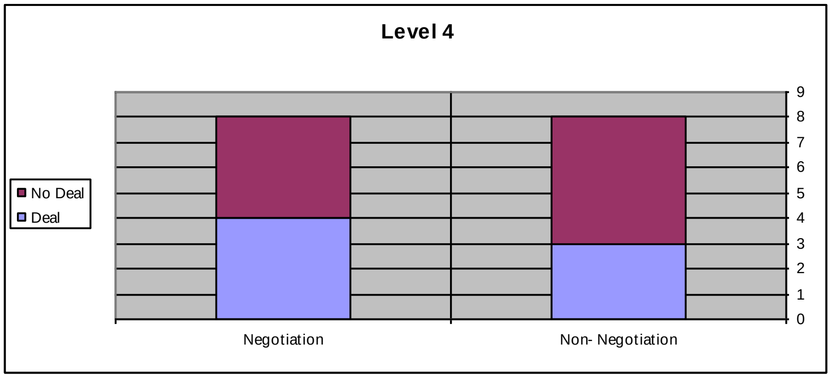

Fig. 58. Negotiation and Non-Negotiation in Level 4.

Level 5: negotiation and non-negotiation contract. Figure 59 below shows the negotiation with the number 5 market trend had made a "Deal" 4 times out of 6 tradings, and had made "No Deal" 2 times out of 6 tradings. Also, it showed the Non-negotiation had made a "Deal" 3 times out of 6 tradings, and had made "No Deal" 3 times out of 6 tradings. As a result, the negotiation with ERPR demonstrated the better performance in e-commerce simulation than Non-negotiation in the market simulation when the market was go down fast.

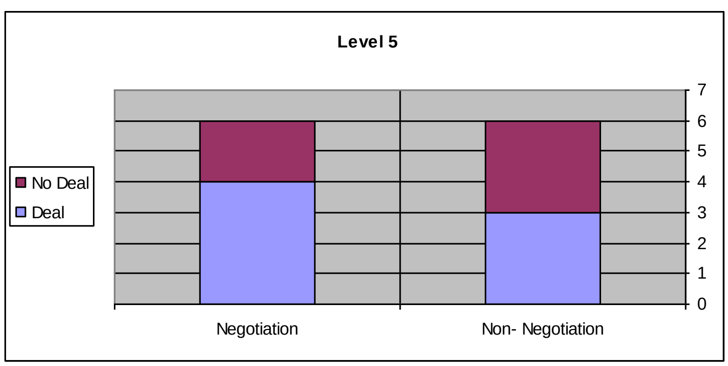

Fig. 59. Negotiation and Non-Negotiation in Level 5.

Compare the deal price between negotiation and non-negotiation. Figure 60 below compares the deal prices between the Negotiation and the Non-

Negotiation situations in the market simulations. Figure 60 shows that 18 times both Negotiation and non-Negotiation systems made deals. Among these deal cases, the Negotiation had made 13 deals with lower price than the Non-negotiation deals, and 5 times, the Negotiation and Non-Negotiation made deals and their deal prices are same. In level 1 market trend, it shows that the Negotiation deal price was 1 time out of 2 tradings lower than the Non-Negotiation's deal price, and deal price was 1 time out of 2 tradings were equal. In level 2 market trend, it shows that the Negotiation deal price was 1 time out of 4 tradings lower than the Non-Negotiation's, and deal price was 3 times out of 4 tradings were equal. In level 3 market trend, it shows that the Negotiation's deal price was 6 times out of 6 tradings better than Non-Negotiation's, and deal price was 0 times out of 6 times were equal. In level 4 market trend, it shows that the Negotiation's deal price was 2 times out of 3 tradings lower than the Non-Negotiation's, and deal price was 1 time out of 3 tradings were equal. In level 5 market trend, it shows that the Negotiation's deal price was 3 times out of 3 tradings lower than the Non-Negotiation's, and deal price was 0 times out of 3 tradings were equal. As a result, the Negotiation with reserved range price can strike a deal lower than the Non-Negotiation's in all the levels of the market trends.

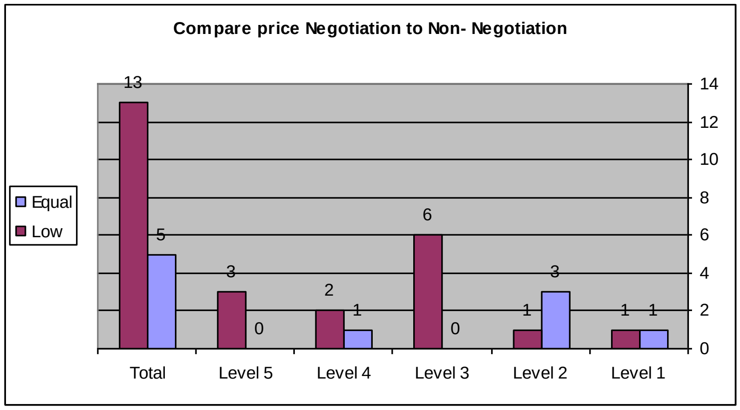

Fig. 60. Negotiation and Non-Negotiation Deal Price.

Figure 61 below compares the deal prices between the Negotiation and Non-Negotiation in the market simulation. It shows, as a result, the Negotiation made deals with lower price than Non-Negotiation in 72% of the time. Also, it shows that the Negotiation and Non-negotiation made deal with same price in 28% of the time.

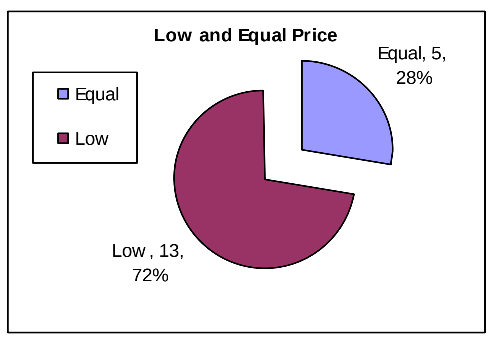

Fig. 61. Negotiation and Non-negotiation Deal Price Percent.

Result Part I: Discussion for intelligent negotiation in plastic market

This section discusses the results that come from the simulation. The section above provides data for the answer to the dissertation question1, which is “Can the estimated reserved price range improve the buyer’s negotiation based on the buyer’s conditions with the seller and support the buyer's trading decision?" In data analysis section, the system provides a comparison between the results of the Negotiation with Estimated Reserved Price Range (ERPR) and the Non-Negotiation. The results demonstrated that the negotiation with ERPR under made more deals with the seller than non-negotiation by 20%. Also, the results based on the market trend index level in Figure 60 demonstrate that the negotiation with ERPR has lower deal price than the Non-Negotiation in three market trend indexes, which are level 3, 4, and 5. The market trend index level 3 which represent the stable market; level 4 is when the market index goes down slowly; level 5 is when the market trend goes down quickly. As the results, that the automated negotiation agent with ERPR improves the buyer negotiation with the seller and supports the buyer's trading decision.

Part II: Improve the Intelligent Consortium Agent for SMEs in the Plastic Market

Within the scope of this dissertation, this section discusses the simulation result data that is the output of simulation of intelligent consortium agents via electronic communication in trading. Even though the simulation data did not come from a real market, a statistical distribution is used for capturing the agents' behavior in e-commerce trading. The purpose of the data analysis is to answer the second dissertation question which is "Can an automated consortium agent based on Modified Knapsack Problem Algorithm (MKPA) improve the trading volume for SMEs in e-marketplace?"

Result Part II: Data Analysis and Reporting

This section analyzes the output data from the simulations and explains the data in every chart. In this section, the figure shows the simulation results from the Modifying

Knapsack Problem Algorithm Consortium (MKPAC) and Exactly Match Consortium (EMC). This section also compares the simulation results from MKPAC and EMC in the plastic market. There were 45 simulations in total that had run for both MKPAC and EMC.

Figure 62 below shows that the MKPAC has 33 “Consortium Happens” and 12 “Consortium Does Not Happen,” and EMC has 15 “Consortium Happens” and 30 “Consortium Does Not Happen.” The MKPAC got 73.33% and EMC got 33.33% of consortium cases out of 33 simulated tradings. The consortium with MKPAC has more consortiums among the buyers by 40% more than EMC in the plastic market.

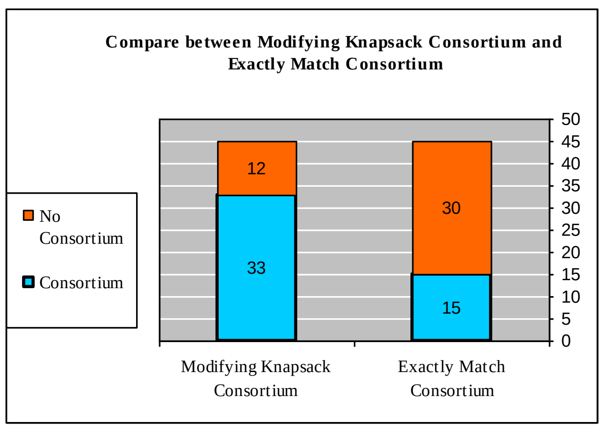

Fig. 62. Compare between MKPAC and EMC

Figure 63 shows that the MKPAC’s result is better than EMC’s when the simulation is based on the Seller Units (SU). It shows that the MKPAC made consortiums 13 times with the 3000 seller units, and EMC has made consortiums only 6 times, which the difference is more than double. Also, it shows the MKPAC has made consortiums 10 times with the 2000 seller units, and EMC has made only 4 times, which shows that the difference is more than double.

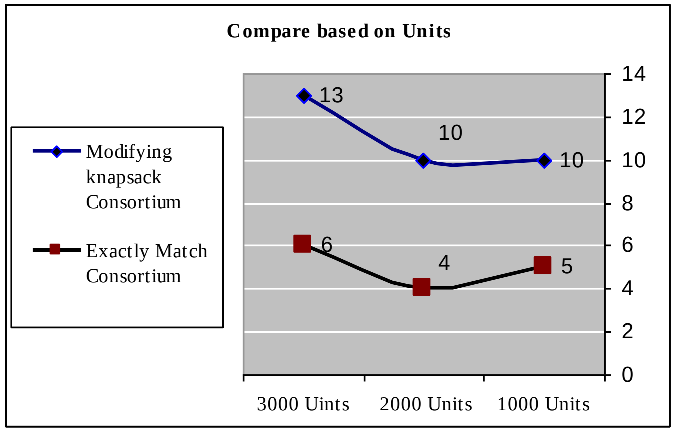

Fig. 63. Compare between MKPAC and EMC Based on the Units.

Figure 64 below shows the MKPAC has made consortiums 10 times out of 13 tradings with 1000 seller Units, which is 76.92% out of 13 tradings. Also, it has made consortiums 10 times out of 15 tradings with the 2000 seller units, which is 66.66% out of 15 tradings. In addition, also it shows that MKPAC has made consortiums 13 times out of 17 times with 3000 seller units, which is 76.47% out of 17 tradings.

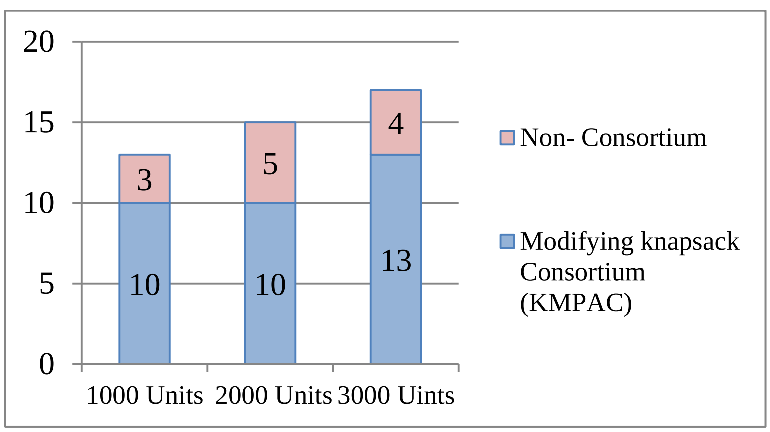

Fig. 64. Compare between MKPAC and EMC Based on the Units.

Figure 65 below shows the EMC has made consortiums 5 times out of 13 tradings with 1000 seller units, which is 38.46% out of 15 tradings. Also, the EMC has made consortiums 4 times out of 15 tradings with 2000 seller units, which is 26.66% out of 15 tradings. In addition, it shows that EMC has made consortiums 6 times out of 17 tradings with 3000 seller units, which is 35.29% out of 17 tradings.

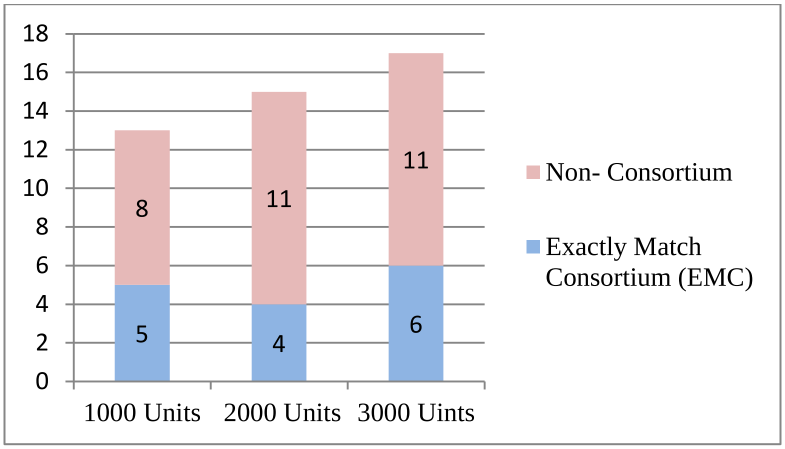

Fig. 65. Compare EMC itself based on the Units.

Figure 66 below shows comparison of the simulation results between MKPAC and EMC with the 1000 seller units. It shows that the MKPAC has 67% of consortium forming rate, which is 10 times, and EMC has only 33%, which is 5 times. The chart also shows that the SMEs with MKPAC demonstrated the better performance than EMC.

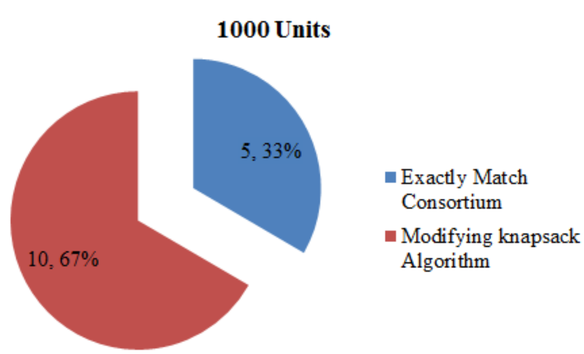

Fig. 66. Compare between MKPAC and EMC Based on the 1000 Units.

Figure 67 below shows comparison of the simulation results between MKPAC and EMC with the 2000 seller units. It shows that the MKPAC has 71% of consortium forming rate, which is 10 times, and EMC has 29%, which is 4 times. It also shows that the SMEs with MKPAC demonstrate the better performance than EMC.

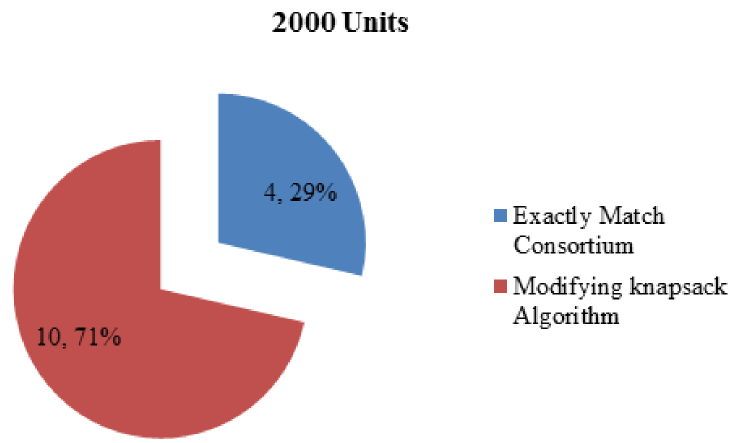

Fig. 67. Compare between MKPAC and EMC Based on the 2000 Units.

Figure 68 below shows comparison of the simulation results between MKPAC and EMC with the 3000 seller units. It shows the MKPAC has 68% of the consortium-forming rate, which is 13 times, and EMC has 32%, which is 6 times. It also shows the SMEs with MKPAC demonstrated the better performance than EMC.

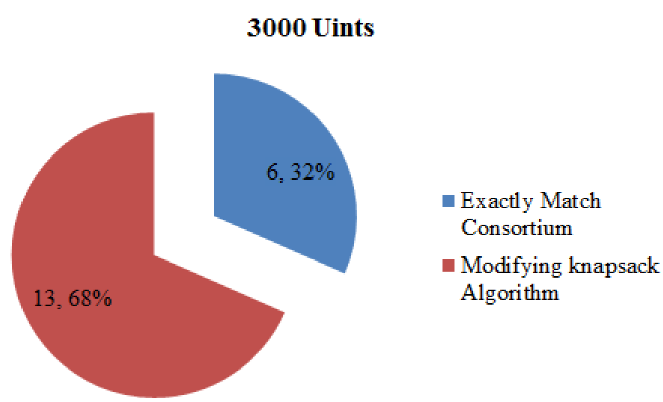

Fig. 68. Compare between MKPAC and EMC Based on the 3000 Units.

Result Part II: Discussion for improve the intelligent consortium agent for SMEs in a plastic Market.

This section discusses the results that come from the part II in chapter 3. The data of this section tries to answers the dissertation question2, which is “Can the estimated reserved price range improve the buyer’s negotiation based on the buyer’s conditions with the seller and support the buyer’s trading decision?” In data analysis section, the system provides a comparison between the results from Modified Knapsack Algorithm Consortium (MKPAC) and Exactly Match Consortium (EMC). The results shows that the MKPAC can form more consortiums than the EMC. As a result, the MKPAC with the EMC can improve the efficiency of the current on-line based plastic market for SMEs.

Part III: Improve the Plastic Market Efficiency by Using Consortium and Negotiation Agents for Small and Medium Enterprises

Within the scope of this dissertation, this section discusses the data that is the output of simulation of intelligent negotiation and consortium agents via electronic communication in trading. Even though the simulation data did not come from a real market, a statistical distribution is used for capturing the agents’ behavior in e-commerce trading. The purpose of this data analysis is to answer the third dissertation question which is “Can the combination of an automated consortium and negotiation agents improve the market efficiency for Small and Medium Enterprises (SMEs)?”

Result Part III: Data Analysis and Reporting

This section analyzes the output data from the simulations. Every chart reflects the summary of the simulation results that are related to the dissertation question. The results of CNSSPM with SMEs and LEs shows that the SMEs with CNSSPM can increase their opportunity to trade with large volume sellers. There were 45 simulations, which had run for consortiums and the negotiation agents.

Figure 69 below shows the trading results, which demonstrate the performance differences between LEs and SMEs. The chart shows that the SMEs can negotiate more deals than LEs. The SMEs made 21 deals with or without competition with LEs, and LEs have made 17 deals with or without competition with SMEs. The results show that the LEs with negotiation made 17 deals out of 45 tradings and LEs without negotiation made only 7 deals out of 45 tradings.

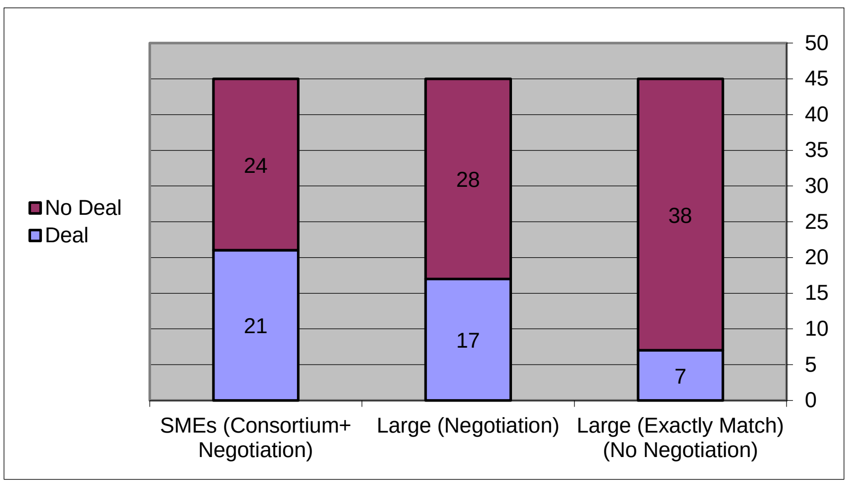

Fig. 69. Compare between SMEs and LEs.

Also, Figure 70 below shows the results when SMEs make deals with or without any challenge with LEs. Also, it shows how many times the system failed to make deals with SMEs or LEs. In addition, it explains how many times deals are made and its deal percentages are demonstrated. In this case, the total number of simulation is 45 times. For example, it shows that in the case of the LEs with challenging, SMEs made deals 16% out of 45 tradings, which is 7 deals, and in the case of SMEs with challenging LEs made deals 11 % out of 45 tradings, which is 5 deals. In addition, it shows that in the case of LEs without any challenge, SMEs made deal 22 % out of 45 tradings, and in the case of SMEs without challenging, LEs made deals 35% out of 45 tradings. In addition, there were 16% of no deals for SMEs and LEs as well.

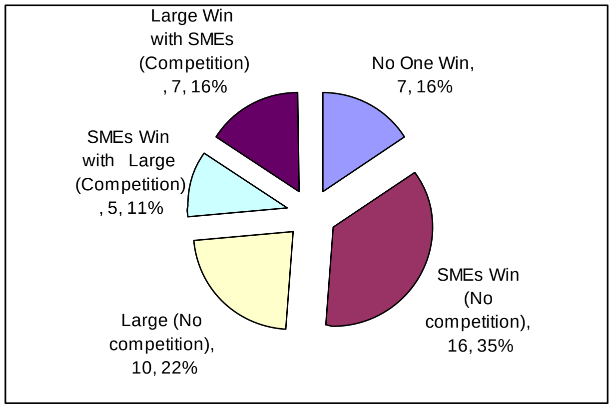

Fig. 70. Compare SMEs and LEs wit and without Competition.

Figure 71 below explains the performance differences between SMEs and LEs when they are compete with each other. The result shows that the LEs had won 58%, which is 7 times and SMEs had won 42%, which is 5 times out of 45 tradings. The result data show that the SMEs win less than LEs in negotiation with the seller when there was a competition.

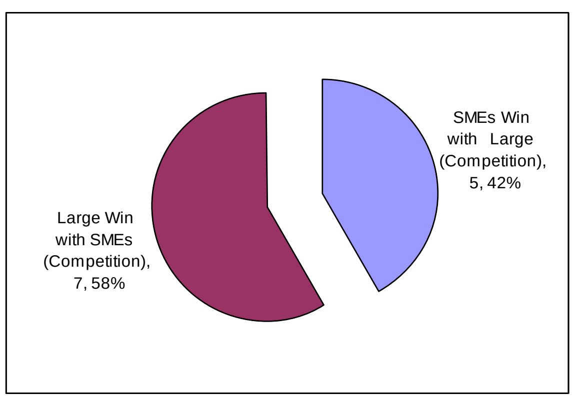

Fig. 71. Compare between SMEs and LEs with Competition.

Figure 72 below explains the performance differences between SMEs and LEs when there is no competition with each other. It shows the SMEs wins 62%, which is 16 times, and LEs wins 38%, which is 10 times. The result data show that the SMEs win more than LEs in negotiation with the seller when there is no competition.

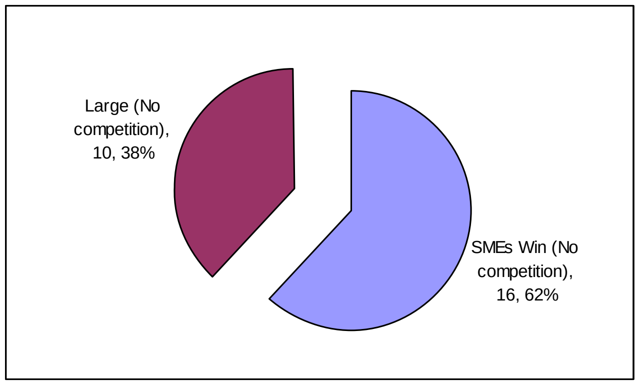

Fig. 72. Compare between SMEs and LEs without Competition.

Result Part III: Discussion for Improve the Plastic Market Efficiency by Using Consortium and Negotiation Agents for SMEs.

This section discusses the results that come from simulations. These results can answer to the dissertation question3, which is, “Can the estimated reserved price range improve the buyer’s negotiation based on the buyer’s conditions with the seller and support the buyer’s trading decision?” The system provides a comparison among the results from Consortium and Negotiation for SMEs (CNSMEs), Negotiation for LEs (NLEs), and Non-Negotiation for LEs (NNLEs). As demonstrated in the simulation result data, the CNSMEs shows better performance than NLEs as well as NNLEs. Also, the SMEs made more deals than others did because the SMEs have advantage of fitting together with or without Permissible Range Units (PRU) to make deals with the seller’s units.

The negotiation with the seller increases the chance of deals among the NLEs than NNLEs. The result shows that the CNSMEs made more deals than NNLEs. As a result, the consortium and negotiation for SMEs can improve the efficiency of the current on-line based plastic market.

Chapter 5. Conclusions

A market is a place where buyers and sellers meet to exchange commodities (Kirkpatrick & Dahlquist, 2010; Håkansson, 1982). In the market, there are four kinds or types of market: direct search markets, brokered markets, dealer markets, and auction markets (Kirkpatrick & Dahlquist, 2010; PF&Investing 2007; Bodie, Kane & Marcus, 2007). In the most traditional auction market, all participants meet together in one place to buy or sell a commodity where the sellers and buyers do not need to search for each other (Kirkpatrick & Dahlquist, 2010; PF&Investing 2007; Bodie et al., 2007).

At the end of the last century, Internet technology has developed, and companies have started using the Internet to sell more goods and services to other potential buyers (Farzamnia & Nalchigar, 2009; Cipparrone, 2006). Internet based trading has become important for companies in many different ways such as reducing operation costs, increasing productivity, and improving communications with customer partners (Zhu, Kraemer & Xu, 2006; Kleindl, 2000). Many companies have started to implement e-commerce platforms (Dahai & Jiajia, 2010).

An electronic trading can be described as a form of trading that uses computer software and electronic media for trading through the computer network (Quirk, 2006). In general, selling has increased through the computer network (Feigenbaum, Parkes & Pennock, 2009). The electronic marketplace has implemented Business-to-Business (B2B). However, the electronic marketplace or e-commerce opens new horizons for Small and Medium Enterprises sized (SMEs) to play more important roles in the modern economy (Zhu & Liang, 2009). The B2B e-marketplace applications involve market principles with various functions and process methods. The e-marketplace, in order to be an intelligent and automated e-commerce, needs new infrastructures (Fortin et al., 2005). One of the infrastructures that can help this e-trading is agent technology (Fortino et al., 2005). One of the software agents is a negotiation agent, which can aid traders in the e-trading process; specifically, it helps to find traders more efficiently, which allows traders to negotiate by exchanging messages. (Ahmadi & Charkari, 2011). Also, another of the software agents is a consortium agent, which can collaborate between the SMEs and broker agent where the idea is to improve the coordination between the SMEs agents in the e-trading process (Zhu & Liang, 2009).

This dissertation implemented both consortium and negotiation in three parts to answer the dissertation questions. Question1: Can an automated negotiation agent with estimated reserved price range improve the buyer's negotiation with the seller and support the buyer's decision? Question 2: Can an automated consortium agent based on Modified Knapsack Problem Algorithm (MKPA) improve the collaboration among SMEs in e-marketplace to buy? Question: Can the combination of an automated consortium and negotiation agents improve the market efficiency for Small and Medium Enterprises (SMEs)?

The first part was to answer question1. A Simulation System was built for a Plastic Market (SSPM), which was implemented and extended in the existing negotiation framework from the paper (Kim & Segev, 2003) to the specific plastic market. It also shows that the efficiency of the automated agent based negotiation system against the non-negotiation system in an on-line based plastic market place. The system use the Estimated Reserved Price Range (ERPR) in the negotiation process and buyer's conditions in searching function. In addition, through simulations, it explained how the

ERPR, buyer conditions, and market environment affected the negotiation process. The results as explained earlier in chapter 4 part 1, the results show that the automated negotiation agent improves the efficiency of the current on-line based plastic market.

The second part was to answer question 2. A Consortium Simulation System was built for Plastic Market (CSSPM), which implemented Modified Knapsack Algorithm Consortium (MKPAC) for Small, and Medium Enterprises (SMEs) in the specific plastic market. Also, it also showed that the performance of MKPAC against the Exactly Match Consortium (EMC) system in an on-line based plastic market. It showed how to implement the Modified knapsack Algorithm (MKPA) in the consortium process for buyers. The results as explained earlier in chapter 4 part 2. The results show that the MKPAC improves the efficiency of the current on-line based plastic market for SMEs.

The third part was to answer question 3. The consortium and negotiation agents were implemented in the plastic market. It built Consortium and Negotiation Simulation System for Plastic Market (CNSSPM). A consortium is formed among the buyers, and the negotiation happens in two ways: 1) the buyers negotiated together to build a consortium, find a Lead Buyer (LB), and find the appropriate price; and 2) the LB and/or LEs negotiated with the seller to get the best price. Also, Estimated Reserved Price Range (ERPR) was implemented for every buyer and seller. The CNSSPM ran both negotiation agents for SMEs and LEs with the seller and consortium agent among the buyers. Also, the CNSSPM compared the results of trading between Small and Medium Enterprises (SMEs) and Large Enterprises (LEs). The results as explained earlier in chapter 4 part 3. The results show that how SMEs with consortium can improve the opportunity in trading in the plastic market.

In conclusion, this dissertation answered three questions. The methodology, results, and discussion were divided into three parts. Every part answers one dissertation question. The methodology is to explain the simulation system in detail to explain how the system was built and runs.

Future work

This dissertation is to simulate the agent between the buyers and the seller. The agents communicate as one-to-many (1: M) communication mod. In the first part, the negotiation is applied to the situation of one buyer agent against many seller agents (1: M). In the second part, the consortium is formed from one buyer agent to many buyer agents (1: M), and from many buyers agents to many buyers agents in the buyer side (N: M). In the third part, one buyer agent represents the many buyers agents in buyer side to build consortium. In a negotiation, many buyers agents work with one seller agent (M: 1). The future work is to develop the simulation negotiation agent to allow both buyer and seller agent to communicate as many buyers' agents against many sellers' agents (N: M). Also, this simulation will be run more than five to ten days. In addition, the future simulation, both the buyer and seller get some information from the database instead of the user directly. Moreover, another future work will be the developing a web purchasing website that includes smart consortium agents in the buyer and seller side.

The simulator studies provide many opportunities and have advanced in the market field to study a real life model. Researchers can study the potential business partner search and communication among trader agents by using the simulations. However, the transfer the knowledge from the simulator to the real-life market is a challenge.

In this dissertation, the simulation is used to demonstrate the communications among trader agents for selling and buying. All the trade decision variables are generated randomly. Even though the random values are ranged by real market values, some values are estimated. In future work, more real-life market conditions will be applied to the simulator. Then the proposed simulator's performance will be improved.

In addition, this dissertation does not include statistical analysis of the simulation results because it was a proof of concept. The future work will have a statistic analysis of the simulation result like t test, ANOVA, ANCOVA or MANOVA. Those types are used for assessing the effect of several predictors on one or more continuous dependent variables.

Finally, a commonly discussed concern about simulation research is that the use of the communication recording which records all the messages between the buyers' agents the sellers' agents in a database. This message log will help improving the performance of the negotiation and the consortium activity because agents can use not only the current market information but also historic data too.

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Published Papers:

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- Alhazmi, R. M., & Hong, S. (2013, July). Improve the Intelligent Consortium Agent for SMEs in the Plastic Market. In *Software Engineering, Artificial Intelligence, Networking and Parallel/Distributed Computing (SNPD), 2013 14th ACIS International Conference on* (pp. 23-28). IEEE. Doi: 10.1109/SNPD.2013.63
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  - Windows 2000 – 2154

- **2001 ORACLE DEVELOPER 2000 TRACK:**
    - Oracle SQL / PLSQL
    - Oracle program Unit
    - Oracle Form I
    - Oracle Form II
    - Oracle Report
- **2001 CIW Web Course:**
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    - CIW – Site Designer
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