DOCTOR OF PHILOSOPHY

A Core Broking Model for E-Markets

Sun, Pen-Choug

Award date:
2011

Awarding institution:
Coventry University

Link to publication

A Core Broking Model for E-Markets

Pen-Choug Sun

A thesis submitted in partial fulfilment
of the requirements for the degree of

Doctor of Philosophy
of
Coventry University

Faculty of Engineering and Computing

December 2011

Dedication

To my wife Ching-Chi, my son Shang-Yang, and my daughter Yu-Mien

Acknowledgements

It is my pleasure to express thanks to those who made this thesis possible. There are so many people who have unselfishly offered their time, love and support to assist me throughout my study, providing emotional, spiritual, and financial support.

First of all, I would like to thank Almighty God for all He has given me. I am deeply grateful to the Aletheia University for granting me the subsistence allowance for two years. I appreciate deeply all that the members of Lower Ford Street Baptist Church (LFSBC) have done and for their generous gifts to my family. My warm gratitude is also due to the Zheng Fengxi Foundation. Without their scholarship, I would have been unable to continue with my research.

My deepest thanks are due to Prof. Kuo-Ming Chao, whose wide knowledge and logical approach to the issues involved have been of great value to me, while his personal guidance has provided a well-founded basis for this thesis. I would like to express sincere gratitude to my director of studies, Dr Michael Odetayo, and my supervisors, Prof. Anne James and Dr. Nick Godwin. Their expertise, guidance and insights have helped and encouraged me to see the research to fruition. I warmly thank my newest supervisor Dr. Rahat Iqbal, whose advice has been invaluable to my thesis especially in the last stage of my research. I owe him my eternal gratitude for his support and understanding. I would also like to thank all the members of the Distributed Systems and Modelling (DSM) Research Group in the Faculty of Engineering and Computing at Coventry University.

My exceptional thanks are due to my 'church family' at LFSBC. Paul Watts, the pastor, passes on God's words of comfort to me in times of difficulty. Peter Cordle, the elder, has showed his warm-heartedness in seeking funding to support my family and my studies. Martin Adams and Dr. Christopher Peters have patiently spent innumerable hours doing the proofreading of this thesis. Geoff Lewis has not only presented some important guidelines for writing a PhD thesis but also gave much valuable advice for the dissertation. Without the love and prayers of my church family throughout the time of my research work, I would have given up hope and quitted in the early stages of my research.

Finally, I owe my most sincere gratitude to my wife Ching-Chi, my son Shang-Yang and my daughter Yu-Mien. As I look back, I realise that they have contributed, more than I could have expected of them. Without their love, support, encouragement and understanding, it would have been impossible for me to finish this work. I am indebted to my parents who bore me, raised me, taught me, supported me and loved me. Without them none of this would have been even possible. My loving thanks are due to my mother in law. Without her permission for me to marry her daughter, my perfect family would not have become a reality. I am deeply grateful to my sister in law Jui-Chih Liu. She sponsored me financially and enabled me to concentrate on my study. I am especially obliged to my three sisters and their families for their loving support.

Abstract

Coalition problems in e-markets attract attention from the research communities and industry. This research focuses on e-trading models relating to online coalitions. A new Core Broking Model (CBM), for online group-trading is presented. This aims not only to bring lower prices for buyers but also to create higher profits for providers.

The survey of current online shopping sites in this thesis shows that it is almost impossible to find a site designed specifically for group-trading, although there are plenty of joint-selling activities and also many online group-buying sites. The former increases competitive advantages and benefits providers. However it allows cartels to take control of price and to disadvantage customers. Recently, the latter have become very popular. The major problem of these models is that they lack the ability to deal with the stability issue in coalitions, which therefore fall apart easily. *The core*, a concept from economics, provides solutions to ensure a stable coalition (Gillies 1953), but its certain problems have hindered researchers from applying it to a real-world market.

Building an online group-trading model is essential. Developing such a new model for e-markets can be a real challenge. Three factors, namely (a) incentive compatibility, (b) distributed computing, and (c) less computational complexity, all have to be considered at the same time. The new model is based on the core and adopts some other solution concepts to resolve group-trading problems in e-markets. It involves bundle selling of multiple goods from several providers, offering volume discounts to many different buyers in group-buying on e-marketplaces.

The CBM successfully creates a win-win-win situation for customers, providers and brokers in e-markets. The comparison between the results of the new model and the core shows the CBM is superior to the core in terms of the three factors mentioned above. The results of the simulation presented in this thesis demonstrate that the CBM can attract customers and deal with online group-trading problems in a large coalition. An extensive evaluation of the techniques in the CBM has been made and shows that all of them produced the desired results in the CBM effectively and efficiently.

Contents

Appendixes

List of Publications

Journal Papers:

Chao, K., Younas, M., Godwin, N. and Sun, P. (2006) 'Using automated negotiation for grid services.' *International Journal of Wireless Information Networks* 13, (2): 141-150

Sun, P., *et al.* (1998) 'Distanced Data-sharing – A platform architecture of CAI material database.' *Distanced education quarterly* 8, 6-11

Conference Papers:

Sun, P., *et al.* (2012 b) 'Evaluations of A Core Broking Model from the Viewpoint of Online Group Trading.' In *Proceedings of The IEEE International Conference on Industrial Engineering and Engineering Management (IEEM 2012)* Held 10-13 December at Hong Kong Convention and Exhibition Centre, Hong Kong, IEEE Press: 1964-1968

Sun, P., *et al.* (2012 a) 'A Core Broking Model for E-Markets.' In *Proceedings of The 9th IEEE International Conference on e-Business Engineering* (*ICEBE 2012)* Held 9-11 September at Zhejiang University, Hangzhou, China: IEEE Press: 78-85 (19.7% acceptance rate)

Sun, P., *et al.* (2009) 'Extended Core for E-Markets.' In Isaias, P., White, B. and Nunes, M. B. (ed.) *Proceedings of IADIS International Conference WWW/Internet 2009* Held 19-22 November at Rome, Italy : IADIS Press: 437-444 (22% acceptance rate)

Sun, P., *et al.* (2006) 'Core-based Agent for Service-Oriented Market.' In Lee, T. and Zhou, M. (ed.) *Proceedings of 2006 IEEE International Conference on Systems, Man, and Cybernetics (SMC'06).* Held 8-11 October at The Grand Hotel, Taipei, Taiwan. Piscataway, New Jersey: the IEEE Inc.: 2970-2975

Sun, P., *et al.* (2003) 'Knowledge Discovery in Online Utility Rating.' In *Proceedings of 9th Conference of Information Management and Applications*, Held 13 December at Dayeh University, Taiwan: 1231-1236

Sun, P., *et al.* (2003) 'Data Mining in Online Utility Rating.' In *Proceedings of Academy 5th Conference of Information, Law and Society*, Held 28 November at Central Police University, Taiwan: 225-232

Sun, P., *et al.* (2003) 'Automated Knowledge Discovery.' In *Proceedings of 2003 Conference of Original Management and New Vision*, Held 15-16 May at Aletheia University, Taiwan: 77-77

Sun, P., *et al.* (2003) 'The Quality of Sharing Knowledge in Virtual Community.' In *Proceedings of the 2003 Conference of Original Management and New Vision*, Held 15-16 May at Aletheia University, Taiwan: 87-92

Sun, P., *et al.* (2002) 'The Construction of Virtual Intellectual Community.' In *Proceedings of the 2002 New Century, New Knowledge, New Thought, 2nd Conference of Academic and practical management on Multiple Domains*, Held 23 November at Tunghai University Taiwan: 48-50

Sun, P., *et al.* (2002) 'The Construction of Intellectual Conversation.' In *Proceedings of 8th National Conference on Quality Control 1*, Held November at Feng Chia University, Taiwan: 69-76

Sun, P., *et al.* (2000) 'A Bargaining Model of E-Commerce.' In *Proceedings of 1st Conference of Original Management and New Vision 1,* Held 1-2 June at Aletheia University, Taiwan: 74-81

Sun, P., *et al.* (2000) 'The Virtual Community with High Interaction.' In *Proceedings of 1st Conference of Original Management and New Vision 2,* Held 1-2 June at Aletheia University, Taiwan: 261-268

Sun, P., Lee, C. and Hsu, C. (2000) 'A Study of Interactive Virtual Community.' In *Proceedings of 2000 Conference of Internet and Distributed Systems 1*, Held 11-12 May at National Cheng Kung University, Taiwan: 443-450

Huang, C. and Sun, P. (1999) 'The Architecture of an Intelligent Database Platform for Distanced Information Sharing.' In *Proceedings of ICCAI 1999, International Conference on Computers Aided Instruction 8*, Held 18-20 March at Feng Chia University, Taiwan: 73-80

Sun, P., *et al.* (1999) 'A Personalised Marketing Solution: Relationship Marketing.' In *Proceedings of 10th International Academic Conference of Information Management 2,* Held 5 June at Central Police University, Taiwan: 1094-1101

Sun, P., *et al*. (1998) 'A Fuzzy Virtual Store Model – Illustrating with a CD store on Internet.' In *Proceedings of 6th International Conference of Theory and Application of Information Management,* Held 4-5 December at Chaoyang University of Technology, Taiwan: 78-78

List of Figures

List of Tables

Chapter 1

Introduction

The purpose of this research is to propose and test a new model for online group-trading, which includes joint-selling and group-buying. When buyers and sellers get together to work out deals, they are forming a coalition. This is usually an effective way to achieve traders' goals. Research shows that goals are more easily obtained in larger coalitions, and that it is simple to form these globally on the Internet (Kauffman and Wang 2001).

Developing such a model can be a real challenge, since many practical problems have to be solved. When forming coalitions in e-markets, further issues have to be tackled, in comparison with traditional commerce. In section 1.1, those factors that must be considered in the model are explained. The background of current e-markets and the motivation of this research are given in section 1.2. The aim and objectives of research are in section 1.3. Developing a workable model for this research was a complicated process which touched a lot of different disciplines. As a result, appropriate methodological approaches are needed in order to produce quality outputs. In section 1.4, a methodology used to develop the new model is given. At the end of the chapter, the structure of the thesis is listed.

1.1 Challenges for Designing Coalition Models in E-Markets

Concepts and algorithms for coalition formation have been investigated. These research domains have been extensively studied in both economics and computer science (Moulin 1995, Sandholm 1999), but the two have approached the topic very differently. The economics literature traditionally stresses the incentives of each selfish participant in coalitions (Green and Laffont 1979). Since the participants are self-interested they will join a coalition only when they are better off in it (Shehory and Kraus 1999). The motivation of all participants in joining a coalition, whatever their roles, has to be taken into account. Therefore, just as in non-cooperative games, all the details of moves available for participants have to be considered. Thus in addition to the issue of the coalition structure, researchers need to consider the incentives for each selfish player.

In real-world e-markets it is not force but incentive that makes people join a coalition. Self-interested participants will join coalitions only if they gain more than they could previously. In other words, consumers and providers are free to join and leave a coalition at any point of time. It is certainly essential for designers to give as many incentives as possible to participants in their coalition models, but trying to determine whether any incentive will be effective in inducing a customer to stay in a coalition is not always easy. One way for researchers in economics to find solutions to these problems has been to examine the stability of a coalition during its life cycle. A coalition with stability indicates that its members are choosing not to break it up, because they are better off remaining in the coalition.

Certain solution concepts for coalition problems related to stability notions have drawn much attention from researchers. The earliest proposed concept was called the stable set (Neumann and Morgenstern 1944), which is a set with stabilities. Its definition is very general and the concept can be used in a wide variety of game formats. For many years it was the standard solution concept for cooperative games (Owen 1995). However, subsequent works by others showed that a stable set may or may not exist (Lucas 1969), and is usually quite difficult to find (Lucas 1992). The core has become a well-known solution concept because of its incentive compatibility and because the way it finds stable sets is more appropriate. It assigns to each cooperative game the set of profits that no coalition can improve upon (Gillies 1953). The core is a solution concept for forming stable and efficient coalitions. Consequently, it is useful to adopt it into the mechanism in the proposed core-base model in this thesis.

On the other hand, the computer science literature downplays incentives and tries to prescribe the formation of algorithms of less computational complexity (Sandholm and

Lesser 1997, Rahwan and Jennings 2007). In computer science, game theory can be regarded as the study of rational behaviour for interactive decision problems (Fudenberg and Tirole 1991). In a game, several players try to maximise their benefits by selecting particular actions, and each player's final profit depends on the profiles of actions chosen by all the players in the game.

There are two branches of game theory, non-cooperative and cooperative, which differ in how they formalise interdependence among the players. In non-cooperative theory, a game is a detailed model of all the moves available to the players. By contrast, a cooperative game is a game having “the possibilities for coalition forming” (Aumann 1987). Here, coalitions of players behave in a cooperative fashion. Hence the game is a competition between subgroups of players, rather than between individual players (McCain 2003). In other words, researchers in cooperative theory are concerned only with the formation of coalitions, but the procedures by which the players join the coalitions are not wholly relevant.

This research is concerned with cooperative games, in which, coalitions are formed in precise structure for the purpose of maximising the overall expected utility (Ferguson, Nikolaou, and Yemini 1989 1989). However, finding the optimal coalition structure to maximise the profit is an NP-complete problem (Sung and Dimitrov 2007), and difficult to deal with. Lessening the computational complexity for coalitions can effectively produce a reduction in working times. Therefore, to do so is crucial for group-trading models in e-markets; the computer science literature reveals a number of attempts to a suitable formation of algorithms for this.

Since the model involves e-commerce in e-markets, it has to interact with multiple computers on the Internet. For instance, when customers access the details of goods or services in e-markets from their computers using a Web browser, they send requests to a Web server, a computer on the e-market. Then the requests are sent to a database at another computer on the e-market to retrieve information about the goods. The results are returned to the Web server, then to the Web browser, and then displayed to the customers. In an e-market, information from various computers is sent via the Internet and then combined to provide a solution which can be used for trading. Obviously, problems on the Internet can be classified into the field of distributed computing. How the model deals with computational problems using the nature of a distributed system will be discussed in chapter 3.

And so, the e-market is an arena in which incentive compatibility, distributed computing, and less computational complexity are all highly relevant. These three factors have been considered in the model developed to deal with group-trading problems on the Internet.

1.2 Background and Motivations

According to Forrester Research, the growth of e-commerce was at one time more than 20% per year all over the world (Forrester Research 2010). Electronic commerce or e-commerce is "where business transactions take place via telecommunications networks" (Turban *et al*. 1999). Amongst all the different kinds of sale channels for e-commerce, Internet e-commerce has moved to centre stage in the thinking of many businesses. Essentially, Internet e-commerce is concerned with transactions among firms or organisations. Generally, in the Internet economy, e-commerce performs a wide range of online business activities to transfer ownership, or rights to use goods, between different companies through networks. An e-market is the main component of Internet e-commerce (Andam 2003). The information shared among traders and the incentive for each individual in e-markets is the main focus of this research.

Buying or selling goods on the Internet in e-trailers such as eBay has become an essential aspect of the daily lives of many people. "Much of the retail sector's overall growth in both the US and the EU over the next five years will come from the Internet," said the Forrester Research Vice President in March 2010 (Forrester Research 2010). Because there will be large potential profits for traders in the next five years on the Internet from 2011 to 2015, this thesis assumes that trading takes place in the e-markets of Internet e-commerce.

An e-market, also called electronic marketplace, gives product information and trading mechanisms to traders and provides them opportunities to execute transactions. Some e-markets allow participants to bid for products and services on the Internet through auction software. There are two reasons why the auction processes in the websites are purposely not discussed in this thesis. Firstly, online trading is the main interest of this research. Not all online trading involves auction processes. Secondly, there are many kinds of auction, for example English or Dutch auctions. Examining the complex nature of auctions would distract from the main concern of this research.

In the last few years, many varied models for e-markets have been developed, suitable for the different activities of traders. The online group-buying is "seen as an effective form of electronic commerce" (Matsuo *et al.* 2010). In chapter 2, a background of online group-buying is presented. Even though Tsvetovat (2000) has declared it may be a win-win strategy for both consumers and providers, online group-buying models mainly consider the benefits of consumers alone. On the other hand, joint-selling models take the viewpoint of providers. Again in chapter 2, issues about joint-selling will be discussed.

A common way to explore online group-trading problems is to break down such a complex issue into online group-buying or joint-selling. In computer science, research has mainly focused on one party only – namely group buyers or joint sellers. However, researchers in economics regard all the traders in a market as a coalition, whether buyers or sellers, and therefore can concentrate on the stability of the coalition. This research is based on the approach of the core which contributes new knowledge to the field of computer science. It aims not only to obtain lower prices for buyers but to create higher profits for providers in e-markets. In other words, the online group-trading problem that this research has to tackle is not only online group-buying but also joint-selling.

1.3 Research Aim and Objectives

The aim of this research is to introduce a new model, called Core Broking Model (CBM), for group-trading in e-markets. The CBM involves joint-selling of multiple products in e-marketplaces, offering a volume discount in group-buying. Several providers are involved in transactions of joint-selling, and, on the other side, many different buyers form coalitions in order to obtain a volume discount. Drawing on a concept from economics known as a ‘core’ to provide a foundation to tackle group-trading problems in e-markets, this model could add new dimensions to other related researches in computer science and E-business. The core is the stable set of profits that no coalition can improve upon (Gillies 1953). This research focuses on the following five objectives:

1. Explore the existing approaches in e-markets including online shopping, group-trading, group-buying and joint-selling.
2. Identify the advantages and problems in applying the core to e-markets.
3. Find solutions to the core and resolve the group-trading problems in e-markets by studying relevant topics about coalitions, such as stability, Pareto efficiency, Shapley value and distributed systems in the fields of cooperative games and economics.
4. Build a new group-trading model for e-markets not only to bring lower prices for buyers but to create higher profits for providers.
5. Evaluate the CBM in incentive compatibility, distributed computing and computational complexity by comparing it with a traditional core.

1.4 Methodology

In order to achieve the aim and the objectives, a methodology was adopted in this research. This new hybrid methodology takes advantage of the approach of computer science and also of the technique of ‘prototyping’, which involves the testing of “a first or preliminary version of a device or vehicle from which other forms are developed” (*The New Oxford Dictionary of English* 2010). In this way prototypes are used to collect test results or feedback from users to perfect the final system. A prototype is usually a non-production model and may be incomplete, unreliable or inefficient, but researchers can generalise the intended model to save time and effort. In this research, prototyping took the form of developing versions and collecting test results rather than user feedbacks due to the inadequacy to have a real-world test in e-commerce site at this stage.

In computing, a research project may involve software development projects, but it mainly focuses on finishing a thesis. A methodology was proposed and used in this research project. The research methodology, shown in Fig. 1.1, contains eight stages: literature review, ideation, actualisation, prototyping, construction, adjustment, evaluation and dissertation. The starting point of the methodology is a proposal, which contains some simple reasons for doing the research, and perhaps a brief description of the expected research. After the proposal is accepted, the research begins.

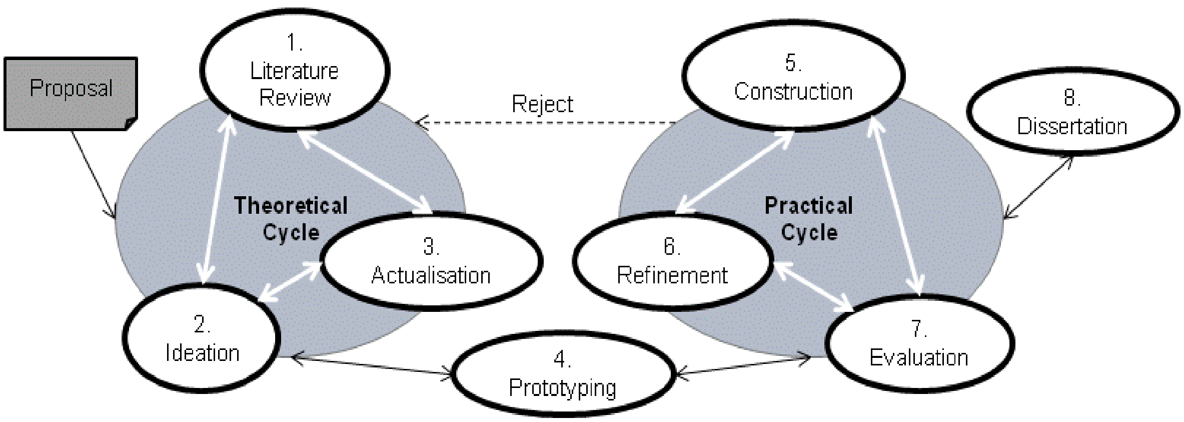


Figure 1.1 Life Cycle of the Methodology

The life cycle of the methodology consists of two developing sub-cycles, a theoretical and a practical sub-cycle. It allows a model developer to focus on logical ideas and concepts in the theoretical sub-cycle, and to concentrate on physical functions and techniques in the practical sub-cycle. The main purpose of the first sub-cycle is to generate some new ideas from old material. It involves three theoretical stages: a literature review, ideation and actualisation. There are three practical stages in the second sub-cycle: construction, adjustment and evaluation. The ultimate goal of the practical sub-cycle is to build a workable model for the research domain. The 8 stages of the methodology are as follows:

1. **Literature review** − a literature review assesses the requirements of existing practice. The main task of this stage is to identify the characteristics and requirements of the

research domain. In this research, it identifies the areas that need to be addressed in current group-trading problems in e-markets. It reviews alternatives that have been suggested for obtaining stable coalitions from the fields of economics and computer science.

2. **Ideation** − this is the stage of idea creation. The aim of this stage is to generate new ideas from existing concepts, by using a process of generating and developing, sometimes called 'brainstorming'. Ideas may also derive from one existing idea by putting the original idea in a new context and improving on it, or may make up a composite idea by using different elements of individual ideas to make a whole. Communication with supervisors and other researchers may also be used to refine concepts. All the useful ideas will be sent forwards to the next stage. Anything that is produced that is unclear will be sent back to the previous stage for identification or alternative solutions.
3. **Actualisation** − the goal of this stage is to record faithfully the ideas, which are generated in stage 2, through written descriptions, in tables, as graphs, or by mathematical expression. The criteria for analysing solution models can also be derived, by considering what is required to produce a satisfactory outcome to the research topic. In this research, several solutions for the problems of the core have been recorded.
4. **Prototyping** − in this stage, a conceptual prototype is built. By taking into account the ideas which are recorded in stage 3, a prototype for solution models can be drafted. It will be modified repeatedly until it reaches the standard of the criteria from stage 3. In this research, the graph of a conceptual prototype for solving online group-buying problems is drawn.
5. **Construction** − a workable model, which is based on the outputs of the theoretical cycle and the conceptual prototype from stage 4, is designed and is implemented in this stage. A design is "(1) a specification of an object, (2) manifested by an agent, who is "a person or company that provides a particular service, typically one that involves organizing transactions between two other parties" (The New Oxford Dictionary of English 2010). (3) intended to accomplish goals, (4) in a particular environment, (5) using a set of primitive components, (6) satisfying a set of

requirements, (7) subject to constraints, (8) to create a design, (9) in an environment" (Ralph and Wand 2009). An implementation can be made according to the design. In this research, the CBM was constructed.

6. **Adjustment** − this is a process of correcting, tuning and modifying the model so as to best fit the requirements of the research topic. The model needs to be corrected when the results it produces are wrong; any errors can be found by executing a series of tests and verifying processes. Tuning the performance of the proposed model can optimise it, including hardware tuning, software tuning and database tuning. Modifications to the system parameters of the model should be made to ensure it is capable of dealing with the real-world situation.
7. **Evaluation** − evaluation is the systematic assessment of the proposed model using criteria against a set of standards. In this research, the main tasks of this stage are to determine the criteria, to make an evaluation plan and to perform the evaluation of the proposed model. The criteria here are based on the ones from stage 3, but these are more detailed and more practical. The criteria and parameters used to evaluate the CBM in this research are discussed.
8. **Dissertation**− a dissertation, also called a thesis or disquisition, is a document which presents the reasons for, the findings of and the results of a research topic. All the contents of this thesis are drawn from the reports and outputs of each stage of the methodology.

The output of the theoretical sub-cycle includes the necessary information like ideas and criteria for the prototyping stage. The theoretical stages are executed recurrently until the theoretical sub-cycle produces enough information leading to the creation of a conceptual prototype.

Every time a new conceptual prototype is generated from the prototyping stage, it is sent to the next stage and sets in motion the process of the practical sub-cycle. A non-functional conceptual prototype will be rejected and sent back to the first sub-cycle. Of course, this will halt the process of the second sub-cycle, and then the first sub-cycle will come into play again, endeavouring to produce a better conceptual prototype by improving the weak points, which are suggested in its evaluation report.

According to the conceptual prototype, a new model is designed, implemented and evaluated in the second sub-cycle of the methodology. The three practical stages of the second sub-cycle are performed repeatedly until an eligible model or software systems for a thesis are fully created. The whole life sub-cycle keeps reiterating until the research is satisfactorily completed and until the ultimate goal, the final dissertation, has been prepared.

This methodology has been used in this research to ensure that the CBM is adequate for group-trading problems in e-markets. A conceptual prototype was generated in the first sub-cycle. Based on the prototype, the CBM was designed, implemented and evaluated.

1.5 Research Contribution

The primary contribution of this research is the development of a new online group-trading model for e-markets. Is the new model beneficial to both sellers and buyers? In order to answer this essential research question, an example in Chapter 5 illustrates the benefits for traders in these models. In brief, the core concept mainly addresses the stability issue in coalitions. By establishing balance of power between two conflicting parties, i.e. buyers and sellers, a stable coalition may be formed. Therefore, the core must consist of both buyers and sellers. So, the new core-based model performs group-trading. It deals with not only group-buying but joint-selling. The new model includes the following main characteristics:

- It is an online model and takes advantage of the Internet environment by adopting the techniques of distributed programming and sharing the workload between multiple e-markets.
- It is based on the core concept and finds a stable set within which traders can always get their best price. In other words, it will not only ensure that buyers get lower prices but also that providers gain higher profits.
- It is a group-trading model which indicates that it provides ways for sellers to

perform joint-selling and allows customers to get wholesale discount from group-buying.

There are other questions needed to be answered in this research. Does an online group-trading model exist in current e-markets? In answering this research question, a broad survey of current e-markets has proceeded and shows that no online group-trading model can be found. Why is no sign of group-trading model in present e-markets? Group-trading models are usually mistaken to be group buying, because joint-selling activities are difficult to be identified by others except those sellers who take part in the joint-selling contracts. Is an online group-trading model in need in e-markets? The answer definitely is a ‘yes’, because the coalition is more stable in an online group-trading model. Through the inspection of current e-marketplace, the coalitions that are formed in online group buying or joint selling models fall apart easily, because none of the models deal with the stability issue in these coalitions.

The core provides some solutions to group-trading problems. Is there any problem in applying the core in e-markets? One of my papers, that appeared just after my research started, pointed out that at least three problems hinder researchers from applying the core concept to the real market place (Sun *et al.* 2006). Another paper of mine talked about how to overcome the problems of the core and build a new group-trading core-based model (Sun *et al.* 2009). The final research question is about the criteria to evaluate this online core-based group-trading model. Two of my papers mentioned about the evaluation of the model (Sun *et al.* 2012a and 2012b). The efficiency and effectiveness of the model are discussed in Chapter 6.

1.6 Structure of the Thesis

The thesis contains seven chapters. In chapter 1, a brief introduction to this thesis is given. Chapter 2 presents existing approaches in e-markets. Portraits of several popular websites used on modern e-marketplaces are introduced to help convey an understanding of how they work and keep abreast of modern trends in e-markets. Chapter 3 discusses the advantages and problems of the core and several solution concepts used in this research to deal with group-trading problems in e-markets. One of these is the use of a broker, “a person who buys and sells goods or assets for others” (*The New Oxford Dictionary of English* 2010). So, brokers are a type of agent who specialise in trading. Chapter 4 gives an overview of the new CBM, the important role of the brokers in the CBM, a Core broking System (CBS), and the fees system for the CBS site. Chapter 5 presents a case study on which the new model was applied. Evaluation results are discussed in chapter 6. Finally in chapter 7, the contributions and limitations of the research are provided in addition to areas for future work.

In the next chapter, a survey of existing approaches in current e-markets is given including online group-buying, which is very popular at the present time (Kauffman, Lai and Lin 2010).

Chapter 2

Existing Approaches in Current E-Markets

The main aim of this research is to build a group-trading model for e-markets. Group-trading in this thesis includes group-buying and joint-selling. In order to determine whether there is a genuine group-trading website today, the nature of existing e-marketplaces must be examined.

Recently, some new models for group-buying have been proposed (Quality Articles Editor 2011). The eBay e-market is the greatest e-market success story to date and provides a very useful case study for e-market builders. An analysis of eBay is presented in Appendixes 1 to 3 as an example of a shopping site. Appendix 1 shows that the most popular shopping site, eBay, does not provide group-buying mechanisms for its members. EBay might consider adopting group-buying for its business model, especially after it pulled out of Taiwan (EBay financial 2006). Events have not been going smoothly in China either (Wang 2010); it should be noted that online group-buying is extremely welcome there.

In section 2.2, the current practices of online group-buying are explored. Actually, group-buying is not new at all. The brief history of online group-buying is given in subsection 2.2.1. A famous and profitable group-buying site called 'LivingSocial' is used in subsection 2.2.2 as an illustration of how an online group-buying site works. In subsection 2.2.3, the advantages and problems of online group-buying are discussed.

One important goal in this research is how to give consumers and providers the opportunity to conduct business in e-markets fairly. In section 2.3, reasons are given why a 'cartel' may disadvantage customers in an e-market. Joint-selling in e-markets and also ways to prevent a cartel are discussed in that section. It is essential to decide a sensible fees system for the CBM. The fees systems of 15 marketplaces are discussed in section 2.4.

2.1 Online Group-Buying and Monopoly

Online group-buying, team buying or collective buying provides a market mechanism that pools several consumers' purchasing requirements to buy large quantities of one particular product from a seller (Gottlieb 2000). This mechanism enables consumers to take advantage of significant quantity discounts from the seller and to get a lower product price (Kannan and Kopalle 2001). Since the consumers can obtain a lower price as the size of the buyer group grows larger, they have the incentive to recruit more consumers and make the price even lower (Kauffman and Wang 2002).

2.1.1 History of Online Group-Buying

Group-buying is not new. The history of such coalitions can be traced back to the late 1800s (McKenna 2002). Health care was one of the earliest areas to see the formation of large group-buying syndicates. Group-buying in the health care sector was first established in 1910 by the Hospital Bureau of New York (SMG Marketing Group 2002). In 1999, more than seventy percent of all hospital purchases in the United States were made through group-buying contracts (Muse & Associates 2000). Today, group-buying coalitions can be found in many industries concerned with the purchase of raw materials and supplies (Zentes and Swoboda 2000).

The advantages that the Internet provides have added to this trend internationally. Online group-buying has become extremely popular in recent years and this means that researchers will find it worthwhile to develop a system for online transactions along these lines (Chang 2007). It attracts a lot attention, including academic researchers and practical investors (Zauberman *et al.* 2009). Analysts and financiers have proposed that it is one of the Internet's most innovative consumer opportunities (Kauffman, Lai and Lin 2010). Researchers have speculated that it may be a win-win strategy for both consumers and providers (Tsvetovat *et al.* 2000).

In the late 1990s, there were several group-buying websites (Anand and Aron 2003). Mercata.com, Mobshop.com and LetsBuyIt.com were notable examples of websites of this kind in the United States (Kauffman and Wang 2002). Although many group-buying websites were established in a short period of time, this business model for Internet-based selling had been fraught with problems since the first online group-buying site was launched (Kauffman, Lai and Lin 2010). Mercata, Mobshop and LetsBuyIt were all unsuccessful, though they were heavily funded (Kauffman and Wang 2002). Mercata was closed in 2000 (Needle 2001). Mobshop closed its consumer operations in 2001 (Clark 2001). LetsBuyIt, a technology shopping site that was once believed to have a bright future, suffered the indignity of seeing its shares suspended on 29 December 2000 (*The Economist* 2001). It did not survive for long and officially terminated its operations in 2002 (LetsBuyIt 2002). The cause of the shutdown of these group-buying sites was their financial problems (Regan 2001) and the lack of customers (*The Economist* 2001).

It is believed that the business model of the old sites might have been the reason for the failure (*The Economist* 2001). Online group-buying, compared to regular online shopping, involves more uncertainty and risk (Lin 2009). The very nature of group-buying coalitions can cause reasons for conflict. Another problem can arise due to unequal member allocations that keep smaller participants from taking part in the group-buying (Bloch, Perlman and Brown 2008). In addition, the discord thus created leads to a lack of commitment among coalition members and is another common problem in group-buying (Heijboer 2003). Even though many people were attracted to the sites, it proved hard to persuade enough of them to sign up for transactions. This may explain the short life of several such businesses (Aylesworth 2003).

Somewhat surprisingly, online group-buying businesses have been trying to make a comeback recently. Ihergo, a group-buying website in Taiwan, has grown at the startling rate of 961 percent in less than two years (Lin 2009). The tuangou phenomenon has been most successful in mainland China (Montlake 2007). Many companies all over the world have adopted group-buying in their business models (Kauffman, Lai and Lin 2010), including Google and Facebook. Google, an American multinational public corporation investing in Internet search and advertising technologies, is using its “strengths in information and technology to build products and advocate for policies that address global challenges” (Google n.d.). One of its products called ‘Google Offers’ has appeared on its site and provides facilities for group-buying by means of virtual communities (Panzarino 2011). A virtual community is defined as a social group on the Internet where users share common interests (Beamish 1995) and social networking services are the most prominent type of virtual community today. As a leader of social networking websites, Facebook has more than 600 million active users (Carlson 2011). One of the newest features of Facebook, called ‘Buy With Friends’, even allows users to perform group-buying on social networks (Marsden 2011).

2.1.2 An Online Group-Buying Site: LivingSocial

Consider the business model of a new international group-buying company, called LivingSocial, which is based on virtual communities and launched in 2007. It “offers daily deals on handpicked experiences that can be shared with friends” (Livingsocial n.d.). Members receive an e-mail presenting the daily offer. Once deals have been made, the buyers receive their redemption vouchers via e-mail the next day, and then collect their goods at leisure. In addition, the buyers may introduce the offer to their friends. If three of their friends purchase it, the buyer obtains it free. The money, which the site collects from the consumers, is split between Livingsocial and the providers. Assume the retail price for an item is £100. Customers pay for an item at a discount of 50%, so they pay £50 for each item. The provider gets £25 out of it and the commission is the other £25. Members can redeem their vouchers and enjoy the products or services from the providers who are the third party. LivingSocial is not the only Internet company offering online vouchers for daily deals. Out of more than 500 online group-buying sites in the world (Weiss 2010), another large online group-buying company ‘Groupon’ is "projecting that the company is on pace to make $1 billion in sales faster than any other business, ever" (Weiss 2010).

The providers come to the sites because they want to find more customers. There are many factors that may affect the process as a customer works through the purchase decision. A survey concluded that ‘price’ is the major factor influencing the purchasing decisions of consumers (Stockford 2008). This survey took place in 2008 and 125 individual consumers were asked to comment on the nine factors shown in Table 2.1.

Table 2.1 Factors Influencing Purchase Decision

This item has been removed due to third party copyright. The unabridged version of the thesis can be viewed at the Lanchester Library, Coventry University.

The results of the survey implied that ‘Company reputation’ and ‘Trust in Brand Name’ are also important factors for customers. So, the strategy of the providers is to use a low price to make as many deals as they can. They might not get much profit out of the deals, but in the long run, with help from the sites, the company gets a better reputation and customers come to trust the brand name more. A research paper showed that customers prefer to join the group-buying deals which have been initiated by someone they trust who has a higher level of expertise (Bansal and Voyer 2000). Undoubtedly, the sites usually have a good reputation and are expert in group-buying (Lin 2009). As far as company reputation and trust in brand-name are concerned, these sites are better. The sites are definitely able to attract more buyers than most providers could on their own, especially when compared with providers who are new or who are unknown to customers.

The group-buying sites provide a new method for providers to advertise their brand and their products. The providers are happy with their risk-free advertising. They are counting on the side effects of these promotions even if there is little profit from these transactions. In these promotions, consumers pay and have the chance to enjoy products from the providers. Businesses offering the deals hope that users who buy the coupon will share the experience they have had, spreading the word about their brand. They also hope that, after trying their business, customers will tell their friends about it, bringing along even more visitors to try it. Thousands of consumers are able to pass on to thousands of friends in a virtual community, the good experiences they have had when responding to the providers’ promotions. Positive word of mouth is a key factor in encouraging providers to join in a group-buying deal, in the knowledge that they will have an exceptional customer experience.

The sites also give providers the opportunity to turn their stock into cash. It is in the interests of the providers to try to sell the large quantity of stock they have bought up, as quickly as possible so that the storage costs they incur are minimal. Consider the following scenario. A provider bought mobile phones in bulk to lower the cost and expects to gain profits from selling them. Every product has a life cycle. A new product is launched, grows, and at some point, may die. Some products have a short life cycle. Unfortunately, the mobile phone is one of them. Most mobile phones exhibit a gradual price decrease over time (Goldsmith 2005), as new phones come onto the market every day. So selling out the stock in a short period of time is a key to creating more profit for the provider. Besides, the space and maintenance fees for the stock can be quite costly if the mobile phones are stored in the warehouse. So it is a good solution for the provider to get them sold on the site as soon as possible.

The first reason why this kind of deal attracts so many customers to the sites is the low prices. Customers get a massive discount usually between 50% and 100%. The second reason which makes the site so popular is perhaps not quite so easy to see. It is the powerful influence that people can wield as members of the same group, to sway each other to accept a deal or not. People pass on information to their friends about offers they would do well to take advantage of. Table 2.1 indicates that 'Peer/Colleague Recommendation' is not a crucial factor in the purchasing process for individual buyers. However, researchers have discovered that the purchasing decisions of people are deeply affected by others in a group (Bikhchandani and Sharma 2001, Pan 2010). People can effectively persuade the members of the same virtual community as themselves and their friends to join their coalition (Doucette 1997, Chen 2008). The trust between members in a virtual community is the key factor for a successful group-buying deal (Lin 2009).

Peer pressure may result from subtle unconscious influences. Individuals in a group can exhibit 'conformity', also known as herd behaviour (Asch 1956), which is "behaviour in accordance with socially accepted conventions" (*The New Oxford Dictionary of English* 2010). Everyone in a group tries to gain benefit from the same discount. If new members want to join the group, they feel they need to be accepted by the group. Groups of people may act in concert, especially in situations that leave little time for decision making (Yarnold, Grimm and Mueser 1986). Obviously, the daily deals on the sites take full advantage of this ‘conformity’ principle to induce more customers to commit themselves to such deals, because 24 hours is not a long time for buyers to make their decision. Thus, the group can place strong pressure on individual members to change their attitude and behaviour to conform to the group standards. The massive discount may be the incentive for a group, but peer pressure is the force which increases the size of the group.

Table 2.2 Annual Revenues of Amazon and eBay

Year	**Amazon**	**eBay**
1996	$15.7	**(million)**
1997	$147.8	-
1998	$610.0	$47.4
2000	$1,640.0	$224.7
2001	$2,761.0	$431.4
2002	$3,122.0	$748.8
2003	$5,263.0	$2,165.0
2004	$6,921.0	$3,271.0
2005	$8,490.0	$4,552.0
2006	$10,711.0	$5,969.0
2007	$14,835.0	$7,672.0
2008	$19,166.0	$8,541.0
2009	$24,509.0	$8,727.0
2010	$34,204.0	$9,156.0

There are three reasons for establishing online group-buying businesses. Firstly, it may be the right time to launch an online business for group-buying. The old sites launched in the late 1990s closed during 2000-2002. It is difficult to find their records due to their closing down. By looking at other shopping sites, their situation at that time can be pictured. The revenues of Amazon, the most successful online provider in the world, were only US $15.7 million in 1996 and eBay had even smaller revenues of US $4.7 million in 1998 (Wikinvest n.d. a). Table 2.2 shows that the revenues of both businesses at that time were low. The old sites had likely been through rather hard times, especially when the market was so very different and computer ownership was so much smaller. Besides, the advanced distributed computing technologies nowadays enable the new generation of group-buying models take full advantages of the Internet and draw more customers to their websites. Moreover, it takes extra efforts to design a computationally distributed system than a centralized one because ‘the additional communication burden of the distributed system needs to be taken on board (Asselin and Chaib-Draa 2006). Some innovations of distributed technology using in e-commerce are discussed in section 4.5.2.

Figure 2.1 History of Amazon's Revenues (Nasdaq n.d. a)

In Fig. 2.1, the trend is of rapidly increasing revenues and reveals the amazing success of Amazon in recent years (Nasdaq n.d. a). This is a real encouragement to other shopping websites. There are signs everywhere showing the popularity of online shopping now. In 2010 eBay had 1,449 million transaction entries on its site for goods worth US $61,819 million (EBay Inc. 2011). Online shopping today is not a strange thing for people any more. This is what has brought online group-buying businesses to life.

Secondly, the new sites are broking systems, while the old sites belonged to providers or retailers. Just like eBay, providers come and sell products and services in these new group-buying sites. Consider a group of buyers, each with a certain purchasing requirement. The people who play the role of coordinator for the group cannot be sellers, because this gives them opportunities to cheat. So in the old sites, the coordinators were quite often general customers who were not as proficient as they should have been. Because the new sites are broking systems, the brokers can be the coordinators for both the seller and the buyers, and be fair and professional. This solves the common problem on old sites which arose due to unequal allocations between members that kept smaller participants from taking part in the group-buying.

Thirdly, the new sites have brought in effective strategies to make their business models a success. Because attracting customers to them is not easy, some new sites try to build up members' trust in groups by using virtual communities (Hagel and Armstrong 1997), such as bulletin boards and social networks. A bulletin board is an online discussion site with various topics to discuss, using forums, threads and individual posts (VBulletin Community n.d.). It is easier for members to form a bigger group, if people try to get a shopping model going in a virtual community. The recent sites have been very successful in this respect, because the customers that they attract already have a commitment to each other. Just like eBay, a large number of customers will draw more sellers to a site. This explains the phenomenal success of group-buying sites around the world.

Groupon used to be the most profitable online group-buying site, but its annual revenue has gone down from the $713.4 million in 2010 to $312.9 million in 2011 (Raice 2011). In October 2011, a report from Forrester Research suggested that its business model was a disaster (Conlin 2011). There are some problems in these models and they are discussed in the next subsection.

2.1.3 Problems of Online Group-Buying

One major problem in online group-buying models is that they cannot sustain themselves for very long. They are still full of uncertainty and risk. By selling items at a large discount the sites are really carrying out a form of advertising which may only work for a short time. This will not be in the interest of providers for long especially as far as profits are concerned. So the sites might run out of supplies. They will not work for the good of customers in the long run either, because the customers might end up with out-of-date or poor products. Therefore, the coalitions could fall apart easily. The cause of this is the potential instability of the group-buying models. Unfortunately, none of these models have the ability to deal with the stability issue in the coalitions.

The second problem in these models is that their markets are ‘monopolies’, giving them “exclusive possessions or control of the supply of or trade in a commodity or service” (*The New Oxford Dictionary of English* 2010). They have substantial control over what the different customers will have to pay for a particular product. In a monopoly, the more customers there are, the higher the price for the item. Competition between customers gives the provider the opportunity to control the price. It is dangerous to have one provider and one product in an e-market. In many countries, specific restrictions have been placed on monopolies by ‘competition laws’, which “promote or maintain market competition by regulating anti-competitive conduct” (Taylor 2006).

The third problem is these group-buying models need to deal with high computational complexity when there are many customers in e-markets. Existing buyer coalition formation schemes have been investigated in game theory, but they cannot deal with thousands of buyers which could join a coalition in practice because of the high computational complexity (Yamamoto and Sycara 2001). The daily deals in LivingSocial or Groupon allow buyers to place their orders on the same product only, which is a good way to reduce the complexity in group-buying. However, in these daily offers, the buyers cannot purchase multiple products at a time. The customers cannot choose items according to their preference either. Consequently, the daily deals are the main attraction for buyers, but they are also barriers for many potential transactions in the e-markets.

The final problem is that providers on group-buying sites are liable to be overcharged, and this definitely scares away many potential providers. In section 2.3, there is a survey for the current fees systems in the e-markets. More discussions will be given there after the ways how providers are commonly charged are learned from the survey.

In order to prevent a price maker in an e-market, it is good to bring as many customers and sellers into an e-market as possible. There are many providers and customers on eBay and Amazon. It is not easy for any seller or buyer to control the selling price there. However, in a group-buying market, during a particular period of time, where there is no alternative, there may only be a single provider for a product. Actually, group-buying models build monopolies in which the sellers dominate the markets and put the customers at a disadvantage (Anand and Aron 2003). If the demand for an item is high, the provider has the opportunity to control the price, as there is no competition at all. It is dangerous to have monopolies and competition laws in many countries have placed specific restrictions on them. The new sites use the low price of deals to avoid violating the competition laws, but this may bring many other problems. Some companies may use these sites to take over markets and to force other companies out. In the end, the customer will either pay more or get bad products and poor services.

Sometimes, a handful of sellers in a coalition have a pricing agreement between them. In the next section, the question of a ‘cartel’ is introduced. When the market becomes a cartel, this encroaches on another sensitive area of competition law. Reasons are given why this is a nightmare for consumers and why it is restricted by ‘competition laws’. Methods for maintaining a healthy trading environment for buyers and sellers is crucial in this research. In the next section, joint-selling in all kinds of situations is discussed and the cartel is also introduced.

2.2 Joint-Selling and Cartel

The aim of this research is to build the model in an e-market where no one person can dominate and be a price maker and so that every seller has some influence in the e-market. However, if only a few producers are attracted to the e-market, they may gang up and become “a group of similar, independent companies which join together to control prices or divide up markets and limit competition” (European Commission 2004) in other words a ‘cartel’, which acts as a formal arrangement between producers and manufacturers who agree to fix prices, marketing, and production (Sullivan and Sheffrin 2003). A possible solution to prevent a cartel in e-markets will be discussed in this section.

Joint-selling allows several traders to increase their benefits by joining coalitions. Authorisation has been granted for many businesses to engage in joint-selling (OECD 2004). In fact, there are plenty of joint-selling activities in markets all over the world, but they are not easy to identify. For instance, joint-selling is quite common in gas markets (Albers 2001), but customers cannot be aware that products are from joint-selling. Customers purchase gas from one company, but they have no way of knowing the company’s joint-selling contract, which is signed by organisations, such as importers and distributors.

A full explanation of the reasons why the model proposed needs to involve group-trading is another important part of this section. In e-markets, by examining the forces of both demand and supply, an equilibrium price might be found. Group-trading may thus involve both group-buying and joint-selling. An introduction to group-buying was given in the previous section. Here joint-selling is described. In this research, there are three reasons for using joint-selling:

1. To give incentives to sellers. It is an effective way to attract many providers to the scenario. Joint-selling increases the ‘competitive advantage’ (Porter 1985), in various ways, including achieving economies of scale and scope, reducing costs of transactions, forming and maintaining a ‘brand’, conducting advertising and initiating research (OECD 2004).
2. To give incentives to buyers. There are certain benefits for consumers in joint-selling, such as new products, low price due to low cost and better services through business partnering.
3. To reduce computational complexity. Using brokers as media to collaborate sellers can effectively lessen complexity and reduce the time taken to process trading transactions. In subsection 3.4.2, collaboration amongst sellers will be discussed.

However, sometimes problems may arise when sellers decide to form a coalition for joint-selling. In a free e-market, doing business should be a competitive game amongst firms. Sometimes, companies may be tempted to avoid competing by setting up agreements between firms. For example, consider the scenario where there are three players in a game of poker. Two players may cooperate to eliminate a third, dividing the winnings between themselves. This is cheating, because the rules of poker forbid cooperation among the players. A situation may occur where the use of a joint-selling model will result in some of the providers in an e-market losing out, even though the idea is that everybody should benefit equally. Things can get worse in a cartel. Providers in a cartel get more than their fair share of the market by controlling prices or dividing up markets. They do not need to provide better value products or quality services at competitive prices. When a cartel limits competition, consumers in e-markets end up paying more for less quality goods or services.

The way to prevent cheating in the aforementioned poker scenario is to forbid cooperation among the players. However, in an e-market, there is no such rule against cooperation among sellers. Cooperation between companies may be necessary if products or services are to improve. Expensive research projects for new products are a very common incentive for firms to collaborate with one another. Agreements between producers and providers can ensure that consumers can buy personalised products which suit them. In other words, agreements between companies may restrict competition but can also be good for consumers and markets. So, a joint-selling agreement which restricts competition will not necessarily turn out to be a cartel.

Joint-selling activities must operate within the guidelines of the government of the country concerned. Competition laws can be enforced to protect the interests of consumers locally. However, because traders in e-markets may be international, competition laws have therefore become global. There are independent public bodies like the UK Competition Commission, "which conducts in-depth inquiries into mergers, markets and the regulation of the major regulated industries, ensuring healthy competition between companies in the UK for the benefit of companies, customers and the economy" (*Competition Commission* n. d.); global organisations like the Organisation for economic Co-operation and Development, "an organisation dedicated to global development", having "34 member countries spanning the globe, from North and South America to Europe and the Asia-Pacific region" (OECD n. d.), or the 'World Trade Organisation', which is "a global international organisation dealing with the rules of trade between nations" (WTO n. d.). Competition authorities in different places around the world have made it their goal to ensure that there is free and fair competition in e-markets (European Commission 2004).

In joint-selling, agreements, such as fixing prices, limiting production or sharing markets or customers, have to be restricted. On the other hand, agreements which have more positive effects are allowed (European Commission 2004). Agreements between companies, which involve developing new products or finding better ways of making products available to consumers, are not illegal and are encouraged, because they are necessary for improvement of products or services and they are good for consumers.

People may be tempted to cheat in some way in the process of trading, but a financial reward can also be an incentive to shopping sites to provide a good service to their users. It is normal for sellers to pay for the privilege of coming to the e-markets and finding potential customers there. In the next section, the fees systems of some popular shopping sites are given.

2.3 Fees Systems in E-Markets

Shopping sites provide online services for their members. People are willing to pay for the services, because they are tailored to their needs. The sites keep themselves afloat with the payments from their users. One site will charge people in a completely different way from another. For instance, some sites are free, but others charge a fee for sellers to list products on their site. This section presents the fees systems of fifteen popular shopping sites and gives an overall picture of the fees in current e-markets. Before listing the fees for the 15 sites, it will be helpful to introduce the fees system of eBay first.

Most shopping sites depend on revenues from commissions, "typically a set percentage of the value involved, paid to an agent in a commercial transaction" (*The New Oxford Dictionary of English* 2010). The brokers' revenue comes from commission paid by the customers. Higher commission usually brings better services from brokers, but if there are fewer customers they may object to paying a high price for commission. Deciding a reasonable fee which will please both brokers and customers is a problem.

EBay's main revenues come from fees for transactions including insertion fees and final value fees. The fees are based on various factors and scales. Insertion fees need to be paid from £0.15 to a maximum rate of 3% for an ordinary listing whenever a seller lists an item on eBay in the UK. The seller will be charged a final value fee that is from 0.75% to 10% of the item's final selling price in the UK. More details about the fees system of eBay are in Appendix 2. Different companies have different ways of charging. The fees of online shopping sites are given here. This will be useful for setting up the fees system for the model.

The commission for each market-broker is normally calculated on the basis of a percentage of the sale price. The percentage is negotiable. The commissions for brokers are commonly part of the confidential data of agreements. For instance, in the area of home buying and selling, brokers usually charge the homeowner 5% to 7% commission (Kokemuller 2011), but commissions may range widely between 1.5% and 12% in practice. Likewise, online broking sites take various commissions. However most of them seem to have standard and non-negotiable fees systems.

Table 2.3 Fees for 15 Shopping Sites

Company	Final Value Fees (Final Selling Price)	Online Store Fees (Per Month)	Insertion Fees (Starting Price)	Reference
Amazon	8.05%, 11.5%, 17.25% £0.86 + £0.16 ~£1.32	£28.75	£0.06	(Amazon n. d.)
Atomic Mall	1~6% of TV	£0~ £12.30	0	(Atomic Mall n. d.)
Blujay	0	0	0	(Anderson 2006.)
Bonanzle	1.5~ 3.5% of FOV + £0.31	0	0	(Bonanza 2011)
CQout	1.8~5.4%	£3.41~£9.25	0	(CQout n. d.)
Craigslist	£6.20	0	0	(Musgrove 2006)
eBay	1.5~10%	£14.99, £49.99, £349.99	£0~£7.95 or 3%+£1	(EBay n. d. e)
eBid.net	3%	£4~£8	0	(EBid.net n. d.)
eCrater	0	0	0	(Ashley 2008)
Etsy	3.5%	0	£0.20	(Etsy n. d.)
GoAntiques	2~10%	£24.20~£49.62	0	(About.com n. d.)
iOffer	1.5~5%	0	£0~£12.40	(IOffer n. d.)
OnlineAuction.com	0	£5	£0~£6.20	(OnlineAuction.com n. d.)
Ruby Lane	0	£12.40	£0.19	(Ruby Lane n. d.)
TIAS.com	2% or10%	£24.80	0	(TIAS.com n. d.)

The fees for 15 marketplaces are listed in Table 2.3 that reveals that the fees for each site are different. There is no average, standard, usual, or normal commission which will apply to every e-market. The 15 marketplaces are exactly the same as the selling venues in Table A4.1. AuctionBytes selected these established marketplaces because they “had traction, had a substantial number of users” (Steiner 2010 a). Generally speaking, there are three types of fees which sellers are charged: online store fees, insertion fees and final value fees. An online store fee is paid monthly by a seller who opens a store on the sites. An insertion fee is calculated at the time an item is listed, even if the item doesn't sell. A final value fee is charged when an item is sold.

Opening an online store is one of the most economic ways for sellers to setup a business. The sellers do not need to spend money on renting a warehouse, but they need Uniform Resource Locators (URLs) for their online shops. A URL "provides a means of locating the resource by describing its primary access mechanism" (Berners-Lee *et al.* 2005). Nearly every online group-buying venue provides URLs for sellers. When the sellers pay only a small monthly fee and open online stores on these sites, they can have URLs for their stores, to which they can easily direct their customers from around the world. There is a good resource here for those market-brokers who need URLs for their online store.

Most of the sites provide special features to allow sellers to customise their professional-looking store with logos, images and colours of their choice. Some marketplaces help sellers with promotional tools, like highlighting special offers and mail newsletters, so that they can advertise their goods and bring in more buyers. EBay charge the highest online store fee, which is £349.99 for an anchor shop and £49.99 for a featured shop. A GoAntiques online shop at £49.62 comes next. And it is then followed by Amazon’s £28.75 and TIAS.com’s online shop at £24.80. The lowest online store fee is £5 on OnlineAuction.com. The average online store fee is about £24.50 taking into account only the more realistic prices, the highest and the lowest fees on the list being somewhat over-exaggerated.

An insertion fee may be charged whenever a seller lists an item on a shopping site. In Table 2.12, all the marketplaces charge a fixed amount of money, except eBay. In nine out of the fifteen shopping venues, listing an item is free. On the eBay site, the insertion fee is zero when the starting price of an auction-style item is less than £0.99. The concept of an insertion fee is perhaps similar to the fee for a newspaper advertisement, but newspaper companies do not charge a fee when the products are sold. It does not seem fair to ask the seller to pay for insertion fees and final value fees at the same time. Most sellers are discontented with this (Steiner 2010 b), especially when they get no profit at all out of an unsold item, but they still have to pay the extra expense of an insertion fee.

Most of the shopping sites calculate the final value fee using a certain percentage of the ‘final selling price’, which is the final price of an item excluding shipping fees, handling fees or sales taxes. Amazon has the highest percentage, at 17.25% a possible reason as to why many of its sellers may have complaints. One seller said that “Amazon’s fees are atrocious” (Steiner 2010 c). The second highest percentage is 10%, which is charged by eBay, GoAntiques and TIAS.com. And it is then followed by Atomic Mall, at

6%, CQout, at 5.4% and iOffer, at 5%. The average percentage of these 15 sites is around 7.5%. Amazon and eBay are consumers' top two websites for shopping this year in the UK (Sillitoe 2011), but they seem to charge the sellers the highest percentages of the final selling price.

In Atomic Mall, the final fee is up to 6% of the Total Value (TV), which is the total price of an item including shipping fees and handling costs. The final value fee on some marketplaces like Bonanzle is based on the Final Offer Value (FOV), which is the sale price minus a shipping fee exemption of up to £6.20. For example, assume that a seller sells a £472 item after shipping. The total shipping for the item is £10, of which only £6.20 is deducted. The FOV is £472–£6.20=£465.80. The fee for the first £310 is £0.31+£310×3.5%=£11.36 while the fee for the remaining amount is £155.80×1.5%=£2.34. So the final value fee is £11.36+£2.34=£13.70. No matter whether it is based on TV or FOV, the final value fee for a seller derived from these two schemes usually turns out to be more than the fee calculated from either of the final selling price of an item.

From among the sites in Table 2.3, the highest percentage is 17.25%. However, most group-buying sites charge a much higher percentage than this, for instance, 30% in LivingSocial (Tallai 2010) and 50% in Groupon (Crudele 2010). Although the final value fee is the only fee which the sellers have to pay, overcharging seems to be a common problem on group-buying sites. In section 2.2, it was discovered that providers regard the group-buying sites as places where they promote their brands and products. Even though the providers do not expect to get great profit from the deals, it is easy to image how upset the providers will be when more than one third of the little profit they have, is taken away by the sites. There is only a slim chance that the providers will return to group-buying sites again. Overcharging providers will drain the online group-buying sites of the stocks that they need. The ultimate consequence is that the sites may not have any providers to support them at all.

2.4 Summary

This chapter has provided a broad survey of current e-markets and gives a general idea about what is happening to e-markets today. The world's largest online trading community e-market, eBay has many strong competitors, and some of them have adopted group-buying in their business model. Online group-buying has become extremely popular in recent years and draws a lot of people's attention. In the late 1990s, there were several group-buying websites, but they were all unsuccessful due to financial problems and lack of customers. More than 500 online group-buying sites in the world have been trying to make a comeback recently. Groupon and LivingSocial are the two most profitable companies. Providers come and regard the deals on the group-buying sites as promotions. Customers are attracted by the low price deals and peer pressure is the force increasing the size of that group. The daily deals on the sites successfully induce more customers to commit themselves to them. A large number of customers will tend to draw more sellers to the sites. There are at least four major problems in these new online group-buying models. The first problem is that their coalitions are unstable and can fall apart easily. The second problem is that their markets are monopolies and may fall foul of competition laws. The third problem is that providers on the sites are liable to be overcharged. The fourth problem is these models need to deal with high computational complexity when there are many customers perform group-buying in e-markets.

In this research, three reasons are advanced for using joint-selling. These relate to maximizing profits for sellers, giving incentives to buyers and reducing computational complexity. Although cooperation between companies may be necessary in order to improve products or services, a cartel is to be avoided. There is no rule against cooperation among sellers, but competition laws protect the interests of consumers. Joint-selling agreements such as fixing prices, limiting production or sharing markets or customers, is considered outside this research.

Generally speaking, three types of fees are charged in e-markets: final value fees, online store fees and insertion fees. Amongst the fifteen popular shopping sites, Amazon charges the highest final value fee. The average final value fee is around 7.5% of the final selling price. The average monthly online store fee is about £24.50, but EBay's monthly online store fee is up to £349.99. Most of the shopping venues, listing an item are free.

No group-trading website was found among the current e-markets reviewed. However, there may be such sites on the Internet. In fact, joint-selling is not easy to identify. Therefore, an online group-trading site might look like a typical group-buying website. This chapter has explained how to perform joint-selling without breaking competition law, but the problem about instability of the coalitions in group-buying is still unsolved. In the next chapter, the core concept is introduced. This concept, drawn from the discipline of economics and is constructed on the principle of the stability of coalitions, will be given as it seems to have an answer to this problem.

Chapter 3

The Core and Solutions

The theme of this chapter is a review of the core; it is one of the crucial elements of this research. Theoretical suggestions for developing proper coalition models by adding the core to suitable coalition structures have already been proposed in the literature (Kahan 1984). The model developed here is based on the core. A detailed examination and illustration of the core is given in section 3.1. First, the reason why the core concept is important for coalition problems needs to be clarified.

The core concept has been tested and run within the simple market games. The results of these games demonstrate that many problems have to be resolved to apply the core in e-markets. Section 3.2 introduces several useful solution concepts to devise a workable group-trading model for e-marketplaces. The e-market is an arena in which incentive compatibility, distributed computing, and less computational complexity are all highly relevant. This chapter considers works that have been written about these three issues and finds solutions to some of the problems that occur in online group-trading.

3.1 An Overview of the Core

The core was first proposed by Francis Y. Edgeworth in 1881 and plays an important role in the area of economics (Kannai 1992). It was later defined in game theory terms by Gillies in 1953 and then it becomes one of the popular and critical concepts of cooperative games in the area of game theory. The core indicates the set of imputations under which no coalition has a value greater than the sum of its members' profits (Gillies 1959). Therefore, members of the core stay and have no incentive to leave, because they receive a larger profit than elsewhere. Individuals in a coalition are not only interested in maximising the coalition’s joint efficiency, but they are also very concerned with their own profits. If an individual can gain better profit by working alone without involving others, the individual will not join the coalition. If a coalition can produce a better profit by excluding certain individuals, the coalition will form a new coalition without those individuals. The core forms stable and efficient coalitions by calculating the profits of different possible coalitions (Osborne 1994).

This section can be regarded as a report following a close examination of the core. The nature of the core is illustrated in some simple market games here. This builds a good foundation for understanding this model as developed later. This section concludes with a list of the advantages and problems of the core also to be considered later when recommending this model.

3.1.1 A Definition of the Core

In cooperative games theory, the core is a set of imputations that are not dominated. A cooperative game, which is denoted as <N, *v*> with a coalition N and a value function v: $2^N \rightarrow \mathfrak{R}_+$, where $\mathfrak{R}_+$ is nonnegative real numbers, and it is always assumed that $v(\phi) = 0$. The game consists of n players {1, 2, . . . , n}, who can form non-empty arbitrary coalitions $S \subset N$. The value of a sub-coalition S is equal to $v(S)$. Suppose that player i contributes an amount of x_i. Since the game is assumed to involve transferable utility, which means one player can transfer part of his/her utility to another player, the cost to the players in the coalition S is simply $x(S)=\sum_{i \in S} x_i$. Since each coalition must pay its due of $v(S)$, the individual costs x_i must satisfy $x(S) \geq v(S)$ for every $S \subset N$. The set of cost vectors $C(v)$ satisfies the following states,

$$C(v) := \{ \boldsymbol{x} \in \mathfrak{R}_+^n : x(S) \geq v(S) \text{ for each } S \subset N \},$$

is the set of aspirations of the game, in the sense that this set defines what the players can aspire to.

The goal of the game is to minimize social cost, that is, the total sum of the costs x(N). Clearly this minimum is achieved when $x(N)=v(N)$. This leads to the definition of the core of a game. The core of the game is the set of aspiration vectors x $\in$ C(v), so that x(N)=v(N) and is regarded as efficient (Scarf 1967). The C(v) of the core can be derived from the following function (Kikuta and Shapley 1986):

$$C(v) := \{x \in \mathfrak{R}^n \mid x(N) = v(N), x(S) \geq v(S) \text{ for all } S \subset N\}.$$

An allocation is inefficient if there is at least one person who can do better, while no other person is worse off (Faigle *et al*. 1997). If any individual conceives of a proposed allocation being disadvantageous to them, they can decide to leave. For example, consider the case where the individuals of a coalition C get profit P. Now, assume there is another coalition D that can generate profit B. If B dominates (is greater than) P, the individuals of C may switch to D. The defectors from the coalition can do better for themselves by deserting their coalition to join other coalitions.

The definition can be summarised as "The core of a cooperative game consists of all un-dominated allocations in the game" (McCain 2005). The profit of the allocations in a core should dominate other possible solutions, meaning that no subgroup or individual within the coalition can do better by deserting the coalition. Even for the self-interested individuals, the core solution is the result they would adopt, if they are rational. The core has become a prominent solution concept in economic applications for coalition problems, because it takes on board the incentive of both consumers and providers in coalitions.

The core is a Pareto efficiency, also called Pareto optimality. It is a central concept in economics, proposed by an Italian economist, Vilfredo Pareto (Ng 1983). A formal definition of Pareto efficiency is "an economic equilibrium in which it is impossible to change the allocation of resources without improving the lot of one agent at the expense of another" (Encarta World English Dictionary 2009). A Pareto efficiency is a state where resources are allocated in the most efficient manner. The mechanism of Pareto efficiency is to select the subset with the biggest v(S), which is simply done by comparing economic outcomes. Because it is a way that people widely accept, researchers embed it in their models to prevent coalitions from falling apart (Fudenberg and Tirole 1991, Haurie 1972, Sen 1993). It may be helpful to use some examples to explore the core and how the mechanism of Pareto Efficiency has been used to decide the core.

3.1.2 Illustrations of the Core

Some simple market games are based on a 'Jeff and Adam game', which was originally used to explain some economic ideas (McCain 2005) and are used here to illustrate the core (Sun *et al.* 2006). A 2-person market game is designed to explain the basic idea of the competition in e-markets. There are four assumptions of these games: complete information, identical cost functions for consumers, identical utility functions for providers, one type of product. The first assumption is complete information, which describes an economic situation in which knowledge about other market participants is available to all participants (Harsanyi 1967). It assumes that all the cost functions and possible coalitions must be made available to the public. Just two types of traders are involved in the games: Consumer and Provider. In order to simplify the games, only one type of consumer and provider are assumed and there is just one kind of product to trade with as well. Consumers may exchange their fund with goods.

It has been common among economists to use level of utility to quantify relative prices of goods and services (Stigler 1972). Utility measures the benefits (or drawbacks) from consuming or selling a good or service. One utility is equivalent to one unit of fund here. A consumer is willing to pay at most 12 units of fund for 3 units of product. Providers trade their goods with consumers in order to obtain the funds. By doing this, they may increase their utilities as well. The marginal utility functions of customers and providers in the following market games are shown in Table 3.1.

Table 3.1 Marginal Utility Function

Customer	**Product**	**1**	**2**	**3**	**4**	
	Utility	7	10	12	13	
	Margin	7	3	2	1	
Provider	**Product**	**1**	**2**	**3**	**4**	**5**
	Utility	7	11	13	14	15
	Margin	7	4	2	1	1

A customer's utility is 7, if he/she owns exactly one item. When he/she has two items, his/her utility becomes 7+3=10. He/she wishes to have at most 4 products, because the utility remains the same when there are more than 5 products. A provider's owns 5 items at the beginning and he/she wishes to exchange them with at least 15 utilities. Suppose he/she sells one item with 2 funds, then his/her total utility becomes 14+2=16.

At the beginning, consumers have 15 units of fund to spend on goods. Each Consumer may purchase at most 4 units of goods. If consumers run out of funds, they have no substitute with which they can interchange goods. A provider only has 5 units of goods to offer. Initially, traders each have a utility of 15. Their utility will change after transactions are agreed. For instance, a consumer purchases 4 goods with 9 units of fund from one provider. The consumer owns 4 items and 15–9=6 units of fund. His/her utility is 13+6=19. On the other hand, the provider has one unit of product and 9 units of fund. The utility of the provider is 7+9=16.

Let N be a set of participants, and *v* be a characteristic function that holds the value of participants' profit. In a 2-person market game, N={Consumer, Provider}, and for the purpose of convenience, Consumer=1, Provider=2. There is only one coalition that they can make $x(N)=x_1+x_2=x(S)$ and $v(N)=v(1,2)=v(S)$, where x_1,x_2 are the profits of the consumer and the provider respectively. Table 3.1 shows a consumer's profits. Here C_0, C_1, …, C_5 are the costs of the consumer. For instance, C_3 is the cost of 3 units of goods. If the consumer pays 9 units of fund, the consumer's remaining fund will be: $15-C_3=6$ and he/she obtains 3 units of goods from the provider. So the gained benefits are 12. So the consumer's profits amount to 18 (i.e.$x_1=15-C_3+12=18$), when he/she pays C_3 units of the fund to get 3 units of goods.

Table 3.2 Characteristic Function

Product Sold	**Consumer's Benefit**			**Provider's Benefit**		
	Product	Fund	Sum	Product	Fund	Sum
0	0	$15 - C_0$	$15 + C_0$	15	C_0	$15 + C_0$
1	7	$15 - C_1$	$22 + C_1$	14	C_1	$14 + C_1$
2	10	$15 - C_2$	$25 + C_2$	13	C_2	$13 + C_2$
3	12	$15 - C_3$	$27 + C_3$	11	C_3	$11 + C_3$
4	13	$15 - C_4$	$28 + C_4$	7	C_4	$7 + C_4$

Table3.2 shows the provider's characteristic function. Because the provider offers 3 units of goods to the consumer, his/her benefit remains 11. However, his/her fund increases to 9 units, and his/her profit is:$x_2=11+C_3=11+9=20$, when he/she offers 3 units of goods to

exchange C_3 units of fund. Note that the fund has no influence on the derivation of the coalition sums, as the sum=$x_1+x_2=27-C_3+11+C_3=38$, but the fund affects individual gains.

In Table 3.3, *v*(S) is the maximum of total utility in the set, which are 38 units of fund. It occurs in the trade when the provider offers 2 or 3 units of goods to the consumer. In the 2-person game, only one coalition can be formed, that is {1, 2}. Therefore *v*(N)=*v*(S), so algebraically the core of this 2-person game is the line *ab*: $x_2=38-x_1$. The line is bounded by $x_1 \geq 13$ and $x_2 \geq 15$.

Table 3.3 Total Characteristic Function

Product Sold	**Benefit of**		**Total Utilities**
	Customer	**Provider**	
0	15 - C_0	15 + C_0	30
1	22 - C_1	14 + C_1	36
2	25 - C_2	13 + C_2	38
3	27 - C_3	11 + C_3	38
4	28 - C_4	7 + C_4	35

Here, an example begins with a 2-person game, a large size core and its possible cost could range from 2 to 14. The unit price for one unit of product is from 0.67 to 4.67 units of fund and the average price is 2.67. The large size of the core is problematic, as the possible deals lying at any point on the line *ab* can be selected by the consumer and the provider. A possible solution to this type of problem is the application of bargaining theories. However, it depends on the bargaining powers of the consumer and provider. If a deal is reached that is close to the point *a*, the provider can gain more utilities. If the final deal is moving towards the point *b*, the consumer has the advantage.

There is the possibility of a situation arising where no deal can be agreed upon when there is no existing ‘equilibrium’ in the market. The economic term ‘equilibrium’ is “a state in which opposing forces or influences are balanced” (*The New Oxford Dictionary of English* 2010). In this state, an ‘equilibrium price’ or best price is established through competition so that “the quantity of goods producers wish to supply matches the quantity demanders want to purchase” (*Dictionary of Finance and Investment Terms* 2007). Alternatively, a unique stable solution can exist by expanding the market to include more consumers and providers. As the size of the market increases from the growth of consumers’ demands and providers’ supplies, it is likely that more market conditions will be imposed. This could lead to a single and unique solution.

This paragraph describes an expanded market that includes 4 players instead of 2. In this case, there are 2 identical consumers and 2 identical providers, so N={1,1,2,2}. Table 3.4 describes the total profit that each coalition can make and indicates the line segment for each coalition. Coalition C3, {1,1,2}, contains two identical consumers and one provider. Its total utility *v*(S) is 58. Line segment *ef* is the benefit trade-off of the coalition.

Table 3.4 Profits of Two-Consumer-to-Two-Provider Coalitions

S	Coalition	*v*(S)	Line	Pareto Efficiency
C1	{1, 2}	38	ab	N
C2	{1, 2, 2}	54	cd	N
C3	{1, 1, 2}	58	ef	N
C4	{1, 1, 2, 2}	76	ab	Y

This market game can be concluded as a non-empty core game, because *v*(N) is always the maximum of *v*(S), which is 76. Coalition C3, {1, 1, 2, 2}, is the core because it is the state of 'Pareto Efficiency'. This is derived from the following steps:

$v(N)=\lambda_{C1}\times v(C1)+\lambda_{C2}\times v(C2)+\lambda_{C3}\times v(C3)+\lambda_{C4}\times v(C4)$, so $\lambda_{C1},\lambda_{C2},\lambda_{C3},\lambda_{C4}$ are 0,0,0 and 1,

because $\Sigma_{S\in B,S\ni i}\lambda_S=0+0+0+1=1$,

and $\Sigma_{S\in B}\lambda_S v(S)=0\times 38+0\times 54+0\times 58+1\times 76=76$,

so $v(N)\geq\Sigma_{S\in B}\lambda_S v(S)$.

Since this market game now has a non-empty core, the next step is to examine whether there is any unique core in the game.

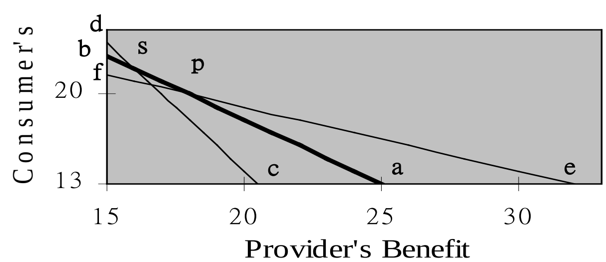


Figure 3.1 Multiple Cores

In Fig. 3.1, the line *ab* intersects the line *ef* on the point *p* and the line *gh* on the point *s*. According to the definition of core, x(S) is not less than *v*(S). All of the allocations on the line *pa* are dominated by those on the line *pe*. So the solutions in the line *pa* cannot be the solution in this game, and neither are those in the line *sb*. The core of a 4-person coalition falls on the smaller line segment, *ps*. As a result, the core can be any point on the line *ps*. In this case, the number of possible solutions has been reduced but multiple choices still remain. So, an ideal solution has not been identified within a 4-person game.

This indicates that the size of the market is not sufficiently large to produce a solution. So, in our example we increase the market to consider 6 participants, 3 providers and 3 consumers.

Table 3.5 Profits of Three-Consumer-to-Three-Provider Coalitions

S	Coalition	*v*(S)	Line	Pareto Efficiency
C1	{1, 2}	38	C	N
C2	{1, 2, 2}	54	A	N
C3	{1, 1, 2}	58	E	N
C4	{1, 1, 2, 2}	76	C	N
C5	{1, 1, 2, 2, 2}	93	B	N
C6	{1, 1, 1, 2, 2}	97	D	N
C7	{1, 1, 1, 2, 2, 2}	114	C	Y

Table 3.5 shows all the possible coalitions for a 6-person game. The 6-person game shows a unique core. The point *t* is the intersection of the lines *B*, *C* and *D* (see Fig. 3.2). Every point on the line *C* except point *t* is dominated, either by line *C* or by line *D*. The core of the 6-person game is just one allocation precisely at point *t*. This is a competitive equilibrium, which is a state of balance between supply forces and demand forces (Arthur and Sheffrin 2003).

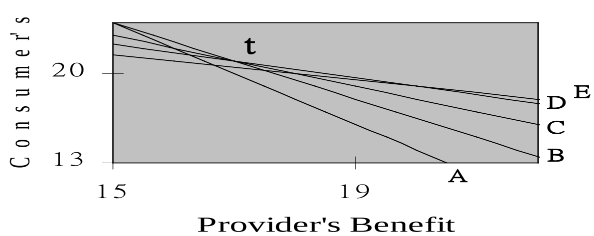


Figure 3.2 Unique Core

As no other coalitions can do better than the point *t*, the deal can be made by the consumers and the providers with the equilibrium price - the consumer pays 2 units of fund to exchange 3 units of product with the provider. The unique core solution may identify a subset, which can produce a maximum joint efficiency and a stable allocation. In addition, the members in the coalition can achieve their best gains.

There are consumers and providers in the above games, thus the games can be regarded as markets. In 2-person and 4-person games, there are many solutions for the participants. So they are games with multiple cores. When it comes to the single solution in the 6-person game, the market becomes a unique core game. In other words, a market needs at least a certain amount of participants to reach the state of equilibrium and to come to the equilibrium price for the participants. Consider the Three-Consumer-to-Three-Provider Coalitions again. There are 8 states in this six-person coalition. Since v(C7)=114 is the highest, the state of {1, 1, 1, 2, 2, 2} is the core .

Table 3.6 Pareto Efficiency in Six-person Coalition

S	Coalition	v(S)	Pareto Efficiency
C0	{}	0	N
C1	{1, 2}	38	N
C2	{1, 2, 2}	54	N
C3	{1, 1, 2}	58	N
C4	{1, 1, 2, 2}	76	N
C5	{1, 1, 2, 2, 2}	93	N
C6	{1, 1, 1, 2, 2}	97	N
C7	{1, 1, 1, 2, 2, 2}	114	Y

The results of the games were produced by a PC in the Windows XP environment. All the games were implemented into Java programs. The above figures were drawn up using Microsoft Excel according to the outputs of the java programs. Only one type of consumer and provider are involved in the games. This seems unrealistic and it is not the case in real-world markets. However, it simplifies the computation process of the core and makes the way the core works easy to understand.

3.1.3 Advantages and Problems of the Core

The core has become an essential solution concept in the area of cooperative games and modern economics. This is due to its incentive compatibility and additionally, the way it finds stable sets is more appropriate (Gillies 1953). By examining the simple market games, the advantages of the core can be revealed.

A stable set is usually difficult to find. However the core provides an appropriate way to find a stable set in the simple market games. In order to form a stable coalition, the profits of providers and consumers must be optimised so they can reach equilibrium. In addition, the maximisation of their joint efficiency should be considered. The fact is that no matter how complex a model is, it is useless for an e-market when coalitions are unstable and doomed to fall apart. Researchers in computer science realise that a useful coalition model for e-markets should consider not only less computational complexity but also the incentives of each selfish participant.

Undoubtedly, providing a way to find a stable set is one of the advantages of the core. In a cooperative game, subgroups are formed to maximise the overall expected utility. Researchers assume participants are cooperative. However, there may be no motivation for an individual to join a coalition. On the contrary, the members are willing to stay in the core, not because they are cooperative, but because they have incentives, which is their own profit. In the simple market games, the core maximises not only the joint efficiency of the core, but also the profits of each member of the core. It gives the members an incentive to stay in the core. In other words, the cooperation in the core is not forced. Incentives need to be given to the customers of the core. The sellers are also the members of the core and they stay because there are potential buyers in the core. So another advantage of the core is that this may be helpful in drawing many consumers and providers to coalitions in e-markets if the core gives them incentives to be cooperative. More incentives for traders in this research are discussed in section 3.2.

Compared with other research in group-buying or joint-selling, the core provides a bigger picture. A stable coalition is a coalition with a stable set. The reason, why the coalition is stable, is that the members in the coalition can attain an equilibrium price or best price. The equilibrium price is a great incentive for the members and it is the best price that makes them stay in the core. Without putting two conflicting parties together i.e. buyers and sellers in the same coalition, the equilibrium price will never be reached and also there will not be any chance to determine whether the coalition is stable or not.

Altogether, there are two advantages of the core. Firstly, it presents a way to find the stable set, which is a set with stabilities. Secondly, its incentive compatibility makes it applicable to real-world markets. The fact that it has these two advantages shows that the core provides some good points towards solving the coalition problems in e-markets:

1. A coalition should include all the traders in a market, not just buyers or sellers.
2. An equilibrium price needs to be found in order to stabilise the coalition.
3. It is important to give incentives to people for them to form a coalition. This is one of the crucial factors for success in e-markets.

Despite the advantages of the core, no practical applications of the core can be found in use today in e-markets, as the core may be difficult to use. As shown in the previous subsection, the core needs to calculate all the results of the subgroups in order to find the one core, which has the best result out of all the subgroups. This seems to be a reasonable way to solve coalition problems. However, the core has at least three problems which hinder researchers from applying it to the real market place.

The first problem concerns the input information. It does not seem as important as the other two followed problems, but it needs to be solved in order to apply the core in the marketplace. In the above market games, the traders' marginal utility functions, which are shown in Table 3.1, describe the values which traders are willing to pay for the goods, or to sell them for. In practice, collecting such information can be a big problem in the real marketplace.

The second problem for applying core in e-markets is its high computational complexity. As illustrated in the previous subsection, the way to find the core is to go through all possible subgroups, and to select the best situation, in which the most profit can be obtained, not only by the coalition but by each member of the coalition. The process to find a core in a coalition is classified as an NP-complete problem (Faigle *et al*. 1997), which means it can be too complex to find a core in a large coalition. For example, it took a long time for the java program to decide the core and find the price for the participants with 20 identical providers and 20 identical buyers in the simple game (Sun *et al.* 2006). The computational complexity is so high that it is hard to imagine how long it would take to determine solutions when dealing with large numbers of participants.

The third problem occurs when there is no stable set in a coalition. The core may exist in different forms, a unique-core game, a multiple-core game or an empty-core game (Curiel 1997). If a cooperative game has a unique core, it is called a unique-core game. The core is a stable set, which may be a subgroup of the coalition. The members in the core are the winners in the market place, since allocations in the core satisfy efficiency and stability. The amount of profit makes the core efficient enough to keep the members in it. A multiple-core game has more than one core in the game. One of the cores in the game may be the winner in the market place. Thus far, research cannot confirm whether the core is stable or not, because a number of qualifying conditions have to be satisfied first (Gellekom *et al*. 1999). Sometimes no stable set can be found in a coalition at all.

It may be the case that there is no stable core in marketplaces. In the exercise in subsection 3.1.2, the utility functions were carefully designed for the consumers and providers, with the result that a stable core appears. As the number of providers and consumers increases, the total utility will not increase in proportion and the individual gains will not be improved. When no core can be found in a game, it is an empty-core game. An empty-core game is unstable, because no solution can be reached in the game at all. This turns out to be a big problem for brokers, sellers and buyers - all the efforts will be in vain if no deal can be agreed in a marketplace. In other words, no one can get any profit from a coalition with an empty-core.

So, there are three problems in applying the core to e-markets. Firstly, in order to locate the core, the market information has to be transparent and public. How to collect the traders' marginal utility functions will be a practical problem in e-markets. Secondly, the core can be effective only when the coalition is small. The computational complexity of the core can sometimes become a big problem to deal with in e-markets, because coalitions on the Internet may be large. Thirdly, the problem can be even bigger, if a coalition has an empty core and is unstable. It can be devastating for participants on an e-market if no deal can be agreed. The problems are not just weaknesses of the core. They can be fatal to its application in e-markets. How to overcome the problems of the core and create a core-based model to solve online group-trading problems will be discussed in the following section.

3.2 Solutions for the Core

Solutions for the three main problems of the core are given in this section. The first problem is the difficulty to collect the marginal utility functions from customers and providers. Instead of marginal utility functions, some common market information is used to find the core of a coalition. Since they are publicly available information in e-markets, brokers can easily collect them and calculate the total benefit of a coalition and the gains of each member. In this research, price lists and orders are collected,

1. Price lists: They contain the prices and volume discounts of the products which are offered by providers. A volume discount is a discount that a seller gives to a customer for buying a large quantity of an item. Just like marginal utility functions, price lists show the profits the sellers wish to gain from selling a good or service.
2. Orders: They contain the amounts and prices of items which the buyers promise to pay for. In order to let customers reveal the price they are willing to pay for certain amounts of items, just like marginal utility functions do, there is a special field called 'expected discount' in customers' orders. This field allows customers to place the orders without committing to buy the items. The system will wait for the final discount to be settled and decide whether the purchase should go ahead or be dropped, by comparing the final and expected discount.

The techniques which listed in subsection 3.2.3 are the solutions to the second problem of the core relating to its high computational complexity in a large coalition. A stability check, which is given in subsection 3.2.1.1, can detect and prevent a coalition with an empty core and turns out to be an effective way to solve the third problem of the core.

Providing solutions to the three problems of the core is not the sole intention. This research has been working on a new approach to making the core applicable to real world e-marketplaces. The core is by nature working within a coalition, so that it is incapable of dealing with coalition problems in multiple e-markets, in which incentive compatibility, distributed computing, and less computational complexity are all highly relevant, some solutions for these problems are introduced in this section.

The main aim of this research is to build a workable core-based group-trading model for the Internet, so that three problems relating to online coalitions have been investigated. In subsection 3.2.1, methods for providing incentives for traders to join coalitions in e-markets are suggested. In subsection 3.2.2, two main reasons for using a distributed system in this research are discussed: the very nature of the model requires the use of the internet to allow communications amongst several computers and the use of a distributed system in this research is to reduce computational complexity. Solutions for the high computational complexity of coalition problems in e-markets are discussed in subsection 3.2.3.

3.2.1 Incentives

In the real world, selfish individuals are concerned more about their own benefit than that of the rest of the coalition together. In an e-market, the people who are worse off will choose to desert the coalition, and in consequence, the coalition disintegrates. It is not too difficult to understand the incentive that makes people collaborate and join the same group. ‘Volume discount’ can bring two opposing parties together for collaboration.

Volume discounts attract customers. In Table 3.7, a 35 percent discount is applied to 30 to 49 units of an item. If the number of units increases to more than 130, the discount is 60 percent. Unlike a fixed discount in group-buying sites, there is an even stronger incentive here for buyers to purchase large quantities of an item. They are also more likely to join a coalition to get more discounts there. On the other hand, a volume discount reduces the profits of sellers for each buyer. When sellers offer volume discounts to buyers, the sellers reduce the cost by selling their products more quickly. It also brings more profits to sellers by selling more units to buyers with incentives.

Table 3.7 Volume Discounts

Number	**0-9**	**10-29**	**30-49**	**50-79**	**80-99**	**100-129**	**130--**
Discount	0%	30%	35%	45%	50%	55%	60%

Providing incentives is always a good means for attracting traders to e-markets. There are at least three incentives for traders to join e-markets in the model: a volume discount, an equilibrium price and a fair distribution. An equilibrium price can be a good incentive for the participants in a coalition. However, the consequences can be devastating if no equilibrium price is agreed in an e-market. A stability check has to be introduced to ensure that the best price can be worked out in a coalition. Before coalitions are combined into larger coalitions to bring greater discounts for customers and more profits for sellers, they have to be checked for their stability to avoid an empty core. The Shapley value is also introduced to distribute the profit to each provider in a coalition fairly.

3.2.1.1 Stability

A coalition with an empty-core is a big problem because no deal can be agreed in a marketplace. A stability check is a solution to this difficulty, which is also the third problem of the coalition with non-deterministic cores. In cooperative games, the stability of cores has been one of the most notorious unsolved problems. It is important to have a stable coalition, for a game with an empty core is to be understood as a situation of strong instability, as any profits that a coalition might have are vulnerable. Detecting the stability of a coalition is crucial in this research. Without an equilibrium price, the members may lose their interest in remaining in the coalition. Determining the stability of the core is a NP-complete problem (Conitzer *et al* 2003). Attempts to solve the above problem seemed to have failed but recent research has showed that a balanced game will always have a stable core (Jain and Vohra 2006).

An important sufficient condition for the non-emptiness of the core is that it is balanced. Let a cooperative game $<N,v>$ be balanced. Then $C(N,v)\neq 0$ (Scarf 1967). From the classical Bondareva-Shapley theorem, a cooperative game has a non-empty core if and only if it is balanced (Bondareva 1963). A game is balanced if, for every balanced collection B, there are weights $\{\lambda_S\}_{S\in B}$ and the following condition holds,

$$v(N)\geq\Sigma_{S\in B}\lambda_S v(S).$$

A collection B is called a balanced collection if

$\exists(\lambda_S)_{S\in B}\forall i\in N\ \Sigma_{S\in B,S\ni i}\lambda_S=1$, where $(\lambda_S)_{S\in B}$ is a vector of positive weights.

Here a simple market game is used in chapter 2 with a coalition of 2 consumers to 2 providers is used as an example here. According to the profits shown in Table 2.4,

$$v(N)=76, \text{ and } v(S1)=38,\ v(S2)=54, v(S3)=58, v(S4)=76$$

$$\text{if } \lambda_{S1}=0.4, \lambda_{S2}=0.3, \lambda_{S3}=0.2 \text{ and } \lambda_{S4}=0.1 \text{ are assumed,}$$
$$v(N)=76\geq\Sigma_{S\in B}\lambda_S v(S)=0.4\times 38+0.3\times 54+0.2\times 58+0.1\times 76=50.6$$
$$\text{and } \Sigma_{S\in B,S\ni i}\lambda_S=0.4+0.3+0.2+0.1=1.$$

So the coalition of 2 consumers to 2 providers is proven to be stable. It is fairly easy to check the stability of a coalition with a computer.

Actually, if condition, $v(\mathrm{N}) \geq v(\mathrm{S})_{\mathrm{S} \in \mathrm{B}}$, holds, the game can be proven to be balanced. Assume there are r subsets in the game.

$$v(\mathrm{N}) = (1/r) \times r \times v(\mathrm{N}) = (1/r) \times \Sigma_r v(\mathrm{N}) = \Sigma_r ((1/r) \times v(\mathrm{N})).$$

Replace v(N) with v(S).

$$v(\mathrm{N}) = \Sigma_r ((1/r) \times v(\mathrm{N})) \geq \Sigma_{\mathrm{S} \in \mathrm{B}} ((1/r) \times v(\mathrm{S})) \text{ and } \Sigma_r (1/r) = 1.$$

In other words, for a coalition N, if the coalition's v(N) is greater than v(S) and S is one of its subsets, the coalition is proven to be stable.

In the CBM, any coalition that fails the check will be rejected. Now that the unstable coalitions have been excluded, it is certain that traders can make a deal using the stable ones. An e-market, where deals can always be made, may attract traders to come. A larger coalition, which combines more than one coalition together, can bring more profits to its members, as long as it can pass the stability check. This also raises another issue about how to distribute the profits fairly amongst the providers. In the next subsection, the Shapley value is introduced to solve this problem.

3.2.1.2 Shapley Value

In cooperative games, Shapley value presents a fair and unique way of solving the problem of distributing surplus profit amongst the players in a coalition, by taking into account the worth of each participant (Shapley 1953). The following four axioms for the solution were proposed by Shapley:

1. **Efficiency –** all the surplus profit of a coalition is fully allocated.
2. **Symmetry –** players with the same contribution should be treated equally.
3. **Additivity –** the total outcome of two coalitions must be equal to the profit from each of these two coalitions added together.
4. **Dummy player –** if players contribute nothing, they get nothing.

To formalise the above situation, assume a coalition N (of |N| players), and a function $v: S \rightarrow \mathfrak{R}$, that is, a so-called 'worth function', going from subsets S of coalition N to real numbers, with the following properties,

1. $v(\emptyset)=0$
2. $v(S+T)=v(S)+v(T)$, whenever S and T are subsets of N.

If the members of coalition S agree to cooperate, then v(S) describes the total expected gain from this cooperation. The first property expresses that a null coalition gains nothing. The second property describes an additivity, which expresses the fact that collaboration can only help but never hurt. The amount that player i gains,

$$Sh_i(N)=\mathbf{\Sigma}_{\mathbf{S\subseteq(N\backslash\{i\})}}(|S|)!(|N|-|S|-1)!\div|N|![v(S\cup\{i\})-v(S)].$$

Assume that three players, player 1, 2 and 3, decide to perform joint-selling. Table 3.8 shows the worth functions of individuals and coalitions. As you can see, the v(S) of {} is 0. It means that there is null output when no one provides any input. Also, the v(S) of {1, 2} implies the profit of the coalition of providers 1 and 2 is 47.

Table 3.8 Worth Functions

S	{}	{1}	{2}	{3}	{1, 2}	{1, 3}	{2, 3}	{1, 2, 3}
v(S)	0	20	20	40	47	65	70	90

According to the Shapley value, the gain of provider 2 is,

$Sh_2(\{1,2,3\})=(0!2!(v(\{2\})-(v(\{\}))+1!1!(v(\{1,2\}-v(\{1\})+v(\{2,3\})-v(\{3\}))+2!0!(v(\{1,2,3\})-v(\{1,3\}))\div 3!=24.5.$

Do likewise to the other two players. So the gains of players 1, 2 and 3 can all be worked out, and they are 22, 24.5, and 43.5 respectively. The sum of the gain of each player is 22+24.5+43.5, which is equal to 90, and this is the same as v({1, 2, 3}). This shows the efficiency of the Shapley value, because it distributes all the gain of the coalition to the players.

Table 3.9 Subsets

Code	Binary	Provider			Subset	Contribution	Size	Coefficient
		3	2	1				
0	000	-	-	-	{}	v({})	0	-
1	001	-	-	Y	{1}	v({1})	1	0!2!/3!
2	010	-	Y	-	{2}	v({2})	1	0!2!/3!
3	011	-	Y	Y	{1, 2}	v({1, 2})	2	1!1!/3!
4	100	Y	-	-	{3}	v({3})	1	0!2!/3!
5	101	Y	-	Y	{1, 3}	v({1, 3})	2	1!1!/3!
6	110	Y	Y	-	{2, 3}	v({2, 3})	2	1!1!/3!
7	111	Y	Y	Y	{1, 2, 3}	v({1, 2, 3})	3	2!0!/3!

Table 3.9 shows the list of the 2^3=8 subsets, which are coded from 0 to 7. By analysing these codes, the size and members of each set can be revealed. For example, subset 3 consists of player 1 and player 2, which are denoted as {1, 2}. After code 3 is converted into binary, i.e. 011_2, the way to find out its members becomes clear. The first and second bits of the binary code are 1, so its members are player 1 and player 2 and the size of this set is concluded to be 2. Therefore the coefficient for subset 3 is (2-1)!(3-2)!/3!=1!1!/3!.

The pseudocode in Table 3.10 was designed to calculate the Shapley Value of the members of a coalition. The input parameters of the function are ‘count’ and ‘contribution’, in which store the size of a coalition and the *v*(S) of each subset in the coalition. The output of the function is ‘Shapley’, that is an array storing the Shapley Value of every member in the coalition. After the size and coefficient of every subset are figured out, the Shapley Value for each provider can be worked out. A program in Table A9.1 was implemented according to this pseudocode.

Table 3.10 Pseudocode to Calculate the Shapley Value

```
procedure calculateShapleyValue(count, contribution)

setNo=2^count;
// calculate size and coefficient of each subset
for code=0 to setNo -1
{
    size[code]=0;
    for i=0 to count-1
        if((code/2^i)%2=1)
            size[code]++;
    coefficient[code]=(size[code]-1)!*(count - size[code])!/count!;
}
// calculate the Shapley Value for each members
for i=0 to count -1
{
    Shapley[i]=0;
    for code=0 to setNo-1
    {
        output=0;
        if((code/2^i)%2=1)
             output=contribution[code]- contribution[code-2^i];
        Shapley[i]+=coefficient [code]*output;
    }
}
return Shapley;
```

The Shapley value is a key solution concept for coalition problems. In this research, the profits of providers are calculated by Shapley Value according to their contributions to the group-trading. Its main advantage is that it provides a unique and fair solution. However, it can be a NP-complete problem itself in computing solutions for some games (Deng and

Papadimitriou 1994). The Shapley value has the same drawback of high computational complexity as the core in a large coalition. But just as the computational problem of the core is dealt with in this research, the drawback of the Shapley value is also resolved.

An advantage of the Shapley value is that everyone gets what they deserve. Increasing the profits by combining cores into a larger core can give an incentive to traders. As long as the total benefit of a coalition and contributions of members are given, the gains of each participant can easily be calculated. It provides another incentive for traders to join the coalition, if they know they will get their fair share.

Shapley value "is the most studied and widely used single-valued solution concept in cooperative game theory" (Perez-Castrillo and Wettstein 2001). And the client-server networking model which is, without question, the most widely implemented model in real-world environments (Zhang 2003), is introduced in the next section.

3.2.2 Distributed Computing

In distributed computing, a problem is divided into many tasks, so it can be solved by multiple network-connected computers. A distributed system uses "a number of independent computers linked by a network" (*The New Oxford Dictionary of English* 2010). In e-markets, the computers are self-governing and interact via a large computer network, i.e. the Internet, and they communicate with each other by message passing (Ghosh 2006). One of the crucial issues for this research is how to build an appropriate online distributed system. During the process of refinement, a Web distributed system based on the model was implemented to show that the foundational principles of this research were workable both in logic and in practice.

Since the potential number of traders in e-markets may be large, the computational complexity in a large coalition can be very high and this can cause many problems in an e-commerce project. The main contribution that many researches in distributed computing have made is that they have provided ways of reducing computational complexity (Foster and Kesselman 2004). One of the common solutions was applying the concept of 'divide and conquer'. Researches show that less computational complexity can be achieved by dividing a coalition into several small sized sub-coalitions (Yamamoto and Sycara 2001). These coalitions are then assigned to different computers connected to the same network or on the Internet. Dividing a coalition into small sized sub-coalitions is a good way to lessen computational complexity. However, it is an NP-complete problem as well (Sung and Dimitrov 2007). It is not a proper solution for this research.

In one of my papers, an effective way is applied to accomplish the job by using the concept of combining multiple e-markets to maximise traders' benefits was introduced (Sun *et al.* 2006). Suppose that there are 14 orders for 3 providers, who offer 10 different products. Consider the pseudocode in Table 3.11. In a single e-market, it takes 14×10×3×10=4200 steps to calculate the total price for every order.

Table 3.11 Pseudocode to Calculate the Total Prices of Orders

```
procedure calculateOrderPrice(provider, providerProduct, order, orderLine)

/* For each provider, there are providerID, providerName, providerProfit and providerProductNo */
/* For each provider product, there are providerProductID, providerProductStock, providerProductSold, providerProductPrice and providerProductCost */

/* For each order, there are orderID, orderDate, orderLineNo,orderCustomerID and orderProviderID */
/* For each order line, there are orderProductID, orderQuantity, orderActuralQuantity orderDiscount and orderExpectedDiscount */

for i=0 to orderNo-1
{
    total[i]=0;
    for j=0 to orderLineNo-1
    {
        for k=0 to providerNo-1
        {
            If(orderProviderID[i,j]=providerID[k])
            {
                for m=0 to providerProductNo-1
                {
                    If(orderProductID[i, j] = prividerProductID[m])
                        total[i] += orderActuralQuantity[i, j]*(1-orderDiscount[I,j])*providerProductPrice[k, m];
                }
            }
        }
    }
    report total[i];
}
```

Because solving the high complexity problem in the core is a crucial task, which has to be resolved in the CBM, a solution to the problem in e-markets is to exploit the nature of online distributed systems. This is explained in the following paragraphs through comparing the computational complexity between a single e-market and a four-e-market scenario. In this research, in order to simplify the complexity, an assumption has been made, which is that an order can purchase goods from one provider only. In Fig. 3.3, the providers' coalition$_0$ offers volume discounts to buyers. Assume there are p buyers' coalitions in the series from buyers' coalition$_1$ to buyers' coalition$_p$. These are assembled on e-market$_1$ through to e-market$_p$ respectively. The buyers' coalition$_0$ holds the orders from the buyers who are in buyers' coalition$_1$ and buyers' coalition$_k$. The core consists of providers' coalition$_0$ and buyers' coalition$_0$. When these two forces which were working against each other before, are put together, the equilibrium price for every item can be reached. In this equilibrium, the providers gain their best profits and the buyers also have their best discount. The buyers' coalition$_0$ contains the winning coalitions: these are the buyers' coalitions which fall in the core.

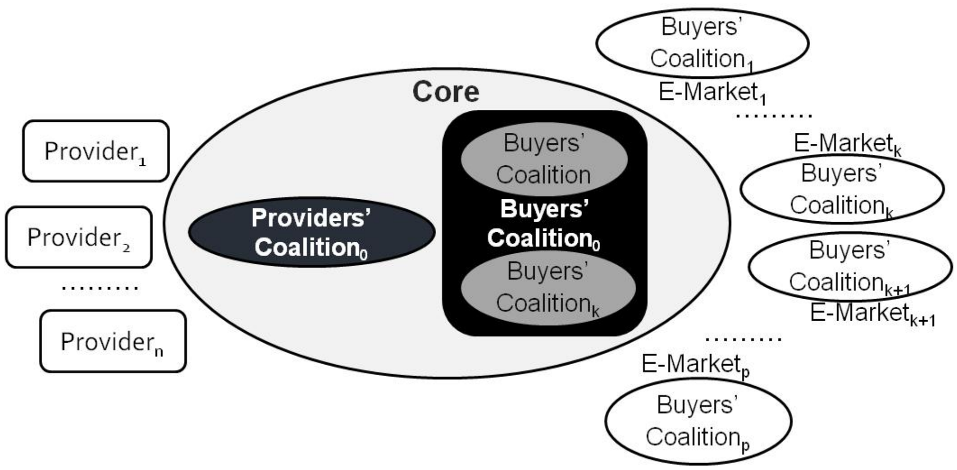


Figure 3.3 Combing E-Markets

Table 3.12 Pseudocode to Joint Providers

```
procedure jointProviders(providerNo, provider, providerProduct)

count=0;
for i=0 to providerProductNo[providerNo]-1
{
    for j=0 to providerNo-1
    {
        sumPrice=0;
        sumCost=0;
        providerProductStock [providerNo, count]=0;
        for k=0 to providerProductNo-1
        {
            sumPrice += providerProductPrice[j, k]*providerProductStock[j, k])
            sumCost += providerProductCost[j, k]*providerProductStock[j, k])
            productProductStock[providerNo, count] += productProductStock[j, k]
        }
        providerProductPrice [providerNo, count] =0;
        If(sum!=0)
        {
             providerProductPrice [providerNo, count] = sumPrice/ providerProductStock[providerNo, count];
             providerProductCost [providerNo, count] = sumCost/ providerProductStock[providerNo, count];
             count++;
         }
    }
}
report provider[providerNo], providerProduct[providerNo];
```

Instead of dividing an e-market into many, the new model combines multiple e-markets into a big one by forming a big provider and a big buyer. After merging the offers in a provider coalition, a big provider holds the combined supplies of all the providers, all of whom have signed an agreement to be the suppliers of a project. The pseudocode in Table 3.12 provides a way to combine the stock of all the providers together and to calculate the average unit price and cost for each product.

Table 3.13 Multiple E-Markets

***A1*(B1)**	***A2*(B2)**	***A3*(B3)**	***A4*(B4)**
O11	O21	O31	O41
O12	O22	O32	O42
O13	O23		O43
	O24		O44
			O45

O1	O2	O3	O4

OO

As shown in Table 3.13, four different e-markets denoted as *A1*, *A2*, *A3*, and *A4* have their own broker to take care of them, namely B1, B2, B3 and B4. These e-markers attract various consumers to themselves independently. By operating in this way, future division into smaller sub-coalitions can be avoided.

Table 3.14 Pseudocode to Combine Orders

```
procedure combineOrders(orderNo, order, orderLine)

count=0;
maxExpectedDiscount=0;
orderID[orderNo]='OO';
orderProviderID[orderNo]='Sun';
for i=0 to providerProductNo[providerNo]
{
    sum=0;
    aSum=0;
    for j=0 to orderNo-1
    {
        if(orderExpectedDiscount[j]>maxDiscount)
            maxExpectedDiscount=orderExpectedDiscount[j];
        for k=0 to orderLineNo-1
        {
            If(orderProductID[j, k]=productID[i]);
            {
                sum+=orderQuantity[j, k];
                aSum+=orderActuralQuantity[j, k];
            }
        }
    }
    if(sum!=0)
    {
        orderProductID[orderNo, count]= productID[i];
        orderQuantity[orderNo, count]=sum;
        orderActuralQuantity[orderNo, count]=aSum;
        orderExpectedDiscount[orderNo, count]=maxExpectedDiscount;
        orderDiscount[order, count]=findDiscount(productID[i], aSum);
        if(orderDiscount[order, count]< maxExpectedDiscount)
            orderDiscount[order, count]=0;
        count++;
    }
}
orderDate[orderNo]=currentDate;
report order[orderNo],orderLine[OrderNo];
```

In this multiple e-markets scenario, instead of one big coalition, 4 smaller coalitions are dealt with in the e-markets' computers at the same time by using the pseudocode in Table 3.11. There are 3, 4, 2 and 5 orders being drawn to e-markets *A1, A2, A3* and *A4* respectively. By using the pseudocode in Table 3.13, the orders O11, O12 and O13 from e-market *A1* are combined into order O1. On the similar basis, O2, O3 and O4 are produced. Finally, O1, O2, O3 and O4 become an integrated order OO. It takes 10×(3+4+2+5+4)=180 steps to combine the orders. As a result, there are only two participants in the core and it takes 1×10×1×1=10 steps to calculate the total price for order OO. It only takes 180+10=190 steps to complete the task. By sharing workload in multiple e-markets, the complexity of computation can be reduced. This is an efficient way to cut down the complexity of e-trading problems.

In the next section, computational complexity is studied. A larger size of core means more profits for the traders. To combine the cores into a larger core with no complexity problems is another important goal of this research. Collaborations between traders can reduce the high computational complexity (Xiang *et al.* 2005). The model proposed is a distributed system, which can also help to reduce computational complexity. The issue of distributed systems is raised again in the next section.

3.2.3 Computational Complexity

The term computational complexity can be defined as "a mathematical characterisation of the difficulty of a mathematical problem which describes the resources required by a computing machine to solve the problem" (*The American Heritage Science Dictionary* 2005). The mathematical study of such characterizations is called computational complexity theory and is important in many branches of theoretical computer science (Shehory and Kraus 1999, Rahwan and Jennings 2007).

In computer science, computational complexity is a measure of the time complexity of an algorithm (Papadimitriou 1994). This quantifies the amount of time taken by the algorithm to solve a problem of a given size of input by calculating how many steps or how much time a computer needs to process it. The time complexity of an algorithm is commonly expressed using big O notation, which was popularised in computer science by Donald Knuth in 1976. The formal definition of big O notation is as follows, Let f, g: $N \rightarrow N$ be two functions. Given $f \in O(g)$ if there exists a real number $c > n_0$ and a nonnegative integer n_0, so that for each $n \in N$ with $n \geq n_0$, we have $f(n) \leq c \cdot g(n)$. Alternatively, $f \in O(g)$ if and only if there is a real number $c > 0$ such that $\limsup_{n \rightarrow \infty} (f(n)+1)/(g(n)+1)=c$. So, big O notation hides constant factors and smaller terms, for instance, if $T(n) = 7n^2 + 15n + 40$, in big O notation one would write $T(n) = O(n^2)$.

Computational complexity is also a way to classify a problem according to its inherent difficulty - that is, whether it is ‘quick’ or ‘slow’ to solve. There are problems in four classes of complexity (Goldreich 2010):

- P: It is the class of problems for which have algorithms to provide solutions in polynomial time i.e. they can be solved within a relative short time. The big O notation of their algorithms are $O(n^k)$ and k is a constant.
- NP: It is the class of problems for which have no known way to sort out them quickly, but if one is provided with information showing what the answer is, it may be possible to work out solutions in polynomial time.
- NP-Complete: The problems in NP are neither in P nor NP-complete (Ladner 1975). Thus the problems in this class are the most difficult problems in NP, in the sense that they are hard and have no fast solution (Garey and Johnson 1979).
- NP-Hard: It is the class of problems which are at least as hard as NP-complete problems. NP-hard problems need not be classified in NP.

Many problems encountered when dealing with trading are classified as NP-Complete problems (Luo and Parnas 1994) and the time required to solve these problems easily reaches into billions or trillions of years, when there are many providers and buyers to exchange huge amount of goods in e-markets. This can be as complicated as shown in Fig. 3.4. In practice, the size of coalitions in e-markets can be too large to deal with. As mentioned in section 3.1, finding a core in a coalition is also an NP-complete problem. To reduce the computational complexity is an important issue. In this research, three methods are adopted in the model to reduce the computational complexity of e-trading problems. One way to solve high complexity computational problems is to design the model in such a way that it becomes a distributed system (Lynch 1996).

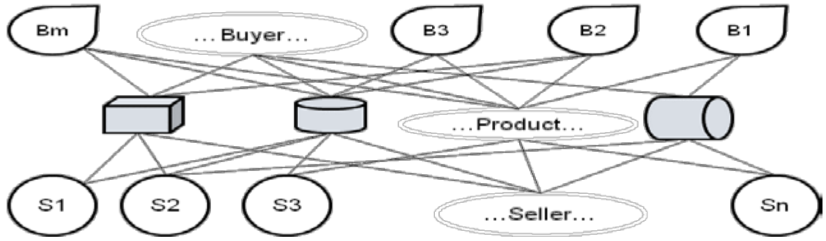


Figure 3.4 Traditional Relationships

Another way this can be achieved is by encouraging traders to collaborate with each other. It has been proven that collaboration between players in games can effectively reduce the computational complexity (Maheswaran and Basar 2003), so collaboration amongst traders will probably be another way to reduce complexity in e-markets. In the next subsection, before this collaboration is discussed, information-hiding needs to be introduced. This is a technique used in the background, behind the collaboration, to deal with the complexity problem in a large coalition as well.

3.2.3.1 Information-Hiding

In computer science, information-hiding is a technique which prevents certain information or software components from being accessible to users. In this research, this technique is used in coalition problems not only to protect market information from other brokers, but also to reduce the computational complexity (Smith and Comiskey 1996). This technique was used in combining multiple e-markets to maximise traders' benefits in this research and the previous works (Sun *et al.* 2012 a).

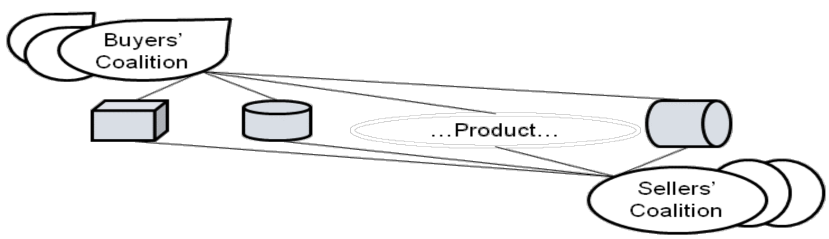


Figure 3.5 Relationships in Collaboration

In Fig. 3.5, the relationship between buyers, providers and goods becomes simple, especially when compared with Fig. 3.4. The offers from a sellers' coalition can be put together and becomes a big seller.

Table 3.15 Three Providers

Provider ID	Product ID	Stock	Price	Cost
P1	T1	32	67	23
	T2	41	47	14
P2	T1	21	65	21
P3	T1	18	59	18
	T2	55	49	15

Table 3.16 A Joint Provider

Provider ID	Product ID	Stock	Price	Cost
Sun	T1	71	64.38	21.14
	T2	96	48.15	14.57

Table 3.15 shows original products offered by the three providers P1, P2 and P3. Broker Sun has all the stocks shown in Table 3.16, after merging providers. The representative called Sun is the new and only seller after the providers are merged. He is the newest provider and therefore put in the last element of the providers' array. The new unit price for each item is the average unit price and the cost of each product averages the cost of the product for all the providers.

Assume there are g goods, p sellers and b buyers in an e-market. It takes $p \times 10 \times b \times g$ steps for the pseudocode in Table 3.11. Its big O notation is $O(n^3)$ when there are many goods, buyers and sellers in the e-market. Now by combining the buyers into one buyer, and the sellers into one seller, the steps for the same pseudocode becomes $1 \times 10 \times g \times 1$. As a consequence, the model just needs to calculate the result between one buyer and one provider and its big O notation is successfully reduced to $O(n)$. The computation therefore becomes trivial and fast.

Who should be the suitable person to present the providers? It is necessary to ensure that this individual is not going to be a potential buyer. A third party such as a broker is recommended by this research for he/she is certainly a better candidate than anyone of the providers. The brokers collect the product information from the providers. Then they put all the offers under their name. Instead of the providers, they now can play as sellers.

In chapter 2, this merging allows the providers to perform joint-selling together, so that they may gain competitive advantages and offer high volume discount to their clients due to low cost. The marginal discounts in Table 3.17 come from the volume discounts in Table 3.7. By checking the minimum quantity in the minimum quantity field, the volume discount for a certain quantity can be known.

Table 3.17 Marginal Discount

Product ID	Margin	Minimum Quantity	Discount
C1	1	10	30%
C1	2	30	35%
C1	3	50	45%
C1	4	80	50%
C1	5	100	55%
C1	6	130	60%

Five orders O1, O2, O3, O4 and O5 shown in Table 3.18, are from buyers in the e-market. Table 3.19 shows that combined order O6 are from the market's broker Ben. The ordered dates on it is the date when the orders are combined, in this case 26 April. So Ben orders products T1 and T2 from provider Sun and the amounts are 3+2+19+18=42 and 14+17+2+5=38 respectively. The 'expected discount' is a special field in the order detail table to be used to decide whether a product of an order will be included or not. When the actual discount of a product in an order is less than the expected discount, the product may be dropped from the order at the end. The maxima expected discount is the final expected discount of the product in the combined order.

Table 3.18 Five Orders

Order ID	Customer ID	Ordered Date	Product ID	Quantity	Expected Discount
O1	Andy01	03/04/2012	T1	3	5%
			T2	14	12%
O2	Ken01	09/04/2012	T1	2	20%
			T2	17	0%
O3	Tom01	11/04/2012	T2	2	8%
O4	Sam01	14/04/2012	T1	19	15%
O5	James01	25/04/2012	T1	18	15%
			T2	5	5%

Table 3.19 A Combined Order

Order ID	Customer ID	Ordered Date	Product ID	Quantity	Expected Discount
O6	Ben	26/04/2012	T1	42	20%
			T2	38	12%

With the sum of all the orders being greater than that of any one individual (Table 3.19) the combined order O6 may get greater discounts from the volume discount actually offered by the providers. As a result, orders from the coalition become a single transaction only. This is a powerful way to reduce the size of coalitions and to speed up the data communication on the internet. In an e-market, it is necessary to hide personal information at the request of individuals and to meet the requirements of Data Protection legislation.

One advantage to gather customers in multiple e-markets is that there is no need to go through the complex process of group division. Another benefit is that it is well suited to the environment of the Internet. A small number of consumers would not be able to gain any bargaining power at all. Through combining small coalitions of e-markets, a larger group can be generated easily. In this way, providers may draw more customers to their joint-selling and gain profits. The process described above has been adopted in the model presented in this work.

The thesis is concerned with cooperative games, where coalitions may enforce cooperative behaviour. The buyers in the five-person coalition can coordinate their strategies to maximise and share the profit. It is beneficial to have representatives like Ben to integrate the strategies of members of a coalition. It is also essential to introduce third-party professional coordinators such as brokers to organise seller coalitions and make them harmonising teams without breaking competition laws.

Collaboration is a process where two or more people or organisations work together for a common goal for their mutual benefit. Using information-hiding can reduce the complexity of a coalition, but collaboration between the participants is essential if this reduction in complexity is to be achieved. In the next subsection, another reason is given for why collaboration is important in this research.

3.2.3.2 Collaboration

In the literature, two relationships are identified: cooperation and collaboration. Cooperation is a term that “assumes two or more parties, each with separate and autonomous programmes, agree to work together in making such programmes more successful” (Hord, 1986). Each cooperating participant remains totally independent, takes no risk, and retains total authority. On the other hand, collaboration is a “mutually beneficial and well-defined relationship entered into by two or more organisations to achieve common goals” (Mattessich, Murray-Close and Monsey 2001). It is a formal relationship involving shared authority and responsibility for planning, implementation, and evaluation of a joint effort. In addition, the risk to each collaborating participant is greater because each member contributes their own resources and reputation.

The collaboration between members of coalitions plays an important role in online group-trading. For example, if there is to be a reduction in complexity, the individual computers in each e-market solving their own part of this big problem need to be linked together and working as part of the group. Otherwise this reduction in complexity cannot happen. Many things need to be coordinated, so that the trading in multiple e-markets can work well and smoothly. Good team work consists essentially of the following roles:

- **Leader**: This is the person who makes sure that the trading is set to a specific schedule, such as which days to close deal and at which time.
- **Recorder**: This person keeps track of what happened during the trading in relation to the project being discussed.
- **Questioner**: This person dares to ask questions that other members might not be thinking about, so that the disadvantages to a decision can be found and the involved risks may be brought up.
- **Harmoniser**: This is a peace maker who creates a harmonious atmosphere and conveys that each participant may have a certain point they want to address.

Since the cooperation between selfish buyers can be unreliable and one provider teaming up with another provider may breach the competition rules, in this research, brokers are introduced to play the above roles. A broker involves one or more than one role. Therefore, the inter-relationship of these roles would need coordinating to ensure the collaboration in coalitions and to smooth the process of group-trading in e-markets.

One of the advantages for buyers when they form a coalition and buy wholesale is that they obtain bulk discounts; this is what the buyers are after, and it gives them the incentive to work together. However, the buyers must depend on someone like broker Ben to transform their coalition into the large buyer. They have to first give Ben the orders, and then he can combine them. When Ben gets the invoice from the provider, the transaction is now his responsibility, and he must figure out the amount each person owes, collect the money, pay the invoice and ask the providers to dispatch the items. The relationship between Ben and each buyer must be more formal than cooperation. Because Ben plays such an important role in the teamwork and holds a position of trust, the buyers may well have a legal agreement with him.

The model proposed will work better with a large number of participants. This is why brokers are brought into use in this research. Sun and Ben are named as brokers and they earn commission by collaborating with the providers and buyers and providing them the service. On the same principle, collaboration between a broker and a coalition of providers can easily lead to a situation where the coalition becomes one very big provider and carries out bundle selling which involves multiple suppliers. In addition, if brokers collaborate with one another, it may be possible for them to find more buyers. For instance, it is good to have several brokers like Ben in different regions. Each broker finds customers locally. This may also save some handling expenses like shipping or tax. If brokers collaborate together well, it will be possible to form a big coalition on a global level and thus to attract in a large number of buyers. In the CBM, the main reason for several brokers working together is that they know that the buyers will get better discounts in a large coalition and providers will gain higher sales. The roles and the main tasks of brokers in the new model will be discussed in the next chapter.

3.3 Summary

'The core' was first proposed by Francis Y. Edgeworth in 1881 as an economics term. It was later defined in game theory terms by Gillies in 1953 indicating the set of imputations under which no coalition has a value greater than the sum of its members' profits. It is important for coalition problems, because it may find a stable set and calculate an equilibrium price. It has been tested and run within simple market games. The results of these games demonstrate that a market needs at least a certain number of participants to reach the state of equilibrium and to come to the equilibrium price for the participants. It also shows the advantages and problems of the core.

Firstly, the core provides a way to find a stable set, which is also a Pareto efficiency allocation. Secondly it gives that set incentive compatibility. It also shows that a coalition should include buyers and sellers to reach an equilibrium price, and this will be crucial in stabilising the coalition. However, it has three problems: (a) no stable set, (b) high computational complexity in a large coalition and (c) difficulty in obtaining input information needed. It does not seem practical to use the core concept in e-markets. Some useful solutions for the problems of the core are introduced by considering incentive compatibility, distributed computing, and less computational complexity.

In the new model, there are at least three incentives for traders: a volume discount, an equilibrium price and a fair distribution. The stability checks and the Pareto efficiency ensure that the traders in e-markets can have the best price. The Shapley value gives the last incentive to traders to join the coalition, because they know they will get their fair share. The new model is a distributed system by nature, because it involves multiple e-marketplaces on the Internet. It is crucial for this research to make efforts towards solving the computational problem in e-markets, because, in practice, the size of coalitions in e-markets can be too large to deal with. In addition to a distributed computing system, information hiding can be also used to solve the problems of high computational complexity. The aforementioned methods were adopted in the new model through the collaboration of the traders in e-markets.

In the next chapter, a new model for group trading in e-markets is proposed. All the concepts mentioned in the present chapter will be included in the proposed model. It will be helpful to discuss the logical processes involved in designing the model to see how these concepts can be blended together theoretically. As the description unfolds it will become clear how combining these concepts together can deliver the basis of a workable group trading site.

Chapter 4

New Core Broking Model

In this chapter, a new group-trading model for e-markets called the Core Broking Model (CBM), is proposed. This new model incorporates the features identified in the conclusions of the previous chapters and are discussed. The CBM is based on the core and adopts other solution concepts to solve the problems of online coalitions. The model involves joint-selling of multiple goods in e-marketplaces, offering volume discount for group-buying coalitions. It inherits the advantages of the core. Additional features incorporated in the new model are presented to ensure that the three problems of the core have been dealt with in section 4.1. These three factors, distributed computing, less computational complexity, and incentive compatibility, are incorporated in the model to resolve the problems associated with trader coalitions on the internet.

The construction of this model is presented in the first section of this chapter. Through a description of the components contained in the main structure of the CBM, the full picture of the CBM can be seen. In the model, besides providers and buyers, there are core-brokers and market-brokers. They play different roles and are important in the trading process. In section 4.2, the profiles of the core-brokers and market-brokers are described. In the real world, a broker functions as an intermediary between parties as they negotiate agreements, purchases, or sales in return for a fee or commissions. Section 4.3 contains a description of how the fees system in the CBM has been set up, so that the providers and the buyers contribute the commission for the brokers.

The model is an online broking system performing functions similar to that of a human broker. In the CBM, there is a Core Broking System (CBS) website, specially designed to support the core-brokers and market-brokers in their tasks of group-trading. In the fees system, the brokers receive a commission by offering their services. How the new model works and what it does are answered more precisely in the overview of the CBM in sections in this chapter.

4.1 Introduction to the CBM

The CBM inherits the core concept and a core in a coalition can also be derived from the same function as the core:

$$C(v):=\{x\in\mathfrak{R}^n \mid x(N)=v(N), x(S)\geq v(S) \text{ for all } S\in 2^N\},$$

However, the CBM creates a virtual market on the Internet by involving multi e-markets. In this virtual e-market, there can be many group-trading projects in the model. Many providers join in the projects and perform joint-selling and sufficient buyers gather in e-markets because they may get the high discounts available in the projects. So there is a healthy level of competition in the virtual e-markets.

The diagram in Fig. 4.1 represents the structure and gives an overview of the CBM. It shows that core-brokers initiate projects, which involve multiple providers, on the CBS website and recruit market-brokers to form a team to work on a session of group-trading. The market-brokers list the project on the appropriate shopping sites and form buyers' coalitions there.

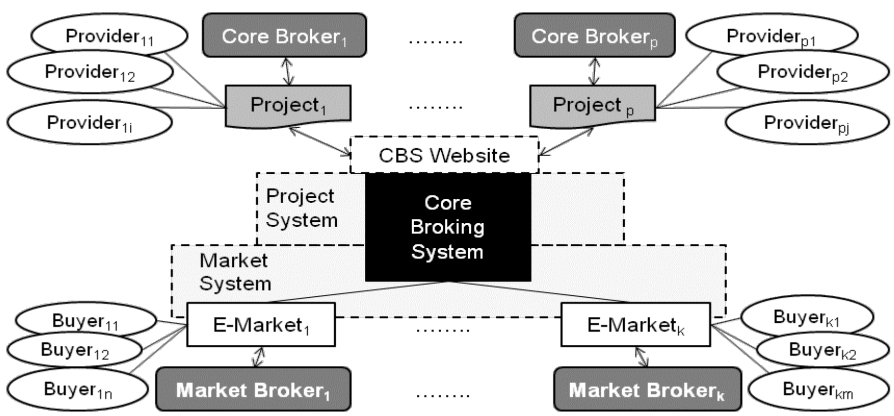


Figure 4.1 Structure of the CBM

The CBM is composed of core-brokers, projects, providers' coalitions, a CBS (Core Broking System), e-markets, market-brokers and buyers' coalitions. The description of each component is as follows:

- **Core-brokers –** the initiators of the group-trading projects.
- **Projects –** sessions of group-trading in e-marketplaces. They involve bundle selling of multiple goods from several providers, offering volume discounts to many different buyers in group-buying coalitions.

- **Providers –** provide products and services for the core-broker.
- **Market-brokers –** professional brokers playing the role of team members in the core-brokers' teams helping them with the group-trading projects.
- **E-markets –** may be any existing online shopping avenues such as eBay, Groupon, Ruby Lane or the market-brokers' own sites on which they can post the projects and find customers.
- **Buyers –** the market-brokers' clients, who have been attracted to the projects.
- **The CBS** consists of three components as follows:
  1. **CBS Website–** list of group-trading projects. Market-brokers may come here and search for the projects which interest them. It is a place where core-brokers and market-brokers meet together.

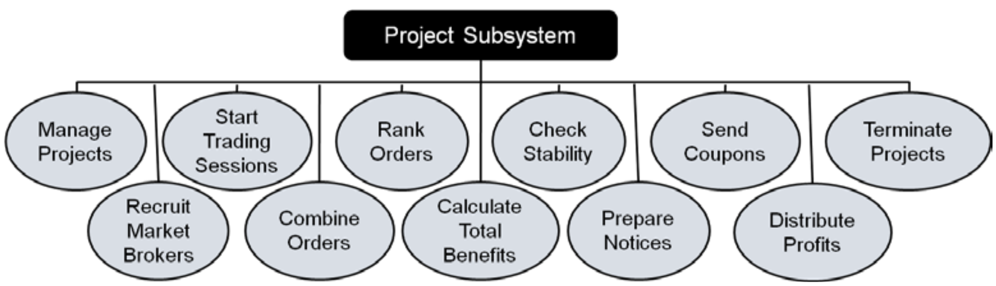


Figure 4.2 Project Subsystem

  2. **Project Subsystem –** a system specially designed to assist the core-broker in managing all the necessary tasks to assure quality outcomes. There are eleven functions in it (Fig. 4.2).

     (a) **Manage projects –** allows the core-brokers to manage their projects and to prepare all the essential pre-tasks before their group-trading projects is running. This function is specially designed to assist the core-brokers to create profitable projects, therefore it consists the following sub-functions:

     (1) Maintain group-trading proposals: A thoughtful proposal usually lead to a successful group-trading project. A proposal can be created, modified, listed and deleted here. The brokers may also refer to some others' proposals if there have been agreed by the owners.

     (2) Find providers: Providers are the most important resource of the core-brokers. They select suitable providers for the group-trading projects.

(3) Joint providers: The core-brokers are the sellers of the projects and the providers' information will not put on the projects. They must joint providers together before the projects are settled.

(4) Refer existing projects: The brokers may also refer to some others' projects.

(5) Maintain projects: A formal project can be created, modified, listed and deleted here.

(6) Display projects: Displaying projects on the CBS site is a direct way for core-brokers to find the market-brokers they want.

(b) **Recruit market-brokers –** the core-brokers can use this function to recruit market-brokers. Every time a new session of group-trading starts, the core-broker needs to ensure that he/she has the right market-brokers.

(c) **Start trading sessions –** sets up the information that is needed before a trading session can begin, such as the starting date and the end date.

(d) **Combine orders** – puts together the orders that the market-brokers have created.

(e) **Rank orders –** sorts the orders on the basis of the time they were submitted.

(f) **Calculate total benefits –** computes the total benefits of a coalition including the discounts of the buyers' coalition and the profits of the providers' coalition.

(g) **Check stability –** ensures that none of the subsets of a coalition has a larger total benefit than the coalition itself.

(h) **Prepare notices –** prepare two kinds of notice. One is to notice the market-brokers how many items are for their clients. The other is for the providers to inform them how many items of theirs have been sold out.

(1) Decides the quantity of products for each market-broker.

(2) Sends out invoices to the market-brokers.

(3) Decides the number of products fairly for each provider according to their contributions.

(4) Sends out orders to the providers.

(i) **Pass coupons –** when payment from the market-brokers has passed into the core-brokers' bank accounts, this function will allow the core-brokers to buy the electronic coupons from the providers and send them to the market-brokers.

(j) **Distribute profits –** calculates the commission for each broker and the payment for each provider.

(k) **Terminate projects** – ends the projects.

3. **Market Subsystem** – this system has seven functions as shown in Fig. 4.3. By using it, the market-brokers can perform transactions for a session on a particular project; purchase electronic coupons from the core-broker and send the coupons to their clients.

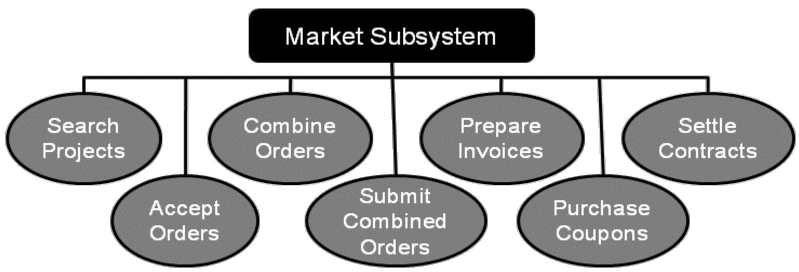


Figure 4.3 Market Subsystem

(a) **Search projects–** on the CBS site, the market-brokers may find a project that they are interested in, by using keyword searching in the lists of projects. There are three options for the market-brokers to choose. The first option is searching by product name. Other options involve using the name of core-brokers, or the ID of a project.

(b) **Accept orders –** confirms the orders from the customers.

(c) **Produce market orders –** creates a 'market order' by combining all the orders that are received from the customers.

(d) **Submit market orders –** sends the market orders to the core-broker for approval.

(e) **Prepare invoices –** when the market-brokers receive the notices from the core-broker, they can use this function to send out invoices to each customer.

(f) **Purchase coupons –** the market-brokers purchase coupons by transferring payment to the core-broker's bank account.

(g) **Settle contracts–** sends out the click-wrap contracts, which are electronic contracts for the consumers to click and wrapped on the Internet (Ravicher 2000), to the customers who have ordered the items, along with the coupons.

The overall concept of the CBM is given and its components are described in this section. The CBM is based on the core concept, but certain improvements have been made in the CBM. An explanation about the differences between the core and the CBM is given in the next section.

4.2 The CBM Versus the Core

Since the CBM is based on the core, the connection between the CBM and core is discussed in this section. At first, an algorithm for the core is presented in Subsection 4.2.1 to describe the way it works. The improvements have been made into the core in the CBM are shown in Subsection 4.2.2. In the end of this section, an algorithm for the CBM is given in Subsection 4.2.3. It is easy to perceive the contrast between the CBM and the core by looking into the algorithms for them.

4.2.1 An Algorithm for the Core

In the real world marketplace, any buyer may purchase many kinds of goods. All these different goods can be sold to any number of buyers. And a provider may sell many different goods. And in one particular situation any of the goods might be provided by any of the sellers. In order to locate the core of a coalition, the v(S) of all the sub-groups of the coalition must be calculated. Assume that there are 2 customers, who are A and B, purchase goods from three providers: 1, 2 and 3. Table 4.1 is the list of the $(3+1)^2=16$ sub-coalitions of the e-market, for example, in sub-coalition C09, denoted as {A, B, 2, 1}, customer A purchase goods from provider 2 and customer B orders items from provider 1.

Table 4.1 Possible Sub-Coalitions

S \ Provider	Customer A	Customer B	Sub-Coalition
C00	0	0	{}
C01	0	1	{B, 1}
C02	0	2	{B, 2}
C03	0	3	{B, 3}
C04	1	0	{A, 1}
C05	1	1	{A, B, 1, 1}
C06	1	2	{A, B, 1, 2}
C07	1	3	{A, B, 1, 3}
C08	2	0	{A, 2}
C09	2	1	{A, B, 2, 1}
C10	2	2	{A, B, 2, 2}
C11	2	3	{A, B, 2, 3}
C12	3	0	{A, 3}
C13	3	1	{A, B, 3, 1}
C14	3	2	{A, B, 3, 2}
C15	3	3	{A, B, 3, 3}

Table 4.2 Pseudocode to Find a Core

```
procedure findCore(coalition, coalitionDetail, provider, providerProduct, order, orderLine)

/* For each coalition, there are coalitionID, coalitionDiscount and coalitionProfit */
/* For each coalition details, there are orderID, providerID */

/* For each provider, there are providerID, providerName, providerProfit and providerProductNo */
/* For each provider product, there are providerProductID, providerProductStock, providerProductSold, providerProductPrice and providerProductCost */

/* For each order, there are orderID, orderDate, orderLineNo,orderCustomerID and orderProviderID */
/* For each order line, there are orderProductID, orderQuantity, orderActuralQuantity orderDiscount and orderExpectedDiscount */

core=’’;
max=0;
for i=0 to coalitionNo-1
{
    coalitionDiscount[i]=0;
    coalitionProfit[i]=0;
    for j=0 to coalitionDetailNo-1
    {
        for k=0 to orderLineNo-1
        {
            for p=0 to providerNo-1
            {
                if(orderProviderID[j,k]=providerID[p])
                {
                    for q=0 to providerProductNo-1
                    {
                        if(orderProductID[j, k] = prividerProductID[p, q])
                        {
                            coalitionDiscount[i]+=orderActuralQuantity[j, k]*orderDiscount[j, k]*providerProductPrice[p, q];
                            coalitionProfit[i]+=orderActuralQuantity[j, k]*(1-orderDiscount[j, k])*providerProductPrice[p, q];
                            coalitionProfit[i]-=orderActuralQuantity[j, k]*providerProductCost[p, q];
                        }
                    }
                }
            }
        }
    }
    sum= coalitionDiscount[i]+coalitionProfit[i]);
    if(sum>max)
    {
        max=sum;
        core=coalitionID[i];
    }
}
report core, max, coalitionDiscount, coalitionProfit;
```

In a market, the *v*(S) of each sub-group sums up the total discount for the buyers and the overall benefit of the sellers in the sub-group. In Table 4.2, a pseudocode is designed to express the algorithm of finding a core. At first, it calculates the *v*(S) of every sub-group, and this is a time consumed task. A sub-coalition, which has the biggest *v*(S), is then selected as the core.

4.2.2 Improvements in the CBM

The CBM deals with large group-trading coalitions on the Internet. Therefore, this research must necessarily include distributed computing. The CBM has incentive compatibility which will attract a large number of participants to take part in trading. The complexity of large coalitions has been taken into account during the design process and it is therefore capable of working out the trading result in a short space of time.

Table 4.3 shows that the CBM inherits two useful techniques from the core concept, which are the marginal utility function and the Pareto efficiency. By means of the marginal utility function, the total benefit of a coalition and the gains of each member can be calculated. As mentioned in section 3.1.3, it is difficult for brokers to collect the marginal utility functions from customers, and therefore the core cannot use them in practice. Price lists from providers and orders from customers are used to calculate the total benefit of a coalition and the gains of each member. Since they are publicly available information in e-markets, they are available for everyone. At the point of Pareto efficiency, an equilibrium price is reached and gives an incentive to both providers and buyers. However, an e-market may not reach Pareto efficient allocation (Anderson 2002). In the CBM, a stability check is used to ensure a Pareto efficient allocation can be reached in a coalition. A coalition, which passes this check, will have an equilibrium price, also known as a best price, for providers and buyers.

Table 4.3 The CBM versus the Core

	Technique	Problem	Result
Inheritance of the core	Marginal utility function	Coalition's benefit	Coalition's benefit
	Pareto efficiency	Individual incentive	Equilibrium price
Additional New characteristics of the CBM	Internet computing	Distributed computing	E-market
	Distributed computing	Distributed computing	E-markets
	Distributed computing	Computational complexity	Less complexity
	Information-hiding	Computational complexity	Less complexity
	Collaborate	Computational complexity	Less complexity
	Stability check	Incentive compatibility	Stability & Best price
	Volume discount	Incentive compatibility	Higher discount
	Shapley value	Incentive compatibility	Fair share
	Market Information (Price lists and Orders)	Information collection	Easier and more effective
	Broker	Price maker	Competitive e-market

The above additional techniques make the CBM capable of coping with online group-trading problems. By using three techniques, which are volume discount, stability check and the Shapley value, the CBM gives traders three incentives: a volume discount, an equilibrium price and a fair distribution. By adding three techniques, which are distributed computing, information hiding and collaboration between traders, the CBM is able to reduce its computational complexity and to speed up the time it takes to finish the task. As it works in e-markets it must therefore use techniques of internet computing and distributed computing. The following precise improvements have been made into the core in the CBM,

- Multiple e-markets environment: The problems of the core mentioned in chapter 3 make it difficult to be used in real world e-markets, but the CBM is designed to be used in a multiple e-markets environment.
- Stability check: It is essential to perform this check to ensure the stability of coalitions from every e-market, so that an equilibrium price can be agreed in a session of a group-trading project.
- Short working time: Through collecting orders in many e-markets and combining them into a large order, the CBM may find a core quickly and work out an equilibrium price for an e-market in a short time.
- Price lists and orders: Since it is difficult to collect marginal utility functions from providers and customers. In this research, price lists and costs of products are the needed information from providers. Orders with an additional field to indicate the expected discount of buyers are the input collected from customers.
- New incentives for participants: Volume discounts are the incentives for customers to join group-buying. Fair distribution of profits may be an important incentive for providers to perform joint-selling.
- Using brokers: Brokers are introduced to ensure the collaboration in the CBM. They are also used to smooth the process of trading in e-markets.

The above improvements need to consider into the algorithm of the CBM. In the next subsection, an algorithm is written and meets the requirements needed in the CBM.

4.2.3 An Algorithm for the CBM

An algorithm is designed to contain the following tasks, which are essential in the life cycle of a CBM group-trading project:

1. Merges the providers who sign the contract for the group-trading project.
2. Starts a session of group-trading project.
3. Combines the orders in the same e-markets to be a market order.
4. Checks the stability of order from every e-market. If any fails in stability check, returns it to its market broker.
5. Sorts the market orders from all the e-markets by their submitted time.
6. Decides the actual quantity for every market order.
7. Produces a big order from the orders which successfully get the items.
8. Decide the number of products for each provider by using the Shapley Value.
9. Calculates the total benefit of the coalition in each e-market.
10. Calculates the total benefit of the core.
11. Calculates the commission for every broker.
12. Calculates the profits for every provider.
13. Ends the session of the project.

Table 4.4 Pseudocode for the CBM

```
procedure CBM(productNo, product, providerNo, provider, providerProduct, marketNo, marketOrderNo, marketOrder, marketOrderLine, orderNo, order, oderLine)

/* For each provider, there are providerID, providerName, providerProfit and providerProductNo */
/* For each provider product, there are providerProductID, providerProductStock, providerProductSold, providerProductPrice and providerProductCost */

/* For each product, there are productID and productSpec */

/* For each market order, there are marketOrderID, marketOrderDate, marketOrderLineNo, marketOrderCustomerID and marketOrderProviderID */
/* For each market order line, there are marketOrderProductID, marketOrderQuantity, marketOrderActuralQuantity marketOrderDiscount and marketOrderExpectedDiscount */

/* For each order, there are orderID, orderDate, orderLineNo and orderCustomerID */
/* For each order line, there are orderProductID, orderQuantity, orderActuralQuantity orderDiscount and orderExpectedDiscount */

providerID[providerNo] = 'Sun';
jointProviders(providerNo, provider, providerProduct);
projectSession= 'on';
while(projectSession='on')
{
    rankOrders(Order); // sort orders by orderDate in ascending order
    for i=0 to marketNo-1
    {
       decideQuantities(providerProductNo[providerNo], providerProduct[providerNo], marketNo, order[i], orderLine);
        combineOrders(marketOrder, marketOrderLine);
    }
    for i=0 to order[marketNo].orderLineNo-1
    {
        findDiscount(order[marketNo].productID[i], quantity);
    }
    decideSoldItems(providerNo, provider, providerProduct);
    stability=checkStability(providerProductNo[providerNo],  providerProduct[providerNo], marketNo, order, orderLine);
    if(stability='y')
    {
        CBMCore=calculateCoalitionBenefit(providerProductNo[providerNo], providerProduct[providerNo], orderLineNo[orderNo], orderLine[orderNo]);
        commission[marketNo]=calculateBrokerCommissions(productNo, providerProduct, marketNo, order, orderLine, 3%);
        for i=0 to marketNo-1
             commission[i]=calculateCommissions(productNo, providerProduct, orderNo[i], marketOrder[i], marketOrderLine[i], 4%);
        calculateProfits(providerNo, provider, providerProduct);
    }
}
report CBMCore, providerProfit, commission;
```

The pseudocode in Table 4.4 reflects the procedure of performing a session of group-trading project and it is used to express the algorithm of the CBM by taking all above tasks into account in order to bring together the new model that has less computational complexity, distributed computing and incentive stability. In the above pseudocode, there are 7 groups of arrays, namely product, market order, market order line, order and order line groups. The descriptions of the arrays are in the following:

- Provider group: consists of four arrays: providerID, providerName, providerProfit and providerProductNo. They are one dimension arrays storing the data of the providers of the group-trading projects.
- Provider line group: consists of five arrays: providerProductID, providerProductStock, providerProductSold, providerProductPrice and providerProductCost. These two dimension arrays store the data of the products which providers offers. The first index of the array is provider ID and the second is for the product ID.
- Product group: consists of two arrays: productID and productSpec. They are one dimension arrays storing the details of products.
- Market order group: consists of five arrays: marketOrderID, marketOrderDate, marketOrderLineNo, marketOrderCustomerID and marketOrderProviderID. They are two dimension arrays storing the details of the orders from the customers in e-markets. The first index of the array is market ID and the second index is the element number of the array. The data of this group are kept within the databases in the e-markets. The brokers in the e-markets do not want to share this information with others relating to their customers' orders.
- Market order line group: consists of five arrays: marketOrderProductID, marketOrderQuantity, marketOrderActuralQuantity marketOrderDiscount and marketOrderExpectedDiscount. These three dimension arrays stores the data of the order lines in customers' orders. The first index of the array is market ID and the second index is order ID and the third is for the order line number of orders. They are also the information kept secret with the market brokers.
- Order group: consists of four arrays: orderID, orderDate, orderLineNo and orderCustomerID. They are one dimension arrays storing the details of the market

orders from the brokers in e-markets.

- Order line group: consists of five arrays: orderProductID, orderQuantity, orderActuralQuantity orderDiscount and orderExpectedDiscount. These two dimension arrays store the data of the order lines in market orders. The first index of the array is order ID and the second is for the order line number of orders.

Since there is a combined element which is merging the other elements together, the last position of the arrays in the above group except the ones in product group is for the big combined element. Take the order array as an example. Suppose there are *b* orders, the original orders are stored in 0^{th} to $(b\text{-}1)^{th}$ elements in the order array. The market order is stored in b^{th} position of the array. The above algorithm calls 9 functions, namely jointProviders, combineOrders, rankOrders, decideQuantities, decideSoldItems, calculateCoalitionBenefit, checkStability, calculateBrokerCommissions and calculateProfits. These functions are described as follows:

1. jointProviders: it merges the providers together into a joint provider. The pseudocode in Table 3.12 provides a way to combine the stock of all the providers together and to calculate the average unit price and cost for each product. Brokers can perform this task by the assistance of the function ‘manage projects’ in the project subsystem.

Table 4.5 Pseudocode to Find Volume Discounts

```
procedure findDiscount( productID, quantity)

/* For each margin, there are marginProductID, marginMinQuantity, marginDiscount */
discount=0;
i=0;
while(productID=marginProductID[productNo, i])
{
    If(quantity>=marginMinQuantity[i])
       discount=marginDiscount[i];
    i++;
}
return discount;
```

2. combineOrders: it combines the orders. By using the pseudocode in Table 3.13, the orders can be combined together into a big order. This pseudocode is used both the function ‘combine orders’ in the market and project subsystem. The pseudocode calls the function in Table 4.5 to find actual discounts for all the products in the combined order. These discounts are based on the order quantity and the volume discount given by the core-broker. The expected discount in the combined order is

the maximal expected discount of all. If the expected discount is greater than the actual discount, the latter for a product is set to zero, which means this product will be drop from the combined order.

3. rankOrders: Sort the orders from the e-markets by the order of the submission time, because the trading is under FCFS principle. Quicksort is the sorting algorithm used in this research, because it is often faster than other algorithms (Skiena, 2008). Core-brokers can execute the function 'rank orders' in the project subsystem to perform this task.
4. checkStability: Check the stability of the core in the CBM. The input parameters are number of e-markets, products' details of the core-broker, the market orders from each e-market and the final big combined order. The pseudocode in Table 4.6 is used in 'check stability' in the project subsystem.

Table 4.6 Pseudocode to Check the Stability of the Coalition

```
procedure checkStability(productNo, providerProduct, marketNo, order, orderLine)

stable='n';
for i=0 to marketNo
    v[i]= calculateCoalitionBenefit(productNo, providerProduct, orderLineNo[i], orderLine[i]);
count=0;
while(stable='n' and count<100)
{
    r=1;
    sum=0;
    for i=0 to marketNo-2
    {
        b[i]=randon(0, r);
        r-=b[i];
        sum+=b[i]*v[i];
    }
    sum+=r*v[i];
    if(v[marketNo]>sum)
        stable='y';
}
return stable;
```

Table 4.7 Pseudocode to Decide Actual Quantities

```
procedure decideQuantity(productNo, providerProduct, marketNo, order, orderLine)

for i=0 to productNo-1
{
    stock=providerProductStock[providerNo, i];
    for j=0 to marketNo-1
    {
        for k=0 to orderLineNo[i]-1
        {
            if(prividerProductID[i]= orderProductID[j])
            {
                If(stock>=orderQuantity[j, k])
                    orderActuralQuantity[j, k]=orderQuantity[j, k];
                else
                    orderActuralQuantity[j, k]=stock;
                stock-= orderActuralQuantity[j];
            }
        }
    }
}
return orderActuralQuantity;
```

5. decideQuantities: Decide the actual quantity for every market order. According to the stock of each product, the pseudocode in Table 4.7 may be used to do so. Since Sun is the sole provider for the products, all the e-markets' brokers purchase goods from him. Core-brokers can execute the function 'prepare notices' in the project subsystem to perform this task.

Table 4.8 Joint-Selling

S	{}	{P1}	{P2}	{P3}	{P1, P2}	{P1, P3}	{P2, P3}	{P1, P2, P3}
Product number	0	12	26	31	47	55	68	90

Table 4.9 Pseudocode to Decide the Sold Items of Providers

```
procedure decideSoldItems(providerNo, provider, providerProduct)

setNo=2^providerNo;
for i=0 to productNo -1
{
    productID= providerProductSold[providerNo,i];
    productSold= providerProductSold[providerNo,i];
    // if all the stock are sold out, the number of the sold product is the stock
    if(productSold= providerProductStock[providerNo,i])
        for j=0 to providerNo -1
            for k=0 to providerProductNo -1
                if(productID= providerProductID[j, k];
                    providerProductSold[j, k]= providerProductStock[j, k];
    else
    {
        for j=0 to providerNo -1
            for k=0 to providerProductNo -1
                if(productID= providerProductID[j, k];
                    contribution[2^j]=min(productSold, providerProductSold[j, k]);
        contribution[0]=0;
        contribution[setNo -1]=0;
        for j=0 to setNo -1
            if(log(j, 2)-int(log(j,2))≠0)
            {
                temp=j;
                totalStock=0;
                k=0;
                while(temp>0)
                {
                    if(temp%2=1)
                        totalStock+=contribution[2^k];
                    temp/=2;
                    k++;
                }
            }
        Shapley=calculateShapleyValue(providerNo, contribution);
        for j=0 to providerNo -1
            for k=0 to providerProductNo -1
                if(productID= providerProductID[j, k];
                    providerProductSold[j, k]=Shapley [j, k];
    }
}
return providerProductSold;
```

6. decideSoldItems: Decide the number of products for each provider by using the Shapley Value. The preferred numbers should be the stocks of the providers, but if the stock is not sold out, the items of each provider that are sold to the customers are decided by using Shapley Value. Assume that three provider, namely P1, P2 and P3 perform joint-selling for one particular product. According Table 4.8, which shows

the number of items sold in every sub-coalition, the items offered by each provider can be decided by using the calculation of the Shapley value. The results are 19, 32 and 39 for providers P1, P2 and P3 respectively. This task can also perform by executing the function ‘prepare notices’ in the project subsystem. Its pseudocode is in Table 4.9.

7. calculateCoalitionBenefit: Calculate the benefit of a coalition. The process of the calculation is simple and straightforward. Core-brokers can execute the function ‘calculate total benefits’ in the project subsystem to perform this task by using the pseudocode in Table 4.10 to calculate the *v*(S) of the coalitions in e-markets and the core in the CBM.

Table 4.10 Pseudocode to Calculate Coalition’s Benefit

```
procedure calculateCoalitionBenefit(productNo, providerProduct, orderLineNo, orderLine)

benefit=0;
for i=0 to orderLineNo[orderNo]-1
{
    for j=0 to productNo-1
    {
        if(orderProductID[orderNo, i]=prividerProductID[productNo, j])
        {
            orderDiscount[orderNo]+=orderActuralQuantity[orderNo,i]*orderDiscount[orderNo,i]*providerProductPrice[productNo,j];
            orderProfit[orderNo]+=orderActuralQuantity[orderNo,i]*(1-orderDiscount[orderNo,i])*providerProductPrice[productNo,j];
            orderProfit[orderNo]-=orderActuralQuantity[orderNo, i]*providerProductCost[productNo, j];
        }
    }
    benefit= orderDiscount[orderNo]+ orderProfit[orderNo]);
}
return benefit;
```

8. calculateCommissions: Calculate the commission for every broker. The suggested commissions, namely handling fees and final value fees for the brokers in the CBM may refer to section 4.4 for the details. The pseudocode of calculating the commissions is shown in Table 4.11. This is one of the tasks of the function ‘distribute profits’ in project subsystem.

Table 4.11 Pseudocode to Calculate the Commissions to Brokers

```
procedure calculateCommissions( productNo, providerProduct, orderNo, order, orderLine, rate)
for i=0 to ProductNo-1
{
    for k=0 to orderLineNo[orderNo]-1
        if(orderProductID[orderNo, k]=prividerProductID[productNo, i])
            n=k;
    commission=0;
    for k=0 to orderNo-1
        for r=0 to orderLineNo[k]-1
            if(orderProductID[k, r]=prividerProductID[productNo,i])
            {
                // Handling Fee
                difference=orderDiscount[orderNo,n]- orderDiscount[k, r];
                commission+=orderQuantity[k, r]*providerProductPrice[providerNo, j]*difference*10%;
                // Final Value Fee
                commission+=orderQuantity[k, r]*providerProductPrice[providerNo, i]*(1- orderDiscount[orderNo, n])*rate;
            }
}
return commission;
```

9. calculateProfits: Calculate the profits of all the providers. The profits for the providers can be easily calculated, when the net profit is figured out by deducting commissions, which is 7% of final value fee from the total profit. The pseudocode in Table 4.12 is to calculate the profits of the providers. This is another task of the function ‘distribute profits’ in project subsystem.

Table 4.12 Pseudocode to Calculate the Profits of Providers

```
procedure calculateProfits(providerNo, provider, providerProduct)

for i=0 to providerNo-1
    for j=0 to providerProductNo[i]-1
    {
        providerProfit[i]=0;
        for k=0 to providerProductNo[providerNo]-1
            if(providerProductID[providerNo,k]=prividerProductID[i, j])
                for r=0 to orderLineNo[orderNo]-1
                    if(orderProductID[orderNo,r]=prividerProductID[i, j])
                    {
                        gain+= providerProductPrice[providerNo,k]*(1- orderDiscount[orderNo,r]*(1-7%);
                        providerProfit[i]+= providerProductSold[i, j]*(gain- providerProductCost[i,j]);
                    }
    }
report providerProfit;
```

In order to ensure a healthy level of competition and the collaboration between traders of group-trading in e-markets, the CBM adopts brokers to prevent price makers as would occur in monopolies or cartels. Brokers are also used to smooth the process of trading in e-markets. Brokers are involved in the group-trading to smoothen the process of transactions. Because brokers are so vital in the model, different roles for core-broker and market-broker need to be clarified. The main subject of the next section is the use of brokers in the CBM.

4.3 Brokers in the CBM

Brokers are “persons who buy and sell goods or assets for others” (The New Oxford Dictionary of English 2010). They typically functions as agents responsible for executing purchases and sales of goods. They have to be available to receive orders and carry out transactions. When they are asked to place an order, they must consult with the client and obtain the specific information they need to complete it. Professional brokers usually have licenses to prove that they are well-versed in the regulations and laws of the securities industry.

Brokers play a wide variety of roles in trading process. They may be salespersons and fill orders based on specific instructions received from their clients. They may also serve as trading advisers to their customers providing services like market research or trade recommendations. Many brokers keep their customers informed regarding any relevant news that might affect customers' trade positions. The broker may be a brokerage firm, but in this research, this term usually refers to an individual.

In the CBM, there are core-brokers and market-brokers. Some valuable lessons have been learnt from the failure of previous group-buying sites. A research article suggests that the expertise of group leaders is an important factor for a member's involvement in a group-buying session (Lin 2009). Unprofessional leadership of a coalition leads to a lack of commitment among its members, and so the conclusion is that group leaders must be specialists. In order to avoid unequal member allocations, the person who organises the group-trading session should not be a member of the group. This makes a broker a perfect candidate to manage a group. Brokers are specialists in trading and do not belong to any coalition, so they can be a great help to group-trading. Brokers organise coalitions and look after the process of trading. In the CBM, suppliers provide products, but they do not directly sell goods to customers. The actual sellers are the brokers.

Two different kinds of broker are assigned varied tasks at different points in time. First, the core-broker brings up a proposal which combines several products together in order to do a session of bundle selling. Then the market-brokers give notice of a sale on their sites and bring the customers in. Next the core-broker collects the orders from the market-brokers and builds up the buyer coalitions by forming them into groups. Finally, the market-brokers close the deals by sending the coupons to the buyers when they have paid for their goods. The core-brokers interact with the providers to get the information they need about items and communicates with the market-brokers about their orders. Also the market-brokers may speak with the core-broker or the buyers.

The core-broker acts as the representative for the coalition of providers, and a market-broker is the representative for a coalition of buyers. The core-broker acts like a project manager. On the other hand, the market-brokers are like salesmen in the CBM. The main interaction is between the core-broker and the market-brokers and it is crucial for the CBM. Commission is an effective way to encourage brokers to fulfil their duties.

4.3.1 Market-brokers

In the CBM, market-brokers act like real-world salesmen. The market-brokers are the people with whom the customers deal in this model. The role of the market-broker is essential in making or breaking a deal with buyers. The interaction between customers and salesmen often determines the final outcome of a retail transaction. In the present competitive world, an unprofitable firm can easily die off. Good salesmen can easily increase the profits of a store in retail marketing. Therefore market-brokers capable of finding potential buyers are necessary for a successful project.

Market-brokers can find the project in which they are interested, on the CBS website, where the current group-trading projects are listed. After signing an agreement for a session of group-trading with a core-broker, market-brokers may advertise on their own online shops and start to gather buyers. They should get a URL for their shops first, so their shops can be easily accessed by customers. Market-brokers will probably not have a URL at this point. They may open their shops on the website of some popular online shopping sites like eBay.

In the CBM, the market-brokers can use the market subsystem to perform all the tasks needed in the trading process on the e-marketplace. They are at liberty to use any other marketing tools they may prefer to help with their sites. There are plenty of useful market function models which have been suggested (Bakos 1998, Giaglis, Klein and O'Keefe 2002, Alonso 2003). Some of these models, working through on-line Web service directories, can produce functions for an e-market to serve three main purposes (Clark 2002): (a) to match buyers and providers; (b) to facilitate transactions and (c) to provide the institutional infrastructure for business.

It is a market-broker's duty to form a buyers' coalition on an e-market. All the orders in the buyers' coalition will be transformed into one single order before the market-broker submits this to the core-broker. Because the core-broker does not have the opportunity to get any information from the buyers, taking care of buyers is the main responsibility of the market-broker. There is another advantage here, in that the CBM regards the information of the customers as the private property of the market-broker. So, nobody, not even the core-broker, can steal the customers away from the market-brokers.

4.3.2 Core-brokers

A successful project always has a responsible core-broker. The role of core-brokers is similar to that of a project manager. The core-brokers create a project for a session of bundle selling and have overall responsibility for the successful planning, execution, monitoring, control and closure of a project. They initialise a joint-selling proposal, in which several providers will need to be involved. One of the things that the core-brokers must look for is people they can work with to be providers and market-brokers. They may find providers through many channels such as the online UK business directory, which "offers free business listings of thousands of companies, businesses, non-profit organisations and charities which serve the UK" (UK Business Directory n . d .).

It does not matter whether market-brokers come from a team that the core-broker has made up or whether they are found in a list of candidates who are interested in the positions. Good market-brokers will need to attract lots of customers. When the market-brokers have formed their buyers' coalitions, the core-broker combines all the coalitions together. The performance of each market-broker is then recorded so that the core-broker will be able to refer to it in the future. The final duty for the core-broker is to calculate discounts for the coalition and to send notices to the relevant market-brokers.

The core-brokers will negotiate an agreement with the market-brokers, but they must lay down the strategies for the market-brokers carefully as these will affect their performance. The core-broker provides all the necessary information to the market-brokers for them to promote the product and market it. Commission and agreements for brokers are discussed in the next section.

4.4 Fees System of the CBM

Core-brokers need the help of several market-brokers for their projects. In the CBM, a core-broker needs to make an agreement with each market-broker individually. An agreement is “a negotiated and typically legally binding arrangement between parties as to a course of action” (*The New Oxford Dictionary of English* 2010). In order to recognise the need for high standards in the quality of the dynamic business processes involved and to guarantee that these are maintained from start to finish, a formal agreement is commonly used to create mutual business relations between the parties. As the agreement is negotiated, the requirements of the parties, such as the duties they must carry out and the commission they will be paid, become established.

A commission agreement is used in the CBM. The specification of commission for each market-broker must be clearly identified. The commission agreement should contain details of the brokers, the duration of the agreement, information about the project and also about the laws in force in that particular country. A satisfactory commission agreement encourages the market-brokers to attract more customers. The main purpose of the commission agreement is to fix the amount of commission paid to the brokers and the terms that will apply; it is an important stage for brokers, as the commission is a powerful incentive for them. In the CBM, the financial transactions between brokers are by bank transfer. In order to determine a suitable commission system for the CBM, the investigation in section 2.4, which examined the commission paid in popular e-commerce shopping sites, is taken into consideration. The average percentage of final value fee is around 7.5%. The average online store fee is about £24.50. Most of the sites do not charge insertion fees.

Good teamwork is essential to a successful group-trading project. Providers supply goods which brokers will sell for them in the CBM. It is the brokers’ job to perform marketing and selling. If the core-broker, as a project manager, is creative enough, effective group-trading sessions will result. The contribution of powerful salesmen will ensure that more customers contribute to the trading. With the help of a professionally designed Web page, a stable e-marketplace can function properly. But unless the fees to these people are at a sufficient level to encourage them to make a contribution to the team, it is unlikely that any group-trading will take place.

This subsection explains the fees system of the CBM and how the members pay their fees. Commission for brokers in the CBM comes from the fees that the providers pay. Charging high fees will make brokers happy, but may repel providers. A site with low fees will end up in debt. A good fees system is essential for a group-trading site. The eBay's fees system in Appendix 2 and the survey of fees systems in current e-markets in section 2.4 contribute greatly to the CBM's fees system here. In the CBM, there are four kinds of fees: a session fee, an online store fee, a handling fee and a final value fee. The session fee and the online store fee are paid to the CBS site, while the handling fee and the final value fee are the commission paid to the brokers.

It is suggested that a session fee of £30 should be paid by core-brokers every time they enter a listing for a session on a project on the site. The session fee is the only fee the core-brokers need to pay. They do not pay any other fee for the project. An online store fee of £24.50 is a suggested monthly fee for market-brokers, who wish to open an online store on the CBS site including purchase of domain name, server use, maintenance etc. These payments are the main income of the site. However, online store on the CBS is not yet available to any market-broker due to the small capacity of current server.

The brokers will earn two kinds of commission in return for their efforts. The brokers set the projects in motion and keep a watchful eye on the process of group-trading and ensure that what is on offer to the buyers will be attractive to them. A final value fee is paid by the providers to reward the brokers. The brokers combine the orders to ensure that buyers get better discounts. A handling fee from the buyers rewards the brokers. These two fees will be automatically deducted from the payments before being transferred into the core-brokers' accounts.

It is suggested that the final value fee in the CBM should be 7% of the final selling value. When a final value fee is received, it is then divided into two portions. The market-broker takes 4% and the core-broker gains 3%. For example, a core-broker CB has four market-brokers: MB1, MB2, MB3 and MB4, who order 100, 80, 120 and 50 items respectively. Assume that the retail price of an item from a provider is £100 and the buyers get 40% discount. The final selling price for one unit of the item is £100×(1–40%)=£60. The total number of items is 100+80+120+50=350. The provider earns £60×350×(1–7%)= £195,300. The core-broker gains £60×350×3%–£30= £600. As an example of a market-broker MB3 gets £60×120×4%=£288.

It is suggested that the handling fee should be 10% of the extra discount, which the customer gains, after each of the brokers has processed the orders. For example, in Table 4.13, market-broker MB3 has four customers C1, C2, C3 and C4. Customer C1 orders 10 items and has a discount of 3% at the beginning. When MB3 put the orders together, the market order has 21% discount. Customer C1's discount increases 21%−3%=18%, so he pays £100×10×18%×10%=£18 to reward MB3. When core-broker CB combines all the orders together, the final discount becomes 40%. C1 pays another £100×10×(40%−3%−18%)×10%=£19 to CB for services. The benefit that MB3 gets from this fee, is £18+£29.70+£29.40+£33.60=£110.70, while core-broker CB gains £19+£62.70+£93.10+£53.20=£228 from MB3's clients.

Table 4.13 Handling Fees

Customer	Quantity	Original Discount %	Extra Discount	Payment	Handling Fee	Total	MB3 (21%)	Handling Fee for MB3	CB (40%)	Handling Fee for CB
C1	10	3%	£370	£600	£37	£637	18%	£18	19%	£19
C2	33	12%	£924	£1980	£92.40	£2072.40	9%	£29.70	19%	£62.70
C3	49	15%	£1225	£2940	£122.50	£3062.50	6%	£29.40	19%	£93.10
C4	28	9%	£868	£1680	£86.80	£1766.80	12%	£33.60	19%	£53.20

Market-broker MB3 has four customers C1, C2, C3 and C4. Customer C1 orders 10 items and has a discount of 3% at the beginning. When MB3 put the orders together, the market order has 21% discount. Customer C1's discount increases 21%−3%=18%, so he pays £100×10×18%×10%=£18 to reward MB3. When core-broker CB combines all the orders together, the final discount becomes 40%. C1 pays another £100×10×(40%−3%−18%)×10%=£19 to CB for services. The benefit that MB3 gets from this fee, is £18+£29.70+£29.40+£33.60=£110.70, while core-broker CB gains £19+£62.70+£93.10+£53.20=£228 from MB3's clients.

The commission to a broker can be calculated by the pseudocode in Table 4.11, in which the handling fees and final value fees are figured out. Brokers may get these two kinds of fees only when their customers' orders are committed, so that they may bring more customers to the group-trading sites and make deals. Online store fees and section fees are the income of the group-trading sites and will never be part of the commission of brokers, so they should not be considered in the pseudocode.

In the CBM, market-brokers attract their clients in e-markets, which may be their own websites or existing e-commerce sites like eBay as long as the sites provide the functions below for them to go ahead their transactions with customers:

- List products and services offered by their providers.
- Send an invoice to a particular customer.
- Receive an order placed online by a customer for the articles listed for sale.
- Communicate with customers.

Most market-brokers may want to open their shops on the website of some popular shopping avenues. One advantage of using an existing site is that such a site may have a good reputation and a large customer base, making it easier for the market-brokers to find buyers there. But they may have to pay a fee to the site although there are many sites, with little or no fee. They have plenty of alternatives to choose from, but they are likely to have varying customer bases. A good market-broker will put a lot of effort into finding potential customers and use more than one website at the same time for the project session. Another advantage for the market-brokers to deal with their clients in such sites is the ‘infrastructure’ support provided by these sits.

In the next section, a definition of infrastructure and the reasons why it is important to an e-commerce site are discussed. The CBM is designed to be used as a practical model, so that its computational infrastructure must be addressed and the considerations for it are listed in the next section.

4.5 A Computational Infrastructure for the CBM

Infrastructure is “the basic physical and organizational structures and facilities needed for the operation of a society or enterprise” (*The New Oxford Dictionary of English* 2010). In computer science, it is the hardware and software structures and technologies needed for companies to provide necessary e-commerce services to their employees, customers and business partners.

In the emerging global economy, e-commerce has increasingly become a necessary component of business strategy for economic cooperation and development. E-commerce is the use of electronic communications and digital information processing technology in business transactions to create, transform, and redefine relationships for value creation between or among organizations, and between organizations and individuals (Lallana *et al.* 2000). E-commerce is usually associated with buying and selling over the Internet, and it is chiefly concerned with any form of business transaction in which the parties interact electronically rather than by physical exchanges or direct physical contact.

Since the potential number of traders in e-markets may be large, a high speed network is required in the group-trading. There are two factors: bandwidth and latency, that contributes to the perceived speed of a network. Bandwidth represents the amount of data that passes through a network connection. A high bandwidth supporting data rates of 300 Kbps or higher is preferred. Another element called latency is a synonym for delay. It is an expression of how much time it takes for a packet of data to get from one designated point to another. On DSL or cable Internet connections, latencies are typical less than 100 milliseconds. Using such high-bandwidth Internet connections between computers can effectively reduce latency of the e-commerce system.

Other than a high-speed network, every e-commerce company requires an infrastructure to support its customers and operations. It is important to choose a correct infrastructure to enable the group-trading operations to run efficiently in this new model. In section 4.5.1, different levels of requirement of the CBM are highlighted, and the technology elements required for its effective development are discussed. Due to the distributed nature of e-commerce systems, the further necessary developments and innovations in technologies that bind the elements together to make the CBM a functioning unit are listed section 4.5.2.

4.5.1 Requirements of the CBM

E-commerce can be regarded as an application of Internet technologies and related standards in business process to deal with the four different levels of requirement in Fig. 4.4, namely information, communication, knowledge and transaction:

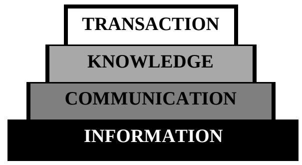


Figure 4.4 Levels of Requirement

- Information: The Internet can be utilises as a powerful resource of information for marketing purposes. In e-commerce, marketing may be the most important of all the infrastructure elements. On the CBS website, there are project specifications, the product descriptions, and the price lists and they can be viewed by visitors. In the CBM, it's market-brokers taking care of most of marketing jobs. They advertise the products on their sites. Once visitors are on the sites, the market-brokers need to keep them there and compel the potential customers to buy from them. Table 4.14 lists the abilities required for information listing and acquirement in this level.

Table 4.14 Information Level

Visitors' Ability	Market-Brokers' Ability
▪ Search products for purchase using e-catalogues.	▪ Provide access to a current catalogue of product offerings. ▪ Provide the means for visitors to register at the site, to make comments, or to request additional information. ▪ Measure and analyze the traffic at the site tomodify and maintain the various applications.

Market-brokers built their own sites on popular shopping avenues, which provide them all the function they need to list the products and attract customers. On the CBS site, visitors may browse the information on the home pages that brokers list.

- Communication: Highly interactive communication between customers, brokers and companies can be accomplished by using e-mail based services via the Internet. Table 4.15 shows the activities in communication level.

Table 4.15 Communication Level

Customers' Ability	Brokers' Ability
▪ Enquire the item details or the postage and payment for the item. ▪ Determine the specifications of the items. ▪ Negotiate the total purchase prices.	▪ Answer customers' questions. ▪ Pass queries and requests to a Web-based call centre. ▪ Collect and list common questions and answers as Frequent Asked Questions (FAQ) for customers.

In the CBM, the communication is the key to a successful project. Good communication between market-brokers and customers in the e-markets may effectively increase the customer base, while high standard of communication between providers and broker in CBS site may lead to profitable projects. The CBS site is a sell-side B2B (business to business) site is enabling brokers to purchase goods and services from provider.

Table 4.16 Knowledge Level

Providers' Ability	Core-Brokers' Ability
▪ Understand their products and know how to promote them. ▪ Have good idea about the potential strength of the products. ▪ Are willing to give knowledgeable support.	▪ Propose group-trading proposals. ▪ Select suitable products and providers. ▪ Joint different providers together and create group-trading projects. ▪ Negotiate with providers. ▪ Have concept of the current markets. ▪ Choose right market-brokers. ▪ Provide the means for brokers to register at the CBS site, to make comments, or to request additional information.

- Knowledge: The Internet can be applied for knowledge exchange. The abilities of providers and brokers are listed in Table 4.16.

  In CBS website, the knowledge sharing in the communities formed by core-brokers. The information of products from providers and full knowledge of the current markets are essential for core-brokers to create profitable group-trading projects. Groupware for community platforms sustains the multilateral exchange of complex information between community members on the Web. Therefore, team or divisional portals may be used by groups or communities that want to share specific content or business functions.

Table 4.17 Transaction Level

Buyers' Ability	Core-Brokers' Ability	Market-Brokers' Ability
▪ Place an order for desired products using a shopping cart. ▪ Confirm an order, ensuring that the desired product is available. ▪ Pay for the ordered products, usually through some form of credit. ▪ Track electronic coupons, after they pay.	▪ Combine orders from market-brokers. ▪ Check the stability for the combined order. ▪ Calculate volume discounts for combined orders. ▪ Decide the amount of providers' products which are sold to buyers. ▪ Calculate the commissions to brokers. ▪ Calculate the profits of providers.	▪ Provide an electronic shopping cart in which buyers can assemble their purchases. ▪ Verify a customer's credit and approve the customer's purchase. ▪ Combine orders and send them to core-brokers. ▪ Confirm orders and send invoices to buyers. ▪ Collect payments for orders ▪ Arrange for electronic coupons delivery.

- Transaction: Business transactions can be completed via the Internet. A B2C (business to customer) electronic storefront must support the same tasks that a physical store supports and needs to offer certain capabilities to buyers and to the merchant. In Table 4.17, the tasks for core-brokers and market-brokers show that they play totally different roles in group-trading process. The tasks of buyers in group-trading are the same as those in normal e-commerce sites.

Choosing the right ecommerce platform is one of the most important decisions. To develop an e-commerce site can be full of complexity. During the process of adjustment, a Web distributed system based on the elements of knowledge level in the CBM was implemented to show that the foundational principles of this research are workable both in logic and in practice. The next section lists the Internet technologies used to support the activities in the CBM when it deals with inter-business or inter-organizational e-commerce and in business-to-consumer transactions.

4.5.2 Technology Infrastructure for the CBM

The CBM is built on the distributed application architecture, which is “designed to allow users of a computer network to access information, applications, and services, as well as to exchange information with others, through a single, consistent user environment” (Sventek 1992). Just like other e-commerce systems, the distributed nature of the CBM needs many innovations in technologies: middleware, groupware and application development standard. These e-commerce technologies are listed in subsection 4.5.2.1, 4.5.2.2and 4.5.2.3. The CBM’s Web programming is built on a multi-tier architecture and this is introduced in subsection 4.5.2.4.

4.5.2.1 E-Commerce Middleware

Middleware is “any software that allows other software to interact” and it is “the glue between software components or between software and the network or it is the slash in Client/Server” (Middleware Resource Centre 2008). It encompasses various technologies and facilitates the availability of backend resources for the CBM.

- Communication middleware: enables application to communicate with each other. The CBM uses HTTP protocol, which is Internet's primary communication protocol between a Web browser and Web server.
- Database middleware: masks the complexities of accessing a database from applications. Open Database Connectivity (ODBC) is the database middleware standards used to increase the CBM's portability in different databases.
- Application middleware: enables the triggering of other applications, extends the functionality of applications and provide various runtime execution services. Common Gateway Interface (CGI) is the traditional portable way to invoke server-side programs. It defines how Web server software can delegate the generation of Web pages to a stand-alone application or an executable file (Robinson 2004). It is especially suitable for less intensive e-commerce application like the CBS site.

4.5.2.2 E-Commerce Groupware

Groupware refers to "programs that help people work together collectively while located remotely from each other" (Rouse 2005). It is an application that enables real time collaboration by using groupware services: sharing of calendars, collective writing, e-mail handling, shared database access, electronic meetings with each person able to see and display information to others, and other activities. The communication methods may be via e-mail, voice communication or new trend of unified messaging that enable a one-step mechanism for storing and retrieving various type of messages.

4.5.2.3 E-Commerce Application Development Standards

E-commerce application requires access to back-end relational databases and other transaction systems. Integration can be accomplished by using e-commerce suite packages customizing, the integration with a Web scripting language such as PHP, Active Server Pages (ASP), or JSP, employing specialized application servers, employing a fullblown EAI tool, or using XML-based technologies. ASP is used as a Web scripting language in developing the CBM.

4.5.2.4 Multi-Tier Architecture and Web Programming for the CBM

Typically, an application system on the Internet uses the client-server communications architecture shown in Fig. 4.5, where the client questions the server about trading, such as making a request for the details of an item, and the server processes the request and returns information to the client.

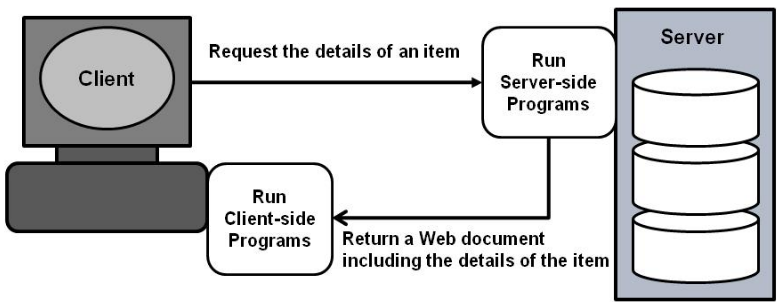


Figure 4.5 Client-server Architecture

Client-server systems are one of the most widely used systems for solving computing problems (Zhang *et al.* 2003, Huang and Ravishankar 1994). An e-market is a website where sellers and buyers make deals. The client-server architecture uses a distributed application structure. “Client-server is often a generic umbrella term for any application architecture that divides processing among two or more processes” (Reese 2000). One of the processes provides multiple users with access to the same resource and acts like a resource provider, usually called a server, and another process, called the client, is the process which obtains the data or creates a demand for it. A server machine is a host that runs server programs which share their resources with clients. A client initiates communication sessions with a server by requesting the server's content.

A computer program that runs in a distributed system is called a distributed program. Distributed programming is the process of writing such programs (Andrews 2000). Web programming is one type of distributed programming which works on the Internet. A website is a Web application on the Internet using a client-server distributed architecture. A Web application is a collection of Web pages, which are Web programmes.

Virtually every e-commerce application requires database access. A multi-tier architecture is an application structure which provides interaction between servers, clients and connection to a back-end database for an e-commerce application. The CBM is built in four-tier architecture. Fig. 4.6 shows an example of such architecture (Burlington, 2002):

Figure 4.6 Four-tier Architecture

1. A Web browser that requests from a client and presents information to the client. A client is also a computer that is connected to the Internet. It uses a Web browser and requests Web pages from the Web server. The first Web browser was created in 1993 (Andreessen 1993). A Web browser such as Internet Explorer, Netscape Navigator, Mozilla or Google Chrome, is a software tool, which uses Web pages to access information resources on the Internet (Cailliau and Gillies 2000).
2. A Web server is a powerful computer that is connected to the Internet. Through a Web server, a website can be available to everyone around the world at all times. Each Web server should have a permanent unique Internet protocol (IP) address and a domain name. A domain name, also called a hostname, is “the part of a network address which identifies it as belonging to a particular domain” (*The New Oxford Dictionary of English* 2010), such as www.hmco.com, which is the address of a computer network connection and identifies the owner of the address. A Web server that delivers Web pages, collects the data sent by the client, and passes data to and from the application server
3. An application server that executes database queries based on the data passed by the Web server, sends the queries to the back-end database, manipulates and formats the data resulting from the database query, and sends the formatted response to the Web server.

4. A database server in which the data are stored and managed and database requests are processed.

This separation of functions makes it easier to change any tier without impacting the other tiers. Thus, an application server can be designed to interface or communicate with a wide variety of databases and database management systems, such as Oracle or MS SQL Server. So Web programming can be regarded as communication between a client and servers. Generally, there are two kinds of software technology in existence to build systems that can integrate Internet and Web components: they are the ‘client-side’ and the ‘server-side’ of Web programming (Deitel and Deitel 2007).

Client-side programmes are executed by the client's Web browser (Raggett 1997). Most of the traditional Web pages, which are built with technologies like JavaScript, ActiveX, Java, and Flash, do not involve any server processing. The greatest problem with these client-side technologies is that they might not be supported by all browsers and operating systems. In addition, the client-side technologies have serious security problems.

On the other hand, in server-side Web programming, a user's request is verified by running a script directly on the Web server to generate dynamic Web pages. In the past, the way to build a server-side Web application was tedious and error-prone (MacDonald 2007) by using the challenging CGI standard. Microsoft Visual Studio is used as a development tool to create the distributed programming applications in this research. In its rich environment, developers can write source codes, compile them and rapidly create ASP.NET applications. In ASP.NET, C# programming is use as scripting languages and .NET languages to develop the CBM.

ASP.NET is a more capable Microsoft Web application platform. ASP.NET does not have the same security problems as the client-side approaches, because it is designed as a server-side technology. It allows programmers to build dynamic websites, Web applications and Web services. It supports new web-enabled devices such as personal digital assistants (PDAs), smart phones and palmtop computers. Although ASP.NET is server-side, it allows programmers to combine the best of client-side programming with server-side programming, and it can intelligently adjust itself to whatever type of client browser is being used. On the ASP.NET platform, an e-commerce site for the CBM can be easily built.

4.6 Summary

In this chapter, an overview of the CBM has been provided. The structure of the CBM enables it to create a virtual market on the Internet by involving multi e-markets. The CBM is composed of core-brokers, projects, providers' coalitions, e-markets, market-brokers, buyers' coalitions and a Core Broking System (CBS), which comprises three components: a CBS website, a project subsystem and a market subsystem. The CBS website is for core-brokers to list their group-trading projects and meet market-brokers. The project subsystem is specially designed to assist the core-broker, while the market subsystem is for the market-brokers.

The CBM inherits two functions from the core, but has made some improvements. In the core, marginal utility function is used, but price lists and orders are used in the CBM to calculate the total benefit of a coalition and the gains of each member. This public information is easier for brokers to collect than that required for the marginal utility function. In the CBM, a stability check is used to ensure a Pareto efficient allocation can be reached in a coalition. Some additional techniques make the CBM capable of coping with the problems of online group-trading; there are volume discounts, stability check and the Shapley value, which give traders more incentives. With the further techniques of distributed computing, information hiding and collaboration between traders, the CBM is able to reduce its computational complexity. Techniques of internet computing and distributed computing enable the CMB to work in e-markets.

An algorithm is designed to find a core. At first, it calculates the $v(S)$ of every sub-group, and this is a time consumed task. A sub-coalition, which has the biggest $v(S)$, is then selected as the core. Another algorithm that involves 7 groups of arrays and 9 sub-functions, reflects the CBM procedure to calculate $v(S)$ of the grand coalition and the participants' benefits in a group-trading.

Two different kinds of brokers: a core-broker and market-brokers, are described in the CBM. A core-broker acts like a project manager, while market-brokers are like salesmen. The core-brokers create a multi-provider project for a session of bundle-selling and have overall responsibility for successful planning, execution, monitoring, control and closure of a project. They must find market-brokers to work with. After signing an agreement with the core-broker, market-brokers start to gather buyers. The core-brokers provide all necessary information to the market-brokers for them to promote the products. Making or breaking a deal with buyers is the main responsibility of the market-brokers, so their interaction with customers often determines the final outcome of a retail transaction.

In the CBM, there are four kinds of fees: a session fee, an online store fee, a handling fee and a final value fee. The session fee and the online store fee are paid to the CBS site, while the handling fee and the final value fee form the commission to the brokers. A session fee is paid by core-brokers every time they list for a session on a project on the site. An online store fee of the CBS is a monthly fee for market-brokers, who wish to open an online store on the site. The final value fee is paid by the providers to reward the brokers and is 7% of the final selling value. The handling fee is 10% of the extra discount, which the customer gains after each of the brokers has processed the orders.

Since the potential number of traders in e-markets may be large, a high speed network with high-rate bandwidth and low latency is required in the group-trading. It is important to choose a correct infrastructure to enable the group-trading operations to run efficiently in the new model. Four different levels requirement of the CBM are highlighted, and then the technology elements that are required for the effective development are listed. Just like other e-commerce systems, the distributed nature of the CBM needs many innovations in technologies: middleware, groupware and application development standard. During the process of adjustment, a Web distributed system based on the elements of knowledge level in the CBM was implemented to show that the foundational principles of this research are workable both in logic and in practice. By using the ASP.NET platform, the CBM is built on the distributed multi-tier architecture which provides interaction between servers, clients and connection to a back-end database for an e-commerce application.

The overview in this chapter clarifies many of the basic concepts and provides the background against which the details of the CBM can be examined in the next chapter.

Chapter 5

A Closer Look at the CBM: A Case Study

In this chapter, a case study demonstrates the processes occurring in the CBM. The applicability of the CBM to e-markets is presented through a case study relating to a group-trading project in a travel agent scenario. In section 5.1, group-trading project S1 is initiated by core-broker Ben. Three suppliers, who provide hotel rooms and car hire around the Midlands, join the project and sell their products using the new method provided by the CBM. The purpose of the project is to enable sessions of bundle selling by integrating the resources of the providers. By offering volume wholesale discounts, customers may form groups in order to purchase items. During the process of this research, an elementary prototype of the Core Broking System (CBS) was developed in C# under the development environment of Visual Studio 2008. It consists of two subsystems: the project subsystem and the market subsystem. It was built to assist core-brokers and market-brokers perform their tasks efficiently and effectively during trading in the CBM. There are four stages in the CBM, namely *commencing*, *gathering*, *combining* and *closing*.

In section 5.2, the processes of these stages are illustrated. The market-brokers collect payment from the customers and transfer it to the core-brokers. On receipt the money in their bank accounts, the core-brokers issue coupons which are then dispatched from the market-brokers to the customers, so that they can claim the products or services from the providers. In the *commencing* stage, the three market-brokers advertise the project in their e-markets. In the *gathering* stage, the market-brokers bring customers to the core-broker, Ben. Unlike normal e-markets, the customers are allowed to place their orders with the discount they wish to get in the CBM. In the *combining* stage, the core-brokers increase the customers’ discounts by combining the orders from the market-brokers. In the *closing* stage, the core-broker and the market-brokers allocate the goods to their customers and decide how much they should pay.

5.1 A Group-Trading Project: S1

Core-broker Ben plans to create a group-trading project 'S1' after he has considered the resources available to him. He will market it as 'Summer Time around the Midlands' to help people travel economically during the summer. The coupons can be purchased by buyers with volume discounts. The buyers will use these coupons for their travelling by sending them to travel agents who provide them with hotel rooms and car hire around the Midlands. Ben has to prepare a proposal first. The aim of the proposal is to bring together a number of different products for a session of bundle selling in which a couple of providers will need to be involved. Three tables, a product table, a supplier table and a providing table, are used by Ben to store the information about suppliers and the products offered. The structure and descriptions of these three tables are listed in Appendix 4. The supplier table and the providing table can only be accessed by Ben, who will wish to protect this valuable resource from others.

Table 5.1 Suppliers

Supplier ID	Name	E-mail	Phone No	Address	Supplier ID	Post Code
P1	Bob	bob399@cbs.co.uk	(01788)556492	399 Barby Rd Rugby	P1	CV22 5DT
P2	Tom	tom1528@cbs.co.uk	(024)76305681	1528 Burton Rd Atherstone	P2	CV9 3PX
P3	Ken	ken416@cbs.co.uk	(01455)293434	416 Bosworth Rd. Nuneaton	P3	CV13 6PA
P4	Mike	mike766@cbs.co.uk	(024)76343459	766 Burling Way Nuneaton	P4	CV10 7RH

Table 5.2 Products

Supplier ID	Product ID	Retail Price	Stock	Cost
P1	Ca	100.91	44	25.15
P1	Cb	67.87	30	16.66
P1	Cc	49.03	40	12.56
P1	Ra	85. 49	20	23.21
P2	Ca	99.29	34	27.62
P2	Cb	64. 49	25	18.09
P2	Cc	47. 68	31	11.29
P2	Cd	27. 02	30	7.46
P2	Ra	90.27	38	21.39
P2	Rb	54.69	41	14.64
P3	Ca	99.28	49	24.72
P3	Cb	70. 85	34	20.70
P3	Cc	49.78	37	11.71
P3	Cd	29. 84	19	6.46
P3	Rb	51.56	22	16.58
P3	Rc	28.08	40	7.00
P4	Ca	98.29	48	25.15
P4	Cb	63.38	36	16.66
P4	Cc	47.04	42	12.56
P4	Rb	50.60	41	14.64

It is essential to seek suitable providers who can offer the right products. In Table 5.1, there are four potential providers for project S1: P1, P2, P3 and P4. In Table 5.2, the information relates to the products provided by the suppliers. A single supplier may provide more than one product and it is not necessary for one product to be obtained from only one supplier. Table 5.3 shows the possible products that Ben can put into his proposal.

Table 5.3 Details of Products

Product ID	Product Description
Ca	Car classed exceptional
Cb	Car classed standard
Cc	Car classed intermediate
Cd	Car classed compact
Ra	Room of twin private
Rb	Room of four-bed Dorm
Rc	Room of eight-bed Dorm
If	Insurance for family under 60
Is	Insurance for single person
Fd	Direct flight from Ireland to the UK

Table 5.4 Volume Discounts from Ben

Car Rental	>=2	>=5	>=10	>=20	>=50
Ca	5%	10%	20%	30%	40%
Cb	0%	5%	10%	20%	30%
Cc	0%	0%	5%	10%	20%
Cd	0%	0%	0%	5%	10%
Hotel Room	**>=3**	**>=8**	**>=15**	**>=25**	**>=45**
Ra	5%	10%	18%	25%	35%
Rb	0%	5%	10%	18%	25%
Rc	0%	0%	5%	10%	18%

According to the contents of the above three Tables, Ben sets up a proposal PR1 for a travel agent to provide hotel rooms and car hire around the Midlands. Ben then works out the volume discount in Table 5.4 for the products he wants to include in the proposal. He will have to discuss the contents of the proposal with the suppliers.

Table 5.5 Details of Products after Negotiations

Supplier ID	Name	Product ID	Retail Price	Stock	Cost
P1	Bob	Ca	98.29	48	25.15
		Cb	63.38	36	16.66
		Cc	47.04	42	12.56
		Ra	82.88	40	23.21
P2	Tom	Ca	96.29	40	27.62
		Cb	62.93	29	18.09
		Cc	46.64	31	11.29
		Cd	26.28	30	7.46
		Ra	87.27	38	21.39
		Rb	50.60	41	14.64
P3	Ken	Ca	96.26	49	24.72
		Cb	68.98	34	20.70
		Cc	45.78	37	11.71
		Cd	26.89	26	6.46
		Rb	50.55	27	16.58
		Rc	24.04	41	7.00

The interviews and the negotiations which now take place with potential providers will transform the idea conceived into a formal project. After responses to this proposal have come through from the suppliers, the negotiations between Ben and the suppliers can begin and a project for online joint-selling created. During the period of negotiation, supplier P4 decides to leave, but suppliers P1, P2 and P3 want to take part in the joint-selling. The providing table in Table 5.5 shows the products that the suppliers provide after Ben negotiates with them. Ben can now transform proposal PR1 into a new project S1.

Table 5.6 Products in Project S1

Project ID	Supplier	Product ID	Retail Price	Stock	Cost
S1	Ben	Ca	96.98	137	25.72
		Cb	65.17	99	18.47
		Cc	46.50	110	11.92
		Cd	26.56	56	7.00
		Ra	85.02	78	22.32
		Rb	50.58	68	15.41
		Rc	24.04	41	7.00

Being assisted by the project subsystem, Ben works out the data for each product in the project using the information in the providing table. Table 5.6 shows the new contents of the project providing table. For instance, in Table 5.6, the total stock of product Ca is 48+40+49=137. The retail price of product Ca is the average retail price, (£98.29×48+£96.29×40+£96.26×49)÷137=£96.98. Likewise, the average cost of product Ca is (£25.15×48+£27.62×40+£24.72×49)÷137=£25.72. In this way, project S1 looks to customers as if there was only one supplier, who is Ben himself. The final retail price in Table 5.6 will be used to calculate the discount for customers and what to pay the providers for the items. He has to determine the volume discounts for these four products.

Table 5.7 Price Lists in Project S1

Project ID	Product ID	Range No	Minimum Amount	Discount
S1	Ca	1	2	5%
		2	5	10%
		3	10	20%
		4	20	30%
		5	50	40%
	Cb	1	5	5%
		2	10	10%
		3	20	20%
		4	50	30%
	Cc	1	10	5%
		2	20	10%
		3	50	20%
	Cd	1	20	5%
		2	50	10%
	Ra	1	3	5%
		2	8	10%
		3	15	18%
		4	25	25%
		5	45	35%
	Rb	1	8	5%
		2	15	10%
		3	25	18%
		4	45	25%
	Rc	1	15	5%
		2	25	10%
		3	45	18%

After Ben discusses it with the suppliers, the project price list table is compiled (Table 5.7). Ben has decided that the new project S1 is a travel agent offering inexpensive hotel rooms and low car rentals. The products have varied discounts, because buyers have ordered different volumes of the product. For instance, ordering 21 units of product Ca falls in range 4 and has 30% discount.

The CBS was designed to assist brokers with their tasks in group-trading and supported by a CBS website for core-brokers to list their group-trading projects. By getting forms from the CBS site, Ben can now prepare the following three documents:

- **Project specs –** this may include description, aims, background, the possible advantages and any information about the project which may be useful to the market-brokers. The initiating and closing date of the project must be also included.
- **Product descriptions –** the products, involved in the project, have to be fully described.
- **Price lists –** the retail prices of the products and the volume discounts for them.

Before core-brokers upload the above three documents to the CBS website, Ben needs first to register himself and project S1 on the CBS website. Once this information is stored in the database and listed on the CBS site, he can start a session of group-trading. In the next section, the process of how Ben executes project S1 on the CBS is demonstrated.

5.2 The Process in the CBM

In the CBM, core-brokers and market-brokers execute group-trading sessions on the CBS website. With the help of programs in the CBS, the brokers can easily calculate the discounts for the buyers. After a project is initiated, a group-trading session can be started.

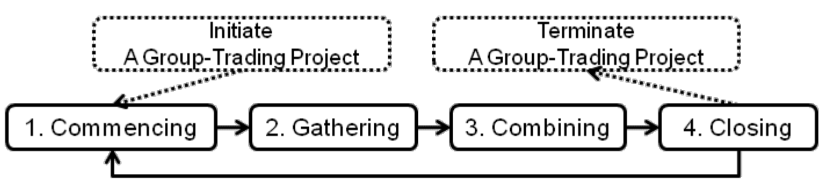


Figure 5.1 System Flow Chart of the CBM

The system flow chart of the model is shown in Fig. 5.1. There are four stages: commencing, gathering, combining and closing. A brief description for these stages is as follows:

1. **Commencing –** the core-broker recruits market-brokers and begins sessions of group trading in a project.
2. **Gathering –** the market-brokers attract buyers to their websites and submit the coalitions of buyers they have formed to the core-broker.
3. **Combining –** the core-broker combines the coalitions together, decides the final prices for the items, checks the stability of the coalitions and sends notices to the market-brokers.
4. **Closing –** the market-brokers close the deal with the buyers. The final orders and invoices for each customer will be prepared by the market-brokers. After the buyers have paid for their purchases, the profits of the providers and the commission for all the brokers will be calculated. At this point, the core-brokers may choose to have a new session of trading or to stop the project for good.

Each session has a starting and end date. The duration of each session should be long enough for a market-broker to form a coalition of buyers of a reasonable size. It should also be short enough to allow buyers to gain the items they want as soon as possible. They may be in a hurry, because some of the products or services will cease to be useful after quite a short period of time (Matear *et al*. 2000). In the CBM, the suggested duration for a session is usually one week. The ending time of a session needs to be clearly communicated to the market-brokers.

The CBS is built to aid brokers with the tasks in each stage of the CBM. A database in the CBS, which contains several tables, is available for the brokers to store the information needed for the tasks in the above stages. The structure and descriptions of these tables are listed in Appendix 4. More details about the stages are given in the following sections.

5.2.1 Commencing

The core-brokers must find several market-brokers to help with the marketing, before a session of online joint-selling starts. It is also necessary for the core-broker to fix a starting and end date for a session of group-buying. In Fig. 5.2, there are two steps: recruit market-brokers and start a session of group-trading.

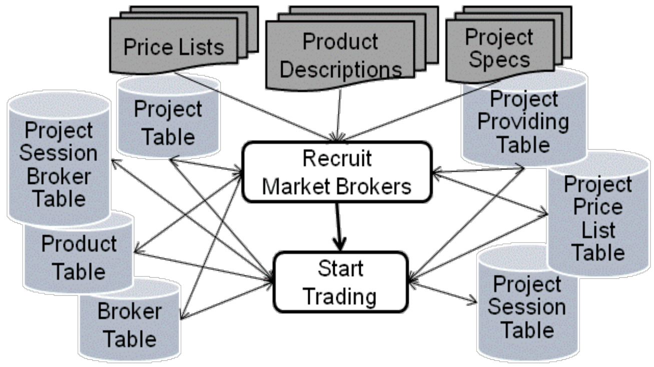


Figure 5.2 Commencing Stage

5.2.1.1 Recruit Market-brokers

The core-brokers have to recruit qualified market-brokers to take part in the project before a session can really start. The market-brokers must be capable of bringing buyers in to join the group-buying for the project. There are plenty of alternatives that core-brokers may use to find market-brokers, such as team members who have already worked with them in the past; new applicants who apply on the CBS site; other core-brokers or their team members; or other potential market-brokers whom the core-brokers find by exploring broker directories at sites like ‘Top20Sites.com’.

Candidates for the positions of market-broker need to be members of the CBS site and have a member ID before they make an application to the core-brokers for the posts. The personal information of a successful applicant is stored in the broker table. A project usually needs 3 or 4 market-brokers, but it is up to the core-brokers to decide how many they want.

In Table 5.8, three market-brokers, Paul, Tim and Phil, are assigned by Ben to the project P1. They are in charge of gathering customers locally, from their own geographical areas. The project that the core-broker has initiated now has global proportions, because the core-broker has collaborated with market-brokers all over the world. In addition to the information shown in Table 5.8, the broker table may contain other information about market-brokers, such as the URL of their shopping sites.

Table 5.8 Market-brokers in Project S1

Broker ID	Name	E-mail	Phone No	Address	Post Code
MK21	Paul	Paul874@cbs.co.uk	(01455)226490	874 Orchard Close, Hinckley	LE10 3LR
MK30	Tim	Tim5361@cbs.co.uk	(024)76305681	5361 Moat Ave, Coventry	CV3 6BW
MK37	Phil	Phil782@cbs.co.uk	(01132)639415	782 Conference Place, Leeds	LS12 3DZ

5.2.1.2 Start Trading

The core-brokers can pay a session fee of £30 and start a project session, when the information such as the starting and end date of the session of trading has been stored in the project session table. In Table 5.9, session 01 of project S1 begins on the morning of 22 August 2011 at 9:00 and will end at 23:59 on 29 August 2011.

Table 5.9 A Session of Group-Trading

Project ID	Session ID	Starting Date	End Date
S1	01	22 August 2011	29 August 2011

Ben inserts three records in the project session broker table as demonstrated in Table 5.10. Each record shows the status of the respective market-broker, in the current session of trading. Each market-broker is given one unique order ID for a session of trading. The order date/time field stores the actual submission time of the market order of a market-broker. The field headed 'total' is the total payment of the market order of a market-broker. The received payment, which the market-broker has paid, is stored in the received field.

Table 5.10 Trading Records

Project ID	Session	Broker ID	Order ID	Order Date	Order Time	Total	Received
S1	01	MK21	OP10121	29/08	18: 42: 56		
S1	01	MK30	OP10130	29/08	09:24:50		
S1	01	MK37	OP10137	29/08	13: 52: 43		

The market-brokers are given the information needed for their own website to promote the project including three documents; a project session specification, a product description and a price list which are shown in the beginning of section 5.2. There may be more than one session of trading for a project and it is not necessary for the same market-brokers to be involved in further sessions. Before a new session of trading starts, the core-broker of the project will need to check that the right market-brokers are in place for the new session. Sometimes, the market-broker may be one of the suppliers in the project, as long as there is an agreement.

Only the market-brokers are permitted to deal with potential customers and accumulate profits. So the core-brokers must attempt to supply the market-brokers with the information they need to promote the project on his/her website, such as the project description, the product descriptions and the price list. In the next section, market-broker Tim illustrates how a market-broker gathers customers in his own area.

5.2.2 Gathering

This section describes how market-brokers gather customers to visit their online shops. First, the market-brokers have to set up their websites, where they can advertise the project and attract customers. They need to submit their coalition to the core-broker before the ending time of the current session of trading. In Fig. 5.3, the market-brokers are responsible for most of the tasks in this stage. Three tables, a customer table, an order table and an order detail table, are used by the market-brokers to store information about their customers and the orders the customers have made.

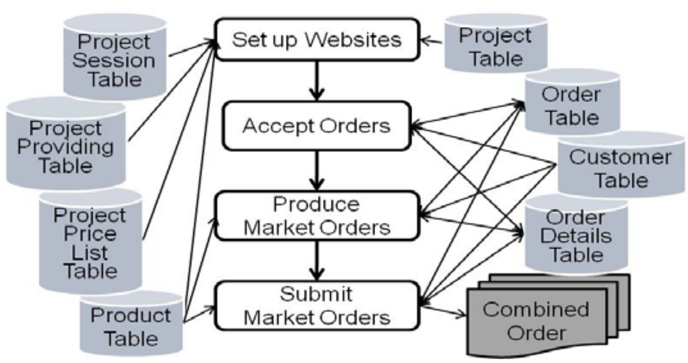


Figure 5.3 Gathering Stage

As the system flow chart shows that there are four steps in this stage, namely: setup websites; accept orders; produce market orders and submit market orders.

5.2.2.1 Setup Websites

In order to perform transactions of online group-buying, the market-brokers must have shopping websites where they can list goods for a session in the group-trading project.

They may set up their own personal website in running their own online shopping site. The key, however, is to find ways to attract customers, which can be quite a problem, even for a market-broker.

Another option involves the compilation of a list the goods for a session in a group-trading project on an existing online shopping avenue. If market-brokers choose a group-buying site, the results will be different from those on a normal site. If they decide to go for a popular non-group-buying site like eBay, they have the additional task of working out a way to form buyers' coalitions on that site. It would be easier to form buyers' coalitions on a popular group-buying site like LivingSocial, but as they only put one product up for sale each day and there are many providers waiting in the queue – Listing could take a long time.

Having set up their group-buying website, the market-brokers may also download the three documents of public information and the five tables of project information on the CBS website. Even though this information should be enough to list the project on their websites, the core-broker will still need to provide as many resources as possible, so that the market-brokers can gather potential buyers. The market-brokers can then advertise the goods on their websites and try to attract potential buyers to purchase the products as a group. If customers show an interest, they are asked to leave their contact details. It is the market-brokers' responsibility to keep the site updated with the latest trading information.

5.2.2.2 Accept Orders

The market-brokers accept the orders from the customers. With aid from the market system, the market-brokers will easily keep updating the status of the current volume discounts for each product and list these on line. The customers may come back and check the latest status on the sites.

A 'submission time' is the time when the market-broker plans to submit the coalition to the core-broker. It is usually near to the end date of the session. Quite often customers will wait and watch without making an order. A submission time is therefore used to urge customers to place orders promptly. Thus, it is good to make the submission time on the market-brokers' websites as clear and easy as possible for the customers to follow. In Table 5.11, market-broker Tim receives four orders which are from three customers: Martin, Steve and John. They each have a unique customer ID in the customer table shown in Table 5.12, namely C34, C92 and C108.

Table 5.11 Tim's Customers

Order ID	Description	Date/Time Ordered	Shipping Address	Customer ID
O081101	1st order of C92.	26 August 12:09:24	727 Abercom Rd. Chapelfield, Coventry CV1 8ED	C92
O081109		26 August 16:20:56	3107 Hartlepool Rd., Coventry CV1 5JB	C34
O081207	2nd order of C92.	27 August 02:36:48	8921 Mowbray St., Coventry CV2 4FZ	C92
O081211		27 August 10:47:25	822 Longford Square, Coventry CV6 8ED	C108

Table 5.12 Tim's Customers' Orders

Cust ID	Name	E-mail	PayPal	Phone No	Address	Post Code
C34	Martin	martin368@cbs.co.uk	Martin51@gmail.com	(024)76717851	368 Earlsdon Avenue South, Coventry	CV5 6DT
C92	Steve	steve591@cbs.co.uk	steve217@ cbs.co.uk	(024)76448217	591 Wyver Crescent, Coventry	CV9 3PX
C108	John	john9762@cbs.co.uk	john9762@cbs.co.uk	(024)76369435	9762 Torrington Ave, Coventry	CV4 9HL

The order lines of these four orders are stored in the order detail table in Table 5.13. The two orders from customer Steve have different shipping addresses. He orders 14 units of product Cd and gets 0% discount for order O081101. When he places his second order, O081207, he purchases another 6 units. So he buys 20 units of product Cd altogether and therefore has 5% discount. So the actual discount for product Cd in order O081101 changes from 0% to 5% discount. In fact, the actual discount and the actual quantity, which customer Steve gets, will finally be decided only after Ben has combined all the market-brokers' orders together.

Table 5.13 Original Details in Tim's Customers' Orders

Order ID	Product ID	Quantity Ordered	Expected Discount	Customer ID	Actual Discount
O081101	Cb	2	10%	C92	0%
O081101	Cc	17	20%	C92	10% (5%)
O081101	Cd	14	10%	C92	5% (0%)
O081101	Ra	11	18%	C92	10%
O081109	Cc	9	10%	C34	0%
O081109	Cd	4	10%	C34	0%
O081109	Ra	6	25%	C34	5%
O081207	Cc	5	20%	C92	10% (0%)
O081207	Cd	6	10%	C92	5% (0%)
O081211	Cb	5	30%	C108	5%
O081211	Ra	8	35%	C108	10%

Customer Steve himself expects to get 10% discount out of product Cd in this group-trading scheme. His intention is shown in the expected discount field in Table 5.13. If the actual discount of a product in an order is less than the expected discount, the product may be dropped from the order at the end. The market-brokers will try to negotiate with the customers about the high expected discounts. This will be discussed below.

5.2.2.3 Produce Market Orders

After the market-brokers have collected the orders from the customers, they use the market system to help them combine the customer orders into market orders. It is up to the market-brokers to decide on the submission time. When the deadline for submission has passed, the market-broker stops taking orders from customers and concentrates on preparing the submission. It is necessary to combine all the orders a market-broker has into one big market order, because a market-broker can only be allowed to give the core-broker one market order for one session.

Table 5.14 Tim's Market Order

Order ID	Description	Date/Time Ordered	Shipping Address	Customer ID
OP10130		29 August 09:24:50	5361 Moat Ave, Coventry CV3 6BW	MB30

The contents of Table 5.14 give the impression that the market order is purely from market-broker Tim with a broker ID, MB30. It does not include any information from Tim's customers. This effectively protects the information of his customers. So combining the orders is beneficial to a market-broker and will reduce the computational complexity of the coalition as well.

In Table 5.10, the four records in the order detail table imply that there are four products in the market order. The field headed 'quantity ordered' stores the total quantities of the products in the orders that have been combined by the market-brokers. In Table 5.13, the quantities of product Ra are 16, 19 and 4. So in Table 5.15, the total quantity of product Cb in Tim's market order is $14+6+4=24$, which makes the actual discount of the product to be 5%.

Table 5.15 Original Details in Tim's Market Order

Order ID	Product ID	Quantity Ordered	Expected Discount	Actual Quantity	Actual Discount
OP10130	Cb	7	30%		5%
OP10130	Cc	31	20%		10%
OP10130	Cd	24	10%		5%
OP10130	Ra	25	35%		25%

For each product, the largest expected discount is selected and this will be the expected discount of all the customers' orders which make up the market order. For example, the expected discounts of Product Ra in orders O081101, O081109 and O081211 are 18%, 25% and 35% respectively, as in Table 5.13. So the expected discount for product Ra in the market order is the largest of these three discounts, that is, 35%. The actual discounts of market order OP10130 in Table 5.15 - as opposed to the expected ones - will not be settled until the core-broker has combined all the orders from the market-brokers.

The quantity of the order line in the market order will be set to zero by the core-broker, when its expected discount is higher than its actual discount. The consequences of this will be quite serious, because now nobody in the group that the market-broker has assembled will get the product. It is the market-brokers' duty to make sure that every member of their group gets the goods they want in the trading session. The system will produce a warning list for the market-brokers containing all the expected discounts that are higher than the actual discounts in the order lines. So they may try to negotiate with the customers, before they submit the market order to the core-broker.

In Table 5.15, all the expected discounts are higher than the actual discounts in the order lines of Tim's order. He has negotiated with his customers and has tried his best to cut down their expected discounts. For instance, in the case of product Ra, Tim had to tell his customers that he was not sure that he would be able to get the expected discount of 35%. So he persuaded customer Steve to change the expected discount for product Ra from 35% to 25%. Table 5.16 shows the order detail table from customers after Tim has fulfilled his duty.

Table 5.16 New Details in Tim's Customers' Orders

Order ID	Product ID	Quantity Ordered	Expected Discount	Actual Quantity	Actual Discount
O081101	Cb	2	5%		0%
O081101	Cc	17	10% (20%)		10%
O081101	Cd	14	5% (10%)		5%
O081101	Ra	11	18%		10%
O081109	Cc	9	10%		0%
O081109	Cd	4	5% (10%)		0%
O081109	Ra	6	25%		5%
O081207	Cc	5	10% (20%)		10%
O081207	Cd	6	5% (10%)		5%
O081211	Cb	5	5% (30%)		5%
O081211	Ra	8	25% (35%)		10%

Table 5.17 New Details in Tim's Market Order

Order ID	Product ID	Quantity Ordered	Expected Discount	Actual Quantity	Actual Discount
OP10130	Cb	7	5%		5%
OP10130	Cc	31	10%		10%
OP10130	Cd	24	5%		5%
OP10130	Ra	25	25%		25%

In Table 5.17, the new order detail table of Tim reveals excellent results after the negotiation. The lower the expected discount is, the greater the chance will be that the customers will be able to obtain the items they have ordered. If the expected discount is to be changed, the buyers must give their consent first. So, competent market-brokers would try their best to persuade their customers to make the expected discount as low as the actual discount.

5.2.2.4 Submit Market Orders

The market-brokers submit the market orders to the core-broker using the market system with the unique order ID provided at the beginning of the session. After the current coalitions have been transformed into market orders, the actual submission time will be recorded in them as the order date/time. The market-brokers must hand in their market orders to the core-broker before the end time of the session. Each market-broker can only give one order to the core-broker in a single session of trading. In Table 5.14, market-broker Tim submits order OP10130 at 9:24:50 on 29/08/2011, which is the critical time in the event of a stock shortfall. At this point, he does not have any way of knowing whether the stock of Ben is enough for all the market-brokers, so the best policy for him is to submit the market order as early as possible. The details of the revised order are given in Table 5.17.

When the end date of a session is reached, the market-brokers send out their market orders and wait for a reply from the core-broker. After the core-broker has processed the orders, the market-brokers will receive notices from the core-broker. In the next section, the core-broker moves all the market orders from the market-brokers into the core and calculates the results for the orders, including the discounts for each product the market-brokers have submitted.

5.2.3 Combining

The purpose of this stage is to try to obtain higher discounts for the market-brokers. The core-broker of the project handles most of the tasks in this stage. When all the market orders of the session have been collected, the core-brokers use the project system to verify the data contained in the orders from the market-brokers. After liaising with the market-brokers and confirming all the details of the orders, they will now combine all the coalitions and provide higher discounts for each product to the customers with the aid of the project system.

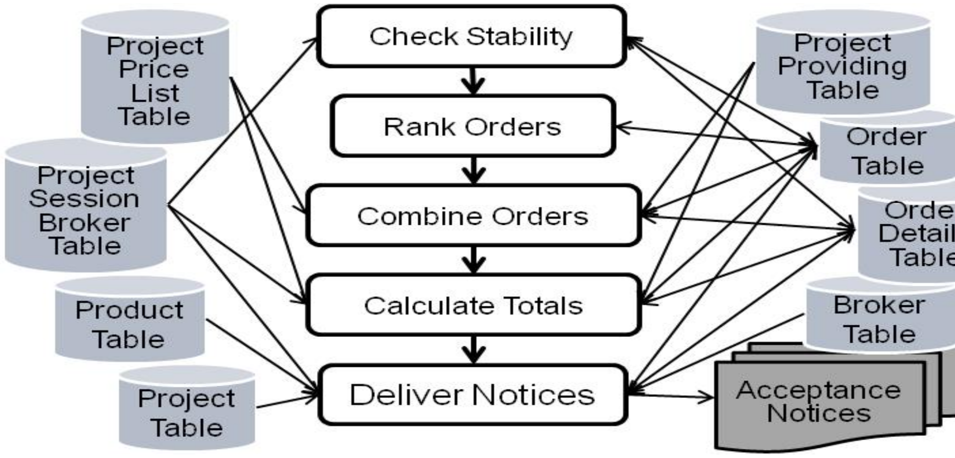


Figure 5.4 Combining Stage

In Fig. 5.4, the system flow chart shows that there are five steps in this stage, namely check stability, rank orders, combine orders, calculate discounts and deliver notices.

Table 5.18 Details in Phil's Combined Order

Order ID	Product ID	Quantity Ordered	Expected Discount	Actual Quantity	Actual Discount
OP10137	Cb	12	20%		10%
OP10137	Cc	15	20%		5%
OP10137	Cd	16	10%		0%

Table 5.19 Details in Paul's Combined Order

Order ID	Product ID	Quantity Ordered	Expected Discount	Actual Quantity	Actual Discount
OP10121	Cb	10	30%		10%
OP10121	Cd	28	10%		5%
OP10121	Ra	36	35%		25%

The details of the market orders from the three market-brokers are shown in Tables 5.17, 5.18 and 5.19 respectively. These tables are used to illustrate how the core-broker processes the orders, as the four steps are followed through.

5.2.3.1 Check Stability

The core-brokers check the stability of the coalition, by making sure that the current coalition's total benefit is larger than the total benefit of its every subset. Before they do so, they have to determine the total profit of the possible subgroups of the coalition.

The quantities of the items, which each market-broker can have as a member of a particular subgroup, can be calculated by using the same method as in step 3. There are four members: Ben, Phil, Tim and Paul in the current coalition. There are 7 subgroups for the coalition. Table 5.20 displays the items each market-broker can have in all the sub-coalitions. Coalition $S_{1,3}$, {Ben, Phil, Paul}, contains Ben and market-brokers Phil and Paul. Function *q*(a market-broker) represents the items which the market-broker can get. In $S_{1,3}$, market-broker Phil get 16 units of product Cd and Paul gains 28 units of Cd and 36 units of Ra.

Table 5.20 Sub-Coalitions

Subgroup	Members	q(Phil)				q(Tim)				q(Paul)			
		Cb	Cc	Cd	Ra	Cb	Cc	Cd	Ra	Cb	Cc	Cd	Ra
S_1	{Ben, Phil}	0	0	0	0	0	0	0	0	0	0	0	0
S_2	{Ben, Tim}	0	0	0	0	7	31	24	25	0	0	0	0
S_3	{Ben, Paul}	0	0	0	0	0	0	0	0	0	0	0	0
$S_{1,2}$	{Ben, Phil, Tim}	0	0	16	0	7	31	24	25	0	0	0	0
$S_{2,3}$	{Ben, Tim, Paul}	0	0	0	0	7	31	24	25	0	0	28	36
$S_{1,3}$	{Ben, Phil, Paul}	0	0	16	0	0	0	0	0	0	0	28	36
$S_{1,2,3}$	{Ben, Phil, Tim, Paul}	0	0	16	0	7	31	24	25	0	0	16	36

Table 5.21 Profits of Sub-Coalitions

Subgroup	*v*(Phil)	*v*(Tim)	*v*(Paul)	*v*(BEN)	*v*(Subgroup)
S_1	**0**	**0**	**0**	**0**	**0**
S_2	0	974.98	0	2461.84	3436.82
S_3	0	0	0	0	0
$S_{1,2}$	42.50	974.98	0	2732.31	3749.78
$S_{2,3}$	0	974.98	1146.12	4122.04	6243.14
$S_{1,3}$	42.50	0	1146.12	1930.66	3119.28
$S_{1,2,3}$	42.50	974.98	1087.69	4189.65	6321.38

Function *v*(a market-broker) indicates the discount for the market-broker's customers. In Table 5.20, market-broker Phil gets 26 units of product Cd in coalition $S_{1,3}$. He gains 10% discount. The value of *v*(Phil) in $S_{1,3}$ is £26.56×10%×16=£42.50, listed in Table 5.21. All the savings made as a result of a market-broker's discount, will be for the benefit of the buyers for whom he/she is working. This will be explained in the next stage.

Function *v*(a core-broker) signifies the profit of the brokers and providers. In $S_{1,3}$, Ben's profit is from the payment from market-brokers Phil and Paul. The costs of product Cd and Ra are £7 and £11.92 respectively. The retail price and discount for product Ra are £22.32 and 35%. The value of *v*(Ben) in $S_{1,3}$ is (£26.56×(1–10%)–£7)×(16+28)+(£22.32×(1–35%)–£11.92)×36=£1930.66. In fact, total profit *v*(Ben) does not belong to Ben only. It will be distributed among the providers and brokers.

Function *v*(a subgroup) represents the total benefit that accrues to both buyers and providers. The value of $v(S_{1,3})$ is £42.50+£1146.12+£1930.66=£3119.28. The benefits of all the seven sub-coalitions are listed in Table 5.21. This data enables Ben to check the stability of the coalition. It turns out that coalition $S_{1,\ 2,\ 3}$ is stable, because it has the largest benefit, i.e. £6321.38.

5.2.3.2 Combine Orders

The core-brokers combine the market orders from the market-brokers into a single large order after the orders are sorted in ascending order according to the dates on them. They combine the orders using the same principle as the market-brokers in the third step of the gather stage. They also calculate the actual discount for each product. The actual quantity ordered is checked against the quantity the core-broker has in stock to take account of any shortfall.

Order OP101ALL shown in Table 5.22 is the result of Ben combining the three orders in Tables 5.17, 5.18 and 5.19. The quantities of product Cd from market-brokers Phil, Tim and Paul are 26, 24 and 28. Thus the quantity of product Cd in order OP101ALL is 26+24+28=78, but the stock of product Cd is only 56 (see Table 5.6). When Ben finds there is a lack of stock, he will try to contact the providers and request a further supply. In this case, Ben did not succeed in getting more items. The actual discount of product Ra is 35% as can be seen from Table 5.7. The expected discounts of product Ra in Tables 5.17 and 5.19 are 25% and 35%. The highest 35% is then put into the expected discount field in Table 5.22 opposite product Ra.

Table 5.22 Non-Finalised Core

Order ID	Product ID	Quantity Ordered	Expected Discount	Actual Quantity	Actual Discount
OP101ALL	Cb	29	30%	29	20%
OP101ALL	Cc	46	20%	46	10%
OP101ALL	Cd	78	10%	56	10%
OP101ALL	Ra	61	35%	61	35%

The order lines of order OP101ALL need to be adjusted if their expected discount is higher than their actual discount. For example, for product Cb in Table 5.22, the expected discount of 30% is higher than the actual discount of 20%. The order lines of product Cb in Tables 5.17, 5.18 and 5.19 have to be dropped from the trading, if their actual discounts are less than the expected discounts. The expected discount of product Cb in

Paul's order is 30%, which is higher than the actual discount, i.e. 20%. After the order line of product Cb in Table 5.18 has been excluded, the quantity ordered of product Cb in order OP101ALL is $29-10=19$. The actual discount of product Cb becomes 10%. The expected discount of product Cb in Phil's order is 20%, which is higher than 10%, and needs to be excluded. Finally, the quantity ordered of product Cb in order OP101ALL becomes $19-12=7$ and the actual discount becomes 5%. In the same way, the order lines of products Cc, Cd and Ra in order OP101ALL can be worked out. The order lines of order OP101ALL after being adjusted are shown in Table 5.23.

Table 5.23 Possible Core

Order ID	Product ID	Quantity Ordered	Expected Discount	Actual Quantity	Actual Discount
OP101ALL	Cb	29	5%	7	5%
OP101ALL	Cc	56	10%	31	10%
OP101ALL	Cd	78	10%	78	10%
OP101ALL	Ra	61	35%	56	35%

5.2.3.3 Calculate Totals

Before continuing to process the orders, the project system will arrange the records in the project session broker table according to the time when they were ordered.

Table 5.24 Sorted Trading Records

Project ID	Session	Broker ID	Order ID	Order Date	Order Time	Total	Received
S1	01	MK37	OP10137	29/08	08: 42: 56		
S1	01	MK30	OP10130	29/08	09: 24: 50		
S1	01	MK21	OP10121	29/08	13: 52: 43		

Table 5.24 shows the result after the records in Table 5.10 are sorted in ascending order by the *order date/time* field, which records the actual date/time that the market-brokers hand in their market orders. The core-brokers can use the system to calculate the total payment for each order that has come from the market-brokers, after they have calculated the actual discounts and the actual quantities of the order lines in the orders.

Ben works on the actual discounts for each market-broker, which are in Tables 5.25, 5.26 and 5.27 with the aid of the CBS system. Firstly, he fills the actual discounts with the same percentages as the actual discounts in Table 5.23. Secondly, he sets the actual discount of the order line to 0%, when the actual discount is less than the expected discount. For instance, 5% is entered in the actual discount field of product Cb in Table 5.25. It works out as 0%, because its actual discount of 5% is less than its expected discount of 20%.

Table 5.25 Final Details in Phil's Market Order

Order ID	Product ID	Quantity Ordered	Expected Discount	Actual Quantity	Actual Discount
OP10137	Cb	12	20%	0	0%
OP10137	Cc	15	20%	0	0%
OP10137	Cd	16	10%	16	10%

Table 5.26 Final Details in Tim's Market Order

Order ID	Product ID	Quantity Ordered	Expected Discount	Actual Quantity	Actual Discount
OP10130	Cb	7	5%	7	5%
OP10130	Cc	31	10%	31	10%
OP10130	Cd	24	5%	24	10%
OP10130	Ra	25	25%	25	35%

Table 5.27 Final Details in Paul's Market Order

Order ID	Product ID	Quantity Ordered	Expected Discount	Actual Quantity	Actual Discount
OP10121	Cb	10	30%	0	0%
OP10121	Cd	28	10%	16	10%
OP10121	Ra	36	35%	36	35%

The principle that the CBM uses in dealing with the orders is first come first served, and this principle is followed in Table 5.24. For product Cd, the actual quantity of order OP101ALL is 56, but the customers' demand was 78. There is not enough stock for all the orders, so in Table 5.27, only $56-16-24=16$ items are left over for order OP10121.

The project system calculates the total payments for each order and puts them in the project session broker table. This is shown in Table 5.28. The retail prices of products Cb, Cc, Cd and Ra are 65.17, 46.50, 26.56 and 85.06, which are shown in Table 5.6. According to the information in Table 5.26, the total payment of market-broker MK30, Tim, is $£65.17\times(1-5\%)\times7+£46.50\times(1-10\%)\times31+£26.56\times(1-10\%)\times24+£85.06\times(1-35\%)\times25=£3686.65$.

Table 5.28 Trading Records with Totals

Project ID	Session	Broker ID	Order ID	Order Date	Order Time	Total	Received
S1	01	MK37	OP10137	29/08	08: 42: 56	382.46	Y
S1	01	MK30	OP10130	29/08	09: 24: 50	3686.65	Y
S1	01	MK21	OP10121	29/08	13: 52: 43	2372.87	Y

By observing above four tables, one can see how important the role of a good market-broker is. After the negotiations by market-broker Tim, his coalition has bought the biggest number of items and has the highest total payment. A competent broker like Tim brings more benefit to both the customers and the providers, and in the CBM, also creates more commission for the brokers. A good core-broker will try to ensure that the market-brokers get the best discounts.

Perhaps someone might question whether the commission of the brokers would cover their costs. There are plenty of customers on the Internet, so this case study presumably would have to be viewed as part of a much larger trading exercise. There are several sessions of trading in a group-trading project. The market-brokers may take part in other sessions of trading, if they want to earn more commission.

5.2.3.4 Deliver Notices

The core-brokers deliver the notices to the market-brokers normally via e-mail and await payment from them. The payment from a customer includes the handling fees and the final value fees for the market-broker and the core-broker. In the CBM, the money for the brokers comes from these two fees. Since the customers' money is sent via the market-broker's PayPal account, a PayPal fee will be taken from that account. However, the market-broker is not responsible for the whole fee. Part of the fee should be paid by the core-broker and the providers and needs to be returned to the market-broker.

Table 5.29 Notice to Tim

Notice to Marker Broker **Order ID:** OP10130 **Order Date:** 29 August 2011 09:24:50 **Due Date:** 06 September 2011 **Winner:** Tim **Marker Broker ID:** MK30 **Total Payment:** **£3460.29** **Bank Account:** 01234567 **Shipping Address:** 5361 Moat Ave, Coventry CV3 6BW											
Product ID	**Quantity Ordered**	**Actual Quantity**	**Original Discount**	**Actual Discount**	**Retail Price**	**Sum**	**Handling Fee**	**Final Value Fee**	**PayPal Fee 1**	**PayPal Fee 2**	**Payment**
Cb	7	7	5%	5%	65.17	433.38	0.00	17.34	0.38	11.69	**403.98**
Cc	31	31	10%	10%	46.50	1297.35	0.00	51.89	1.13	34.99	**1209.34**
Cd	24	24	5%	10%	26.56	573.70	3.19	22.95	0.59	15.47	**537.87**
Ra	25	25	25%	35%	85.06	1382.23	21.27	55.29	1.82	37.28	**1309.10**
						3686.65	**24.45**	**147.47**	**3.92**	**99.43**	**3460.29**

A notice sent to market-broker Tim is shown in Table 5.29. The total payment is £3460.29. The due date is eight days after the order date. The order date, the shipping address, the quantity ordered and the original discount come from Tim's market order, which can be seen in Tables 5.14 and 5.15. The actual quantity and the actual discount have been taken from Table 5.24. For product Ra, the payment is £26.56×(1–35%)×25=£1382.23, and the handling fee for Ben is worked out to be £26.56×(35%–25%)×25×10%=£21.27. The final value fees is £26.56×(1–35%)×25×4%=£55.29. The field 'PayPal Fee 1' is Ben's PayPal fee, but it has actually been paid by Tim. Because the total sum is £3478.11, and the rate charged is 2.9% (refer to Table A3.6), the fee for product Ra for Ben is (£1382.23×3%+£21.27)×2.9%=£1.82. The other part of the PayPal fee, PayPal Fee 2, should be paid by the providers £1382.23×(1–7%)×2.9%=£37.28. The payment to Ben for product Ra is £1382.23+£21.27−£55.29−£1.82−£37.28=£1309.10. Tables 5.30 and 5.31 are the notices for Phil and Paul respectively.

Table 5.30 Notice to Phil

Notice to Marker Broker **Order ID:** OP10137 **Order Date:** 29 August 2011 08:42:56 **Due Date:** 06 September 2011 **Winner:** Phil **Marker Broker ID:** MK37 **Total Payment: £370.96 Bank Account:** 01234567 **Shipping Address:** 782 Conference Place, Leeds LS12 3DZ											
Product ID	**Quantity Ordered**	**Actual Quantity**	**Original Discount**	**Actual Discount**	**Retail Price**	**Sum**	**Handling Fee**	**Final Value Fee**	**PayPal Fee 1**	**PayPal Fee 2**	**Payment**
Cd	16	16	0%	10%	26.56	382.46	4.25	15.30	0.46	0.00	**370.96**
						382.46	**4.25**	**15.30**	**0.46**	**0.00**	**370.96**

Table 5.31 Notice to Paul

Notice to Marker Broker **Order ID:** OP10121 **Order Date:** 29 August 2011 13:52:43 **Due Date:** 06 September 2011 **Winner:** Paul **Marker Broker ID:** MK21 **Total Payment: £3460.29 Bank Account:** 01234567 **Shipping Address:** 874 Orchard Close, Hinckle LE10 3LR											
Product ID	**Quantity Ordered**	**Actual Quantity**	**Original Discount**	**Actual Discount**	**Retail Price**	**Sum**	**Handling Fee**	**Final Value Fee**	**PayPal Fee 1**	**PayPal Fee 2**	**Payment**
Cd	28	16	5%	10%	26.56	382.46	2.12	15.30	0.39	10.32	**358.58**
Ra	36	36	25%	35%	85.06	1990.40	30.62	79.62	2.62	53.68	**1885.11**
						2372.87	**32.75**	**94.91**	**3.01**	**64.00**	**2243.69**

The core-brokers rely on the market-brokers to collect money for them, because they have no way to contact the buyers. The next stage explains the process by which the market-brokers receive payment from clients, the way that the items are transferred to a customer and how the profit can be distributed among providers and brokers.

5.2.4 Closing

When the market-brokers receive the notices from the core-broker, they need to distribute the gain to all the buyers. It is the market-brokers' turn now, and they close the transactions with the buyers. They use the market system to prepare invoices for their clients, send the invoices out, collect the money from their clients via Paypal and put it in the core-broker's bank account. The core-broker then sends coupons to the market-brokers. The transaction is considered completed when a customer receives the coupons.

At the same time, the core-broker will distribute the profit to each of the providers according to the contribution they have made. The number of items that will be taken from each provider is calculated using the Shapley value. This means that the actual number of items, that each provider will now be allowed to supply, is decided by the quantity that they offered in the first place. In the CBM, all the different suppliers will have set their own prices for each product. The final retail price for each product is the average of the original prices that the providers said they would charge. This final price will be the new retail price for everyone who is involved.

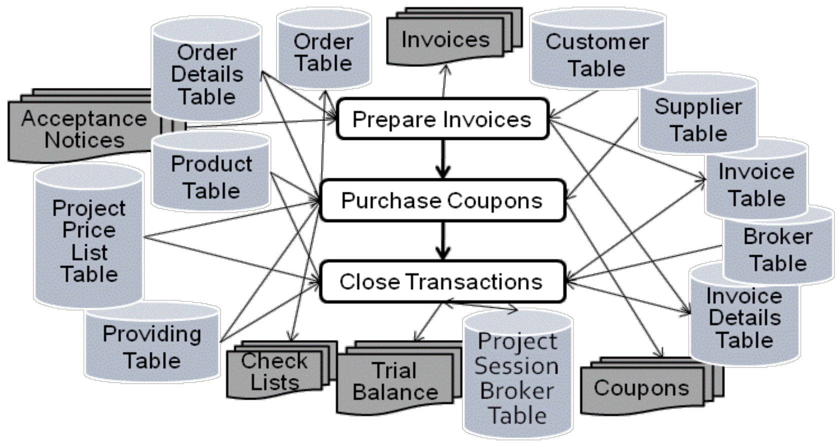


Figure 5.5 Closing Stage

This section describes the performance of the CBM, and it will conclude by listing all the profits the participants gain in the group trading session. As in Fig. 5.5, there are three steps in this stage: prepare invoices; purchase coupons and close transactions.

5.2.4.1 Prepare Invoices

The market-brokers prepare invoices for the customers, when the notice has been received. To complete this task, they need to look at the original orders from the customers. Because the actual discounts have been given to them by the core-broker, the market-brokers need to figure out the actual quantity and calculate the payment and handling fee for each order line.

If the actual quantity is less than the quantity ordered, the market-brokers have to decide how to distribute the items fairly. One option for doing this is FCFS. The other option is to use the Shapley value, which is decided by the original amount ordered by each customer.

According to customer Martin's order in Tables 5.11 and 5.16, market-broker Tim works out an invoice for him, which is shown in Table 5.32. For product Cc, the handling fee is £46.50×(10%–0%)×9×10%=£4.19, and the payment is £46.50×(1–10%)×9=£376.65. Martin can settle the total payment of £824.40 via Tim's PayPal account, at Tim536@cbs.co.uk.

Table 5.32 Invoice for Martin

Invoice
Order ID: O081109 **Order Date:** 26 August 16: 20: 56 **Due Date:** 04 September 2011
Winner: Martin **Customer ID:** C34 **Total Payment: £824.40 PayPal Account:** Tim536@cbs.co.uk
Shipping Address: 3107 Hartlepool Rd., Coventry CV1 5JB

Product ID	Quantity Ordered	Actual Quantity	Original Discount	Actual Discount	Price	Payment	Handling Fee	Sum
Cc	9	9	0%	10%	46.50	376.65	4.19	380.84
Cd	4	4	0%	10%	26.56	95.62	1.06	96.68
Ra	6	6	5%	35%	85.02	331.58	15.30	346.88

In Table 5.33, Tim's balance sheet shows the total of utility is equal to the total amount under the debits balance columns.

Table 5.33 Tim's Balance Sheet

Title	Debit	Credit
Payment to BEN		3459.68
Cash from Steve	2157.18	
Cash from Martin	824.40	
Cash from John	770.29	
PayPal Fee from BEN		3.92
PayPal Fee from Providers		99.41
Steve's Handling Fee		14.68
Martin's Handling Fee		14.92
John's Handling Fee		11.83
Steve's Final Value Fee		85.22
Martin's Final Value Fee		32.15
John's Final Value Fee		30.07
Total:	**£3751.87**	**£3751.87**

5.2.4.2 Purchase Coupons

The brokers order the coupons from the providers. If the accounts balance and the customers' payments have arrived, the market-brokers can proceed to pay for the coupons by transferring that money into the core-broker's account. The core-brokers can then pay the providers, when they have determined how many items they should take from each provider.

Table 5.34 Worth Functions for Products

Product ID	{}	{1}	{2}	{3}	{1, 2}	{1, 3}	{2, 3}	{1, 2, 3}
Cb	0	7	7	7	7	7	7	7
Cc	0	31	31	31	31	31	31	31
Cd	0	0	30	26	30	26	56	56
Ra	0	40	38	27	61	61	61	61

Table 5.34 shows the number of items sold in each coalition. Call provider 1, Bob, provider 2, Tom, and provider 3, Ken. Coalition $\{1, 2\}$ contains providers Bob and Tom, and they provide 30 units of product Cd. Coalition $\{3\}$ supplies 27 units of product Ra which come from provider Ken.

By using the Shapley value and the data in Table 5.34, all the different amounts of each product can be worked out and how they can be distributed fairly, to each provider. In Table 5.35, Tom is only allowed to make and receive payment for $0!\times2!\times38+1!\times1!\times(61-40+61-27))+2!\times0!\times(61-61)\div3!=22$ units of product Ra. The core-broker calculates the payment that each provider will receive.

Table 5.35 Shares of Items

Product ID	Bob	Tom	Ken
Cb	3	2	2
Cc	11	10	10
Cd	0	30	26
Ra	23	22	16

Table 5.36 An Order to Ken

Order **Order ID:** OO090703 **Order Date:** 07 September 2011 15:21:30 **Provider :** Ken **Total Payment: £1050.97 Marker Broker :** Ben							
Product ID	**Quantity**	**Actual Discount**	**Retail Price**	**Sum**	**Final Value Fee**	**PayPal Fee**	**Payme nt**
Cb	2	5%	65.17	123.82	8.67	3.34	111.82
Cc	10	10%	46.50	418.50	29.30	11.29	377.92
Cd	26	10%	26.56	621.50	43.51	16.76	561.24
Ra	16	35%	85.06	884.62	61.92	23.86	798.84
				1163.83	**81.47**	**31.39**	**1050.97**

In Table 5.36, Ben sends out an order to Ken. He also sends similar orders to Bob and Tom. An explanation will be given of the contents of this table, when the profits of the core-broker and the providers are discussed. Because the market-brokers have deducted their revenues before they transfer the money out, the core-brokers only need to calculate their own revenues and the money for each provider.

In Table 5.37, the amount that Ben receives for product Ra includes the final value fee and the handling fee. The final value fee is $£3372.63\times3\%=£101.18$. When his handling fees are added up, namely £21.27 and £30.62 (see Tables 5.29 and 5.31 respectively) the total handling fee is £51.89. Likewise, the PayPal fee is $£1.82+£2.62=£4.44$. The profit, which Ben gains from product Ra, is $£51.89+£101.18-£4.44=£148.63$. The total profit for Ben is the sum of the profit from the four products. It is £12.62+£37.79+£48.28+£148.63=£247.32.

Table 5.37 Ben's Commission

Product ID	Stock	Actual Quantity	Actual Discount	Retail Price	Sum	Handing Fee	Final Value Fee	PayPal	Profit
Cb	99	7	5%	65.17	433.38	0.00	13.00	0.38	12.62
Cc	110	31	10%	46.50	1297.35	0.00	38.92	1.13	37.79
Cd	56	56	10%	26.56	1338.62	9.56	40.16	1.44	48.28
Ra	78	61	35%	85.06	3372.63	51.89	101.18	4.44	148.63
					6441.98	**61.45**	**193.26**	**7.39**	**247.32**

Table 5.38 Providers' Profits

Product ID	Stock	Actual Quantity	Actual Discount	Cost	Retail Price	Sum	CB's Final Value Fee	MB's Final Value Fee	PayPal	Profit	Payment
Cb	36	3	5%	16.66	65.17	185.73	5.57	7.43	5.01	117.74	167.72
Cc	42	11	10%	12.56	46.50	460.35	13.81	18.41	12.42	277.55	415.71
Ra	40	23	35%	23.21	85.06	1271.65	38.15	50.87	34.30	614.51	1148.34
					Bob	**1917.73**	**57.53**	**76.71**	**51.72**	**1009.80**	**1731.77**
Cb	29	2	5%	18.09	65.17	123.82	3.71	4.95	3.34	75.64	111.82
Cc	31	10	10%	11.29	46.50	418.50	12.56	16.74	11.29	265.02	377.92
Cd	30	30	10%	7.46	26.56	717.12	21.51	28.68	19.34	423.78	647.58
Ra	38	22	35%	21.39	85.06	1216.36	36.49	48.65	32.81	627.83	1098.41
					Tom	**2351.98**	**70.56**	**94.08**	**63.43**	**1316.63**	**2123.91**
Cb	34	2	5%	20.70	65.17	123.82	3.71	4.95	8.67	3.34	70.42
Cc	37	10	10%	11.71	46.50	418.50	12.56	16.74	29.30	11.29	260.82
Cd	26	26	10%	6.46	26.56	621.50	18.65	24.86	43.51	16.76	393.28
Ra	27	16	35%	16.58	85.06	884.62	26.54	35.38	61.92	23.86	533.56
					Ken	**1163.83**	**34.91**	**46.55**	**81.47**	**31.39**	**724.51**

The payment for each item to the providers needs to exclude the expenses, which are the brokers' commission and the PayPal fee. In Table 5.38, the payment to Bob for product Ra is £1271.65−£38.15−£50.87−£34.30=£1148.34. The profit is the payment minus the cost. His profit for Product Ra is £1148.34−£23.21×23=£614.51. In this table, in order to calculate the providers' net profits, the cost of each product is given. In reality, nobody would reveal this information to anyone, even the core-brokers.

Table 5.39 Ben's Check List

Market Broker	Product ID	Quantity	Retail Price	Discount	Actual Discount	Bob	Tom	Ken	Cash From MB	Cash Check	Pay Provider	Pay Check	Coupon In	Coupon Out
Tim	Cb	3	65.17	5%	5%	√			174.03		167.72			
Tim	Cb	2	65.17	5%	5%		√		116.02		111.82			
Tim	Cb	2	65.17	5%	5%			√	116.02		111.82			
Tim	Cc	11	46.50	10%	10%	√			431.33		415.71			
Tim	Cc	10	46.50	10%	10%		√		392.12		377.92			
Tim	Cc	10	46.50	10%	10%			√	392.12		377.92			
Tim	Cd	24	26.56	5%	10%			√	540.64		518.06			
Tim	Ra	23	85.06	25%	35%	√			1210.58		1148.34			
Tim	Ra	2	85.06	25%	35%		√		105.27		99.86			
								Sum	**3478.11**		**3329.16**			
Phil	Cd	16	26.56	0%	10%		√		360.64		345.38			
								Sum	**360.64**		**345.38**			
Paul	Cd	14	26.56	5%	10%		√		313.76		302.20			
Paul	Cd	2	26.56	5%	10%			√	44.82		43.17			
Paul	Ra	20	85.06	25%	35%		√		1047.28		998.55			
Paul	Ra	16	85.06	25%	35%			√	837.83		798.84			
								Sum	**2243.69**		**2142.77**			
								Total	**6082.44**		**5817.30**			

A check list like the one in Table 5.39 will help Ben when he collects the money from the market-brokers and pays the providers for the coupons. The money is transferred into Core-broker Bens' bank accounts and coupons are received in exchange. The agreement is that Ben must send out the coupons within two working days, after he has received the money. Ben will try his best to make sure that the market-brokers receive the coupons and close the transactions as soon as possible.

5.2.4.3 Close Transactions

When the coupons have arrived, it is time for all the brokers to close the transactions. The core-broker sends the coupons to the market-brokers who close the transactions with their clients. Finally, the core-broker closes the transactions with the providers and ends the current session of group trading. He/she has to decide whether to start a new session of trading or to terminate this group-trading project. The check list in Table 5.39 will also be used by Ben to check the coupons and determine where they are from and where they are going. Sometimes, the coupons received for one particular product may come from different providers, for instance, 3 of the coupons that Tim has for product Cb are from Bob and 2 of them are from Ken.

The core-broker passes the coupons on. When the customers are certain that they have received all the coupons they ordered, the market-brokers can close the transactions with the customers. If all the market-brokers reply with an OK, the transactions between the core-broker and the providers are then closed.

Table 5.40 Tim's Check List

Order ID	Customer	Product ID	Retail Price	Quantity Ordered	Actual Quantity	Original Discount	MB's Discount	Actual Discount	Cash from Customers	Cash Check	Payment to BEN	Pay Check	Coupon In	Coupon Out
O081101	Steve	Cb	65.17	2	2	0%	5%	5%	124.47		115.42			
O081101	Steve	Cc	46.5	17	17	10%	10%	10%	711.45		663.19			
O081101	Steve	Cd	26.56	14	14	5%	5%	10%	336.52		313.76			
O081101	Steve	Ra	85.02	11	11	10%	25%	35%	631.27		575.73			
O081207	Steve	Cc	46.5	5	5	10%	10%	10%	209.25		195.05			
O081207	Steve	Cd	26.56	6	6	5%	5%	10%	144.22		134.47			
								Subtotal	**2157.18**		**1997.62**			
O081109	Martin	Cc	46.5	9	9	0%	10%	10%	380.84		351.10			
O081109	Martin	Cd	26.56	4	4	0%	5%	10%	96.68		89.65			
O081109	Martin	Ra	85.02	6	6	5%	25%	35%	346.88		314.04			
								Subtotal	**824.40**		**754.78**			
O081211	John	Cb	65.17	5	5	0%	5%	5%	311.19		288.56			
O081211	John	Ra	85.02	8	8	10%	25%	35%	459.11		418.72			
								Subtotal	**770.29**		**707.27**			
								Total	**3751.87**		**3459.68**			

Another check list (Table 5.40) will be used by market-broker Tim when he takes the money from the customers, pays for the items, receives the coupons and sends them out via e-mail. The only thing the market-brokers need to do is fill in the customers' names on the coupons. The customers will be able to claim the products and services from the providers, on presentation the coupons.

This completes the review of a session of group-trading. The benefits for all the participants are now clear to examine. Table 5.41 shows the discounts for the customers the commission for the core and market-brokers, and the profits of the providers.

Table 5.41 Benefits for All

Product	Discount of Tim's Customers	Discount of Phil's Customers	Discount of Paul's Customers	Market Broker Phil's Commission	Tim's Handling Fee	Market Broker Tim's Commission	Market Broker Paul's Commission	Core Broker BEN's Profit	Provider Bob's Profit	Provider Tom's Profit	Provider Ken's Profit
Cb	0.00	22.81	0.00	0.00	4.84	17.34	0.00	12.62	117.74	75.64	70.42
Cc	0.00	144.15	0.00	0.00	0.53	51.89	0.00	37.79	277.55	265.02	260.82
Cd	42.50	63.74	42.50	15.30	24.88	22.95	15.30	48.28	0.00	423.78	393.28
Ra	0.00	744.28	1071.76	0.00	28.95	55.29	79.62	148.63	614.51	627.83	533.56
Total	**42.50**	**974.98**	**1114.25**	**15.30**	**59.20**	**147.47**	**94.91**	**247.32**	**1009.80**	**1392.26**	**1258.07**

Some of the expenses incurred by the brokers in using the CBS site are not considered in the examples, such as a £30 session fee for Ben to list the session of the group-trading project on the site. But every participant seems to get a reasonable benefit out of the group-trading session in the project. The customers get more discounts when they team up together. The providers earn more money because they have attracted more customers. They achieve this by creating new products and using this new way of trading, involving brokers, who play an important role and gain commission for it.

Ben gains £247.32 commission. Market-broker Tim's commission is £59.20+£147.47=£206.67. Tim's handling fee can be shown here, but in the real-world, would only be disclosed to anybody except the market-brokers and their clients. Ben has no way to know the handling fee of the market-brokers. Although the core-brokers seem to have more information than the other participants, the customers' orders and personal information will always remain hidden from them.

The rates of commission for the brokers are fixed throughout the illustrations in this chapter. In practice, they are fixed for the duration of the session, but the handling fee from customers and the final value fee from the providers are definitely negotiable between sessions. The session fee and the online store fee are fixed but they are also subject to negotiation in real-world websites. There may be several sessions of trading in a group-trading project. When a session of trading ends, the flow returns to stage 1. The process is repeated until the core-broker decides to terminate the project. A project terminates only when the broker decides to drop the list from the CBS website.

5.3 Summary

This chapter provides a deeper insight into the functioning of the CBM and to demonstrate the applicability of the CBM to real-world markets. This has been demonstrated through the case study in the group-trading project using the scenario of a travel agent. Core-broker Ben created group-trading project by integrating the products from the three providers offering inexpensive hotel rooms and low car rentals for economical travel in the Midlands.

The CBS website is for core-brokers to advertise their project and find market-brokers to sell the products. Ben registered himself and project S1 on the CBS site and uploaded three documents: project specs, product descriptions and price lists to the site. He then listed S1 and began a session of group-trading. The case study illustrates the processes of the four stages in the CBM, namely commencing, gathering, combining and closing. Brokers can use the CBS to help them with the tasks during the trading.

In the commencing stage, core-broker Ben recruited three market-brokers. He started a session of the group-trading project. The market-brokers promoted the project on their websites. In the gathering stage, the market-brokers attracted customers. Market-broker Tim received orders from three customers and combined the orders. After he has negotiated with his customers and reduces their expected discounts, he submitted a market order to Ben. Market-broker Phil was the earliest one and Paul was the last one who submitted the order.

In the combining stage, Ben combined all the orders from the market-brokers into one final order and calculated the actual discount and quantity of each product. The order lines were dropped from the trading, when their actual discounts are less than the expected discounts. Because the principle that the CBM uses in dealing with the market-brokers' orders is FCFS, some of the market-brokers may not get what they ordered. After the final order has been passed the stability check, Ben delivered the notices to the market-brokers and awaited payment from them.

In the closing stage, Ben calculated the number of items taken from each provider by using the Shapley value and ordered the coupons for the market-brokers. The market-brokers prepare invoices for their clients and sent the invoices out. When the money from the customers had come through, the market-brokers proceeded to pay for the coupons by transferring the money into the Ben's account. The market-brokers closed the transactions with the buyers by sending the coupons to them. Finally, Ben closed the transactions with the providers and ended the current session of group trading. He has to decide whether to start a new session of trading or to terminate this group-trading project.

It would appear, the CBM created a win-win situation for all participants in a group-trading session. In the next chapter, some data, generated in the two scenarios, will be used as input in both a traditional market and also in a group-trading e-market in the CBM. The results of these two markets will be compared and discussed.

Chapter 6

Empirical Evaluation

As mentioned in the previous chapters, the e-market is an arena in which distributed computing, incentive compatibility, and less computational complexity are all highly relevant. These three factors have been considered as evaluation criteria for the CBM. On the other hand, in the words of Reeve and Peerbhoy (2007) evaluation is an assessment about “the degree to which something is successful in producing a desired result”. Two factors, namely effectiveness and efficiency, need to consider as additional evaluation criteria for the CBM. The effectiveness of the new model requires an assessment having the right support to broader marketing objectives. Within e-commerce context, common efficiency measures across marketing activities to ensure minimising resources or time needed to complete a business process. And so, this chapter is about the evaluation of the CBM with five criteria, namely distributed computing, computational complexity, incentive compatibility, effectiveness and efficiency.

One possible way to test the CBM is to use it in a real-world site and collect data from it. A CBS site has been developed, but the crux of this research is to demonstrate the effectiveness and efficiency of the CBM versus the Core as the mechanism drives it. At this stage, a real-world test would be inappropriate; further it would be unlikely to produce the data set necessary for rigorous testing. Simulation, “the imitation of the operation of a real-world process or system over time” (Banks *et al.* 2001) provides an approach. In this research, a simulation system was implemented to aid the evaluation of the model, and is introduced in section 6.1. The system consists of a Test Case Generator (TCG), a Core Simulator (CS) and a CBM Simulator (CBMS).

This simulation system was used to perform the evaluation of the CBM. Firstly, its TCG generated the test data for the evaluation in two scenarios: normal and demanding customers. The data is based on group-trading project S1, which was created by Ben and discussed in the previous chapter. In this project, the data produced by the TCG from these two scenarios was put into the CS and the CBMS. Secondly, from the outputs of the simulators, a comparison for the between the core and the CBM was made and is discussed in section 6.2. The simulation system was also used to test the performance of the CBM, when there are a large number of customers in an e-market. These results from the CBMS are discussed in section 6.3. A final evaluation of the techniques used in the new model is made at the end of this chapter.

6.1 A Simulation System

This simulation system was developed to produce results which would usually come out of a shopping site. A database to store the data output from the simulators consisted of the following eight tables: customer table, supplier table, product table, providing table, project price list table, broker table, order table and order detail table. The specification of the above tables can be found in Appendix 4.

The simulation system was written in C# using the Visual Studio 2008 development environment. The system runs on a Windows operating system. All the results in this chapter were produced on a Windows Vista platform with a 1.86 GHz CPU with 2GB RAM and a 1280x800 display. The minimal hardware requirement for the system is a 1.6 GHz CPU with 384 MB RAM and a 1024x768 display.

The TCG is described in subsection 6.2.1. It was built to create data for the tables needed for the simulators. The CS was based on the concept of the core and is described in subsection 6.2.2. The CBMS in subsection 6.2.3 was constructed according to the pattern of the CBM.

6.1.1 A Test Case Generator

The TCG creates input data for the CS and the CBMS. In Fig. 6.1, this test data generator contains seven functions: customer creator, supplier creator, product creator, price list manager, providing allocator, market-broker creator and order creator.

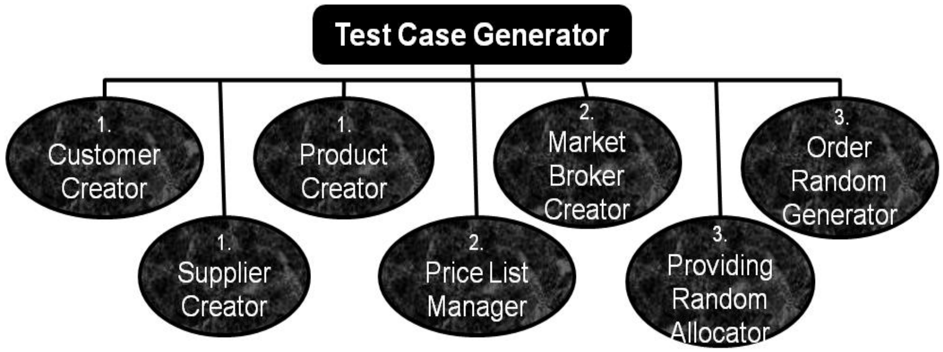


Figure 6.1 Test Case Generator

1. **Customer creator** – creates new customers' records into the customer table.
2. **Supplier creator** – generates the records of new providers and adds them into the supplier table.
3. **Product creator** – creates data about new products and adds it into the product table.
4. **Price list manager** – sets up a price list for a product including what volume discount customers may get, when they order a certain number of items. This data is stored in the project price list table.
5. **Market-broker creator** – allows users to assign an existing broker to be a market-broker. The users can also add a new broker's record into the broker table and assign him/her as a market-broker.
6. **Providing random allocator** – allows users to input the number of providers and creates the information about the products which the providers offer. The data is created by using a random number generator and is stored in the providing table.
7. **Order random generator** – creates the data for each customer's purchases randomly. It generates a certain number of records for the order table and for the order detail table, according to the number of customers the user inputs.

These seven functions work independently, and most of them are accompanied by a 'list' button that allows users to produce a report about the current contents in the tables related to that respective function. However, they have to be completed before users run the functions with higher level numbers. The interface of the TCG is shown in Appendix 7. The users may run the TCG repeatedly until they are satisfied with the data in the tables.

6.1.2 A Core Simulator

The Core Simulator (CS) is based on the core concept. Its aim is to find a core in a coalition. In Fig. 6.2, there are three functions: core combination generator, core discount calculator and core locator. The interface of the CS is given in Appendix 8.

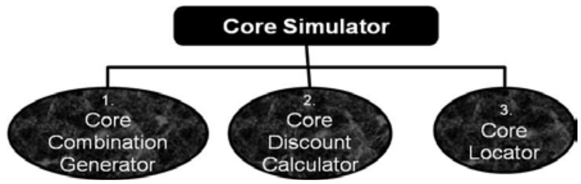


Figure 6.2 Core Simulator

1. **Core combination generator –** creates all the possible combinations of providers and customers. In order to reduce the complexity in the core, one customer can only purchase items from one provider. For instance, three providers: A, B and C, and two customers: a and b, have nine possible combinations, as shown in Table 6.1. This function can store these nine combinations in the order table and order detail table.

Table 6.1 Core Combinations

Combination	Provider A	Provider B	Provider C
1	Customer a	Customer b	
2	Customer a		Customer b
3	Customer b	Customer a	
4	Customer b		Customer a
5		Customer a	Customer b
6		Customer b	Customer a
7	Customer a and b		
8		Customer a and b	
9			Customer a and b

2. **Core discount calculator –** calculates the discount for the customers, which they may get in all the combinations.
3. **Core locater –** finds the core, which is the one which has the largest total benefit. It calculates the total benefit, which is the sum of providers' profits and customers' discounts in each combination. This function also works out the benefit for each individual in the core.

This simulator will determine the number of providers and customers in a database automatically, when users assign the database to this simulator and run it. When this simulator is used, in order to locate a core, the above three functions need to be executed in the above sequence.

6.1.3 A CBM Simulator

The CBMS is built to the pattern of the CBM. Its aim is to find a bigger core in a coalition effectively. In Fig. 6.3, there are four functions: core-broker creator, CBM combination generator, CBM discount calculator and stability checker. The interface of the CS is given in Appendix 9.

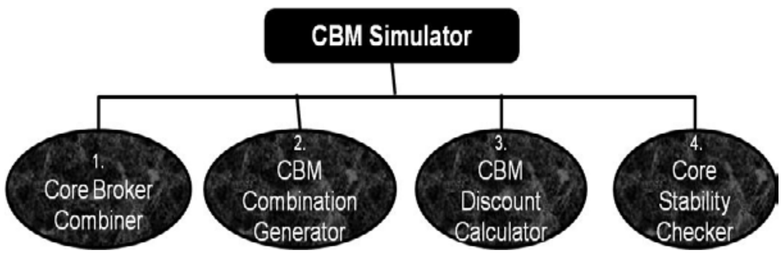


Figure 6.3 CBM Simulator

1. **Core-broker combiner –** this function allows a user to add together what all the providers have provided and to store it in the providing table as if it were what the core-broker has provided.
2. **CBM combination generator –** works out all possible combinations of providers' coalition and customers' coalitions. For example, one providers' coalition from core-broker CB and three customers' coalitions 1, 2 and 3 from market-brokers: 1, 2 and 3 respectively could be joined together. There are seven possible combinations for them in Table 6.2. This function can store these combinations in the order table and order detail table.

Table 6.2 CBM Combinations

Combination	The Core
1	Buyers' Coalition 1
2	Buyers' Coalition 2
3	Buyers' Coalition 3
4	Buyers' Coalition 1 and 2
5	Buyers' Coalition 1 and 3
6	Buyers' Coalition 2 and 3
7	Buyers' Coalition 1, 2 and 3

3. **CBM discount calculator** − calculates the discounts of customers' coalitions and the profit of the providers' coalition in each combination.
4. **Stability checker** − calculates the total benefit of each combination. This checker will make sure that the coalition which has the biggest number of people is also the one which has the largest total benefit.

Just like the previous simulator, the functions in this simulator need to be executed in the right order to produce the correct results. Users can input the number of providers, customers and market-brokers, generate some test cases, and use the simulators to produce results in a traditional market as well as in multi e-markets with the CBM.

Two sets of test data for the evaluations were produced by the TCG. Each set of data contained orders from 99 different buyers and the items offered by the three providers are given in Table 6.3. One set of orders given in Appendix 5 has been generated from a scenario where buyers do not expect such a high discount. The other set of orders given in Appendix 6 is based on a scenario where buyers are more demanding.

There may be thousands and thousands of traders on the Internet, therefore it would not be considered as a large coalition, when there are only 198 buyers and 3 providers in an e-market. However, the number of these test data is large enough to fulfil the main purpose of this chapter – comparing the new model with the core. In the next section, the above test cases were put into the CS and the CBMS at the same time. By comparing the outputs of these two simulators, it can be determined whether the CBM is more beneficial to the traders than the core. Using the outputs of the simulators, a comparison is made between the core and the CBM and the results are given.

6.2 Comparison between the CBM and the Core

In this section, the main focus is the comparison between the core and the CBM. Five criteria, namely the use of distributed computing, the degree of computational complexity incentive compatibility, efficiency and effectiveness are used to judge between them.

In distributed computing, a problem is divided into many tasks, each of which is solved by one or more computers. In subsection 6.2.1, the core and CBM are examined to establish whether they can solve problems better by using multi computers or more than one market. Their abilities to deal with the Internet environment are also assessed. A problem with large coalition can cause high computational complexity in solving it. In subsection 6.2.2, the complexity of both the core and CBM are evaluated when there are large numbers of participants in coalitions. In subsection 6.2.3, in order to compare the incentive compatibilities in the CBM and in the core, the assumption has been made that providers are willing to offer more volume discount to customers. The judgements of efficiency in the CBM and in the core are given in subsection 6.2.4. Their effectiveness is discussed in subsection 6.2.5.

One of the aims of the CBM is to create a win-win situation for both customers and providers. So the discounts of buyers and the profits of suppliers are calculated and compared to see whether the CBM is superior to the core in subsection 6.2.4.

6.2.1 Distributed Computing

To fit in a distributed computing environment, by nature, a distributed model requires involving multiple computers to be effective. Another two distributed contexts, namely Internet and multi-markets, are used here to assess the models too.

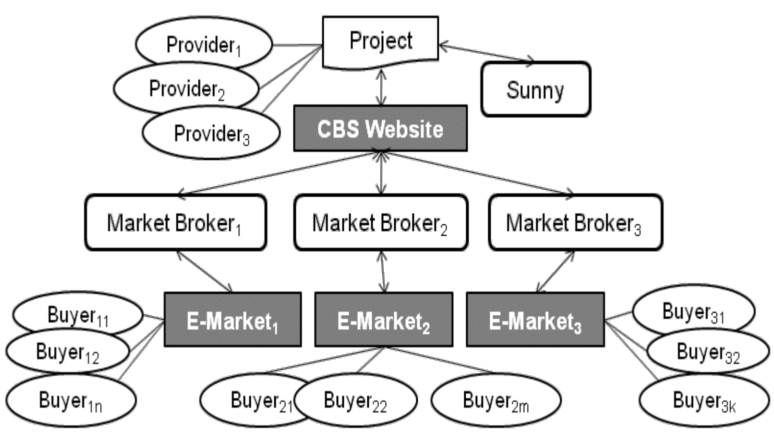


Figure 6.4 Multi E-Markets in the CBM

The core concept is used to find a stable set for a coalition in a traditional market. This is normally done on one computer. It might cause extra complexity if this problem were to be solved by using multi computers. The core might be used in an e-market, but it is difficult to apply it to multiple e-markets in the Internet environment. Fig. 6.4 shows how Ben involves three e-markets and the CBS website in the group-trading project. This indicates that the CBM enables a core-broker to use more than one e-market on the Internet and so bring more benefits to the participants. The core is normally used in a traditional marketplace, but it might be possible to put it into an e-market where it would allow customers to place orders via the Internet.

Table 6.3 Distributed Computing

Distributed Computing Environment	The CBM	The Core
Multi Computers	Yes	No
Internet	Yes	Maybe
Multi e-Markets	Yes	No

When the two systems are judged according to the criterion of distributed computing, Table 6.3 summarises the results which show that the core may be applied on the Internet but it fails when it is used with multi computers or e-markets. On the other hand, the CBM can use more than one computer being specially designed to make the best use of multi markets on the Internet.

6.2.2 Computational Complexity

The computational complexity can be expressed as big O notation, which is also a useful tool to analyse the efficiency of algorithms regarding the time it takes for them to complete their jobs. Assume there are *p* providers, *b* orders and *g* products in the market. There are at most 10 order lines in an order. The number of sub-coalitions is $(p+1)^b$. The pseudocode in Table 4.2 takes $(p+1)^b \times b \times 10 \times p \times g$ steps to find a core in a coalition. If *p*, *b* and *g* are large, the big O notation of finding the core is $O(n^n)$, which can be classified into extremely high computational complexity. This is a fatal weakness of the core if applied in the real world markets.

Now suppose there are *m* e-markets in a group-trading project. In the CBM, the time for the result is the total time of the tasks shown in section 4.2:

1. jointProviders: It takes $p \times g^2$ steps to merge the b providers for using the pseudocode in Table 4.5, so its big O notation is $O(\mathrm{n}^3)$.
2. combineOrders: Suppose there are b_1, b_2, …, b_m in each e-market respectively. It takes $g \times (b_1+b_2+\ldots+b_\mathrm{m}) \times 10+g \times 10=g \times b \times 10+g \times 10$ steps to combine the orders into a big combined order and decide the discounts for every product in it for using the pseudocodes in Table 4.5 and 3.14 when combining the orders in the *m* e-markets. Its big O notation should be $O(\mathrm{n}^2)$. It takes $g \times m \times 10+ g \times 10$ steps when combine *m* market orders from the e-markets. Because the number of e-markets is a constant, so the big O notation is $O(\mathrm{n})$.
3. checkStability: The pseudocode in Table 4.6 takes $100 \times m \times \mathrm{g}+100 \times g+100 \times m$ steps. The big O notation is $O(\mathrm{n})$.
4. rankOrders: The big O notation of a quicksort algorithm is $O(\mathrm{n} \log \mathrm{n})$ (Hoare 1962). The number of orders is equal to the number of e-markets, i.e. *m*. Since a group-trading project commonly involves not more than 10 e-markets, so that *m* is a constant. Therefore, the big O notation of the sorting here is $O(1)$.
5. decideQuantities: According to the stock of each product, the pseudocode in Table 4.7 may be used to decide the actual quantity for every market's order and it takes $g \times m \times 10$ steps. Since *m* is a constant, the big O notation of the pseudocode is $O(\mathrm{n})$.
6. decideSoldItems: pseudocode 4.9 takes $3 \times p \times g \times (g+2^p)$ steps to decide the number of items for each provider and its big O notation is $O(\mathrm{n}^2 \times 2^\mathrm{n})$.
7. calculateCoalitionBenefit: The pseudocode in Table 4.10 takes $10 \times g$ steps to find the benefit of a coalition. Since there are m coalitions in the e-markets and a big coalition which is combined from them, so it takes $10 \times g \times (m+1)$ to calculate the benefit of a coalition. The big O notation is $O(\mathrm{n})$.
8. calculateCommissions: Calculate the commissions for the market-brokers and core-broker using the pseudocodes in Table 4.11. The steps are $p \times g \times 10 \times (2 \times m+b)$ and $p \times g \times 10 \times (m+1)$ and their big O notation are $O(\mathrm{n}^3)$.
9. calculateProfits: Calculate the profits of the providers. Table 4.12 can be referred to see the pseudocode of calculating the profit of each provider and it takes $\mathrm{p} \times \mathrm{g}^2 \times 10$

steps. So, the big O notation is $O(\mathrm{n}^3)$.

The steps for the pseudocode in Table 4.4 for the CBM is $40\times g+100\times m+10\times g\times b+30\times g\times m+10\times p\times g\times(3\times \mathrm{m}+b+1)+3\times p\times g\times 2^p$ and for the core is $(p+1)^b\times b\times 10\times p\times g$. Consider 3 providers, 100 customers, 10 products and 3 e-markets. In Table 6.4, the steps of the core and CBM are 9600 and 10320 respectively, when there are two customers.

Table 6.4 Steps Needed in the Core and CBM

Buyer No	Core	CBM	Buyer No	Core	CBM	Buyer No	Core	CBM	Buyer No	Core	CBM
1	1200	9920	**26**	3.51281E+19	19920	**51**	7.75802E+34	29920	**76**	1.30165E+50	39920
2	9600	10320	**27**	1.45917E+20	20320	**52**	3.16406E+35	30320	**77**	5.27511E+50	40320
3	57600	10720	**28**	6.05284E+20	20720	**53**	1.28996E+36	30720	**78**	2.13745E+51	40720
4	307200	11120	**29**	2.50760E+21	21120	**54**	5.25720E+36	31120	**79**	8.65940E+51	41120
5	1536000	11520	**30**	1.03763E+22	21520	**55**	2.14182E+37	31520	**80**	3.50760E+52	41520
6	7372800	11920	**31**	4.28887E+22	21920	**56**	8.72306E+37	31920	**81**	1.42058E+53	41920
7	34406400	12320	**32**	1.77089E+23	22320	**57**	3.55153E+38	32320	**82**	5.75247E+53	42320
8	157286400	12720	**33**	7.30491E+23	22720	**58**	1.44554E+39	32720	**83**	2.32905E+54	42720
9	707788800	13120	**34**	3.01051E+24	23120	**59**	5.88183E+39	33120	**84**	9.42844E+54	43120
10	3145728000	13520	**35**	1.23962E+25	23520	**60**	2.39261E+40	33520	**85**	3.81627E+55	43520
11	13841203200	13920	**36**	5.10016E+25	23920	**61**	9.72995E+40	33920	**86**	1.54447E+56	43920
12	60397977600	14320	**77**	2.09673E+26	24320	**62**	3.95578E+41	34320	**87**	6.24971E+56	44320
13	2.61725E+11	14720	**38**	8.61360E+26	24720	**63**	1.60783E+42	34720	**88**	2.52862E+57	44720
14	1.12743E+12	15120	**39**	3.53611E+27	25120	**64**	6.53342E+42	35120	**89**	1.02294E+58	45120
15	4.83184E+12	15520	**40**	1.45071E+28	25520	**65**	2.65420E+43	35520	**90**	4.13774E+58	45520
16	2.06158E+13	15920	**41**	5.94792E+28	25920	**66**	1.07801E+44	35920	**91**	1.67349E+59	45920
17	8.76173E+13	16320	**42**	2.43719E+29	26320	**67**	4.37739E+44	36320	**92**	6.76750E+59	46320
18	3.71085E+14	16720	**43**	9.98089E+29	26720	**68**	1.77709E+45	36720	**93**	2.73642E+60	46720
19	1.56680E+15	17120	**44**	4.08520E+30	27120	**69**	7.21290E+45	37120	**94**	1.10634E+61	47120
20	6.59707E+15	17520	**45**	1.67122E+31	27520	**70**	2.92697E+46	37520	**95**	4.47243E+61	47520
21	2.77077E+16	17920	**46**	6.83343E+31	27920	**71**	1.18751E+47	37920	**96**	1.80781E+62	47920
22	1.16108E+17	18320	**47**	2.79279E+32	28320	**72**	4.81696E+47	38320	**97**	7.30655E+62	48320
23	4.85544E+17	18720	**48**	1.14089E+33	28720	**73**	1.95355E+48	38720	**98**	2.95275E+63	48720
24	2.02662E+18	19120	**49**	4.65862E+33	29120	**74**	7.92122E+48	39120	**99**	1.19315E+64	49120
25	8.44425E+18	19520	**50**	1.90148E+34	29520	**75**	3.21131E+49	39520	**100**	4.82081E+64	49520

When the number of customer increases, the number of steps taken in the core is getting much larger than that in the CBM. The number of steps in the core is enormous, i.e. 4.82081E+64, while the CBM only takes 49520 steps when there are 100 orders. The small number of steps needed in the CBM demonstrates that it has less complexity when it tackles problems in a large coalition. The fact that CBM has less computational complexity than the core can also easily tell by examining their big O notations. The core and CBM are $O(\mathrm{n}^\mathrm{n})$ and $O(\mathrm{n}^2\times 2^\mathrm{n})$ respectively.

Among the tasks of the CBM, task 5, which decides the number of items for each provider, seems to be a time-consuming job. In Table 6.5, the difference between the processes of the CBM with and without task 5 is 0, when the numbers of providers and customers are more than 58. This means that the time, which is taken in task 5, makes the other tasks in the CBM trivial. Therefore, task 5 is proven to be a critical task in the CBM.

The steps taken in pseudocode 4.9 are $3\times p\times g\times(g+2^{p})$. They have nothing to do with the number of buyers, but mainly come from the number of providers, i.e. p. Assume p is limited within 20, the total steps taken in the process of the CBM becomes $30\times g+10\times g\times b+20\times g\times m+300\times g\times(3\times \mathrm{m}+b+1)+60\times g\times 220$. Its big O becomes $O(\mathrm{n}^2)$ and can be classified as an algorithm with low computational complexity. The computational complexity can be dramatically lessened in the CBM by limiting the number of providers.

Table 6.5 Time-Consuming Task in the CBM

Buyer No	Seller No	CBM	CBM Without T5	Difference	Buyer No	Seller No	CBM	CBM Without T5	Difference
1	**1**	4260	360	**3900**	**31**	**31**	1.99716E+12	1.99716E+12	**165900**
2	**2**	7240	840	**6400**	**32**	**32**	4.12317E+12	4.12317E+12	**174400**
3	**3**	10720	1620	**9100**	**33**	**33**	8.50404E+12	8.50404E+12	**183100**
4	**4**	15120	3120	**12000**	**34**	**34**	1.75235E+13	1.75235E+13	**192000**
5	**5**	21400	6300	**15100**	**35**	**35**	3.60777E+13	3.60777E+13	**201100**
6	**6**	31720	13320	**18400**	**36**	**36**	7.42170E+13	7.42170E+13	**210400**
7	**7**	50880	28980	**21900**	**37**	**37**	1.52557E+14	1.52557E+14	**219900**
8	**8**	89440	63840	**25600**	**38**	**38**	3.13361E+14	3.13361E+14	**229600**
9	**9**	170440	140940	**29500**	**39**	**39**	6.43214E+14	6.43214E+14	**239500**
10	**10**	343800	310200	**33600**	**40**	**40**	1.31941E+15	1.31941E+15	**249600**
11	**11**	717040	679140	**37900**	**41**	**41**	2.70480E+15	2.70480E+15	**259900**
12	**12**	1520560	1478160	**42400**	**42**	**42**	5.54154E+15	5.54154E+15	**270400**
13	**13**	3245880	3198780	**47100**	**43**	**43**	1.13470E+16	1.13470E+16	**281100**
14	**14**	6937480	6885480	**52000**	**44**	**44**	2.32217E+16	2.32217E+16	**292000**
15	**15**	14807200	14750100	**57100**	**45**	**45**	4.74989E+16	4.74989E+16	**303096**
16	**16**	31524480	31462080	**62400**	**46**	**46**	9.71089E+16	9.71089E+16	**314400**
17	**17**	66919720	66851820	**67900**	**47**	**47**	1.98440E+17	1.98440E+17	**325888**
18	**18**	141636760	141563160	**73600**	**48**	**48**	4.05324E+17	4.05324E+17	**337600**
19	**19**	298929360	298849860	**79500**	**49**	**49**	8.27536E+17	8.27536E+17	**349440**
20	**20**	629237200	629151600	**85600**	**50**	**50**	1.68885E+18	1.68885E+18	**361472**
21	**21**	1321303960	1321212060	**91900**	**51**	**51**	3.44525E+18	3.44525E+18	**373760**
22	**22**	2768345640	2768247240	**98400**	**52**	**52**	7.02562E+18	7.02562E+18	**387072**
23	**23**	5788251520	5788146420	**105100**	**53**	**53**	1.43214E+19	1.43214E+19	**399360**
24	**24**	12079714720	12079602720	**112000**	**54**	**54**	2.91833E+19	2.91833E+19	**417792**
25	**25**	25165950600	25165831500	**119100**	**55**	**55**	5.94475E+19	5.94475E+19	**425984**
26	**26**	52345048120	52344921720	**126400**	**56**	**56**	1.21057E+20	1.21057E+20	**425984**
27	**27**	1.08717E+11	1.08716E+11	**133900**	**57**	**57**	2.46437E+20	2.46437E+20	**458752**
28	**28**	2.25486E+11	2.25486E+11	**141600**	**58**	**58**	5.01521E+20	5.01521E+20	**0**
29	**29**	4.67078E+11	4.67078E+11	**149500**	**59**	**59**	1.02034E+21	1.02034E+21	**0**
30	**30**	9.66368E+11	9.66368E+11	**157600**	**60**	**60**	2.07526E+21	2.07526E+21	**0**

One interesting finding in this research is that CBM's computational complexity will not become higher, when there are more orders in the e-markets, so market-brokers are free to take as many clients as they could in their e-markets. However, it may take time for them to negotiate with buyers if the size of a coalition becomes too big or the communications get too busy. In order to make sure brokers to collect the orders in time, one important principle is to limit the size of coalitions in e-markets within one group-trading session, and this needs to be applied in the model. It is usually the brokers who monitor the size of coalitions in their e-markets. All of the brokers have to follow this principle in order to prevent situations where a coalition becomes too large to handle.

The aim is to produce outcomes for a group-trading project on an average computer within a reasonable time. To achieve this, a core-broker should limit the number of suppliers to form a group-trading project. The suggested number of providers is 15. What would happen to the core, if the number of providers was increased to 20? It takes $2^b \times b \times 200 \times g$ steps to find the core in a coalition in Table 4.2. The big O, i.e. $O(\mathrm{n}^2 \times 2^\mathrm{n})$, has high computational complexity and greatly depends on the number of orders. So even with only a few providers in a market, it is still a time-consuming job to find the core with many customers in a large coalition.

In summary, the complexity in the core can be incredibly high and this means it will not reach the required speed and will not be able to support a large coalition in a marketplace. On the contrary, the CBM proposed here can effectively and efficiently reduce the computational complexity in online trading even when multiple providers and many customers are involved.

6.2.3 Incentive Compatibility

It is crucial to give people incentives to participate in online trading. The effectiveness of both models is assessed by comparing the benefits for participants. The core cannot deal with wholesale transactions in a buyers' group, therefore individuals cannot obtain very good discounts within it when they purchase items from providers. In order to compare the incentive compatibilities, the assumption has been made that providers are willing to offer more volume discount to customers if a group of them purchases the same item from the same provider in the core, although it is rather unusual for them to give customers such discounts in a traditional market. If this is not done, there will be no means of comparing the two systems.

There are three incentives for traders, namely volume discounts, an equilibrium price and a fair distribution. The providers offer volume discounts to customers in the CBM. As mentioned in chapter 3, if the core may be empty and unstable, an equilibrium price will not be reached in a coalition. The CBM performs a stability check to make sure that there is a best price for traders. An evaluation was made to determine how fairly the profits that providers get were distributed, in both the core and the CBM, and the results are given here.

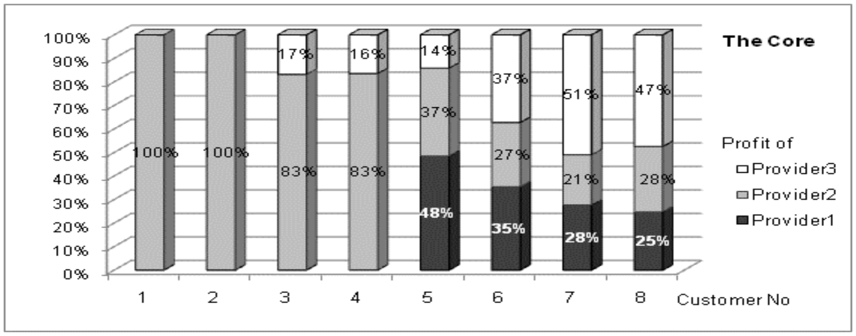


Figure 6.5 Uneven Providers' Profits in the Core

Fig. 6.5 shows that in a traditional market place the profits are not distributed to all the providers evenly. This is a contrast to the fair distribution of profit in the CBM in Fig. 6.6, in which the percentage of the profit that each provider attains stays quite close to its average amount. The amount the provider gets is more or less constant. By using the Shapley value, the CBM can make a fair decision as to which items are allocated to which provider, even when customers' requirements are less. The CBM provides fair shares to customers and providers, but the core does not. Fair distribution is crucial in teamwork. The providers might leave the team if the profits have been distributed unfairly, even though the profit they can get out of it is good. In the CBM, suppliers have a great chance to sell out their products. Even if the customers do not purchase all that is on offer, the suppliers still get their fair share. This will also give them satisfaction.

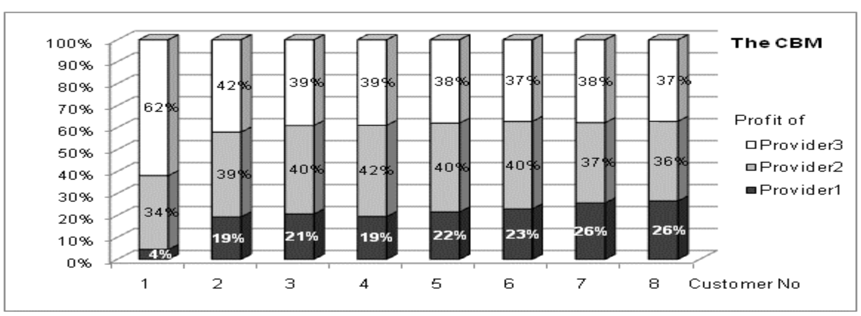


Figure 6.6 Distribution of Providers' Profits in the CBM

Table 6.6 Incentive Compatibility

Incentive Compatibility	The CBM	The Core
Volume Discount	Yes	Yes
Equilibrium Price	Yes	Not Sure
Fair Share	Yes	No

Table 6.6 summarises incentive compatibility in the CBM and the core. The CBM has higher incentive compatibility than the core. The CBM created a win-win situation for all participants in a group-trading session.

6.2.4 Efficiency

Efficiency generally describes the intent to which some valuable resources are well used for an intended outcome. In this thesis, the efficiency of the CBM and the core are judged by the time and cost which they use to complete tasks.

The CBM is more efficient than the core in collecting the necessary information to locate a stable set. It is a time-consuming job for the core to collect the information of marginal utility functions shown in Table 3.1, which describe the values that customers are willing to pay for the goods and the price the providers want to sell them for. Just as mentioned in subsection 3.1.3, collecting such information can be a big problem in the real marketplace. On the other hand, the inputs needed for the CBM, which are price lists and orders, are market information and can easily be collected by a core broker. For example, the expected discounts of the orders in Table 5.13 show the max values that customers are willing to pay and the volume discounts of the price lists in Table 5.7 indicate the prices the providers want to sell the customers for.

Table 6.7 Efficiency in the CBM and the Core

Efficiency / Task	Less Time		Less Cost	
	The CBM	The Core	The CBM	The Core
Information Collecting	√	-	-	-
A Stable Set Finding	√		-	√

Table 6.7 shows that the CBM has better efficiency than the core. By jointing providers together and combining orders from multiple e-markets, the CBM becomes more efficient than the core in locating a stable set in a large coalition. Firstly, it hides the information of providers and customers to ensure that there are less information and quicker data transfer between e-markets. Secondly, as mentioned in subsection 6.2.2, the big O notations of the CBM and core are $O(n^2 \times 2^n)$ and $O(n^n)$ respectively. It successfully reduces the computational complexity and executing time in group-trading, but there are

extra costs in doing so, including some expenses involving multiple e-markets and the commissions for the brokers.

In the next subsection, the effectiveness including the discounts to customers, the profits for the providers and the total benefits in the CBM and the core are discussed. The net total benefits excluding the extra expenses to the brokers need to be checked to certain that it is worthy to spend the costs to perform group-trading in the CBM.

6.2.5 Effectiveness

There are effectiveness of data protection and fairness in the CBM. Market brokers can hide their customers' personal information before they submit orders to the core brokers. An example is in Tables 3.18 and 3.19. The profits are shared by the providers. The Shapley value is used in the CBM to distribute the profit to each provider in a coalition fairly (reference Fig. 6.6).

In a market, it is usual that if the customers get better discounts, then the providers receive less profit. To ensure the CBM has taken into account the interests of both customers and providers, the average discount that buyers can obtain and the average profit of suppliers are examined here. In this way, the CBM can be evaluated to see whether it gives more benefits than the core to both customers and providers.

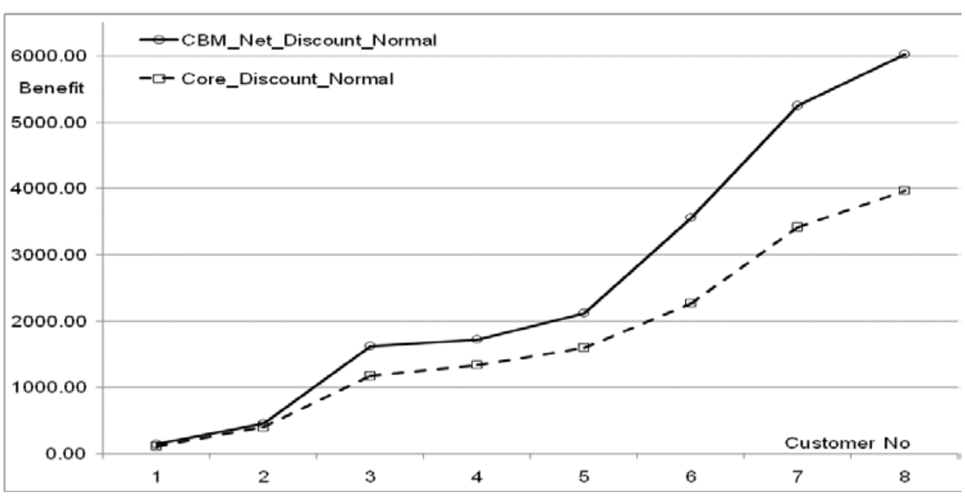


Figure 6.7 Customers' Discounts

In Fig. 6.7 and 6.8, the discounts of the customers and profits of the providers in the CBM are all higher than the ones in the core. The discounts of the customers in the CBM are net discounts, which have had the brokers' commission deducted from them. The same traders can gain more benefit in the multi e-markets of the CBM than they can in the core of a traditional market.

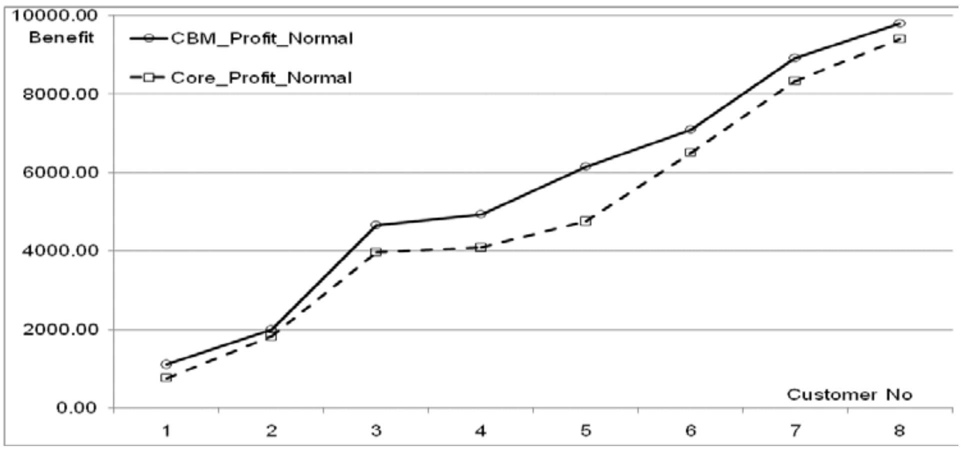


Figure 6.8 Providers' Profits

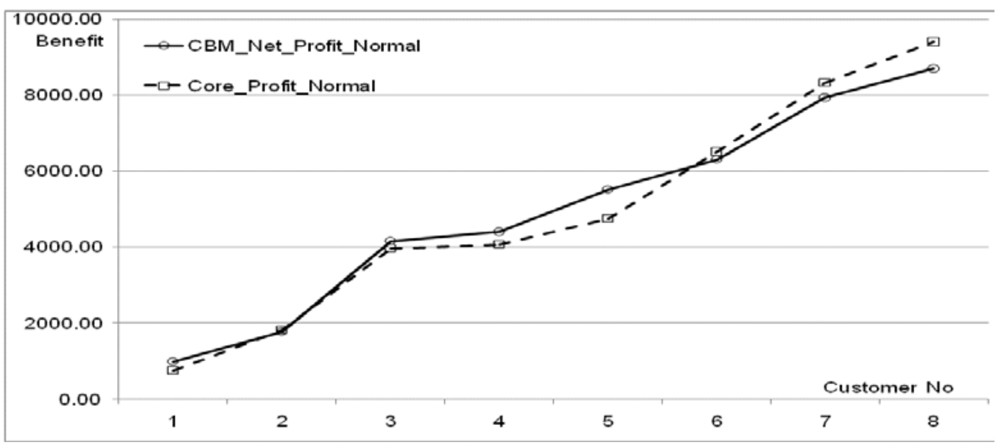


Figure 6.9 Providers' Net Profits

In Fig. 6.9, for the providers in the CBM, the net profits are not always greater than the profits they can get in the core. It may be argued that the brokers deserve to be paid, if they do not bring more profits to the providers. In the CBM, the brokers earn commission because they provide a new channel of selling for suppliers and attract all kinds of customers including those who desire to get high discounts.

It is quite common in an e-market nowadays to have many demanding customers. It is also very difficult to attract such customers to a traditional market. It is important to show that CBM can effectively allure such buyers to e-markets and bring more profit to providers. It is also crucial that the simulation system provides evidence to show that there are far more discounts in the CBM for customers than in the core. For this purpose, the TCG created test data for a scenario of demanding buyers, who only buy items at an extremely low price. This data, which given in Appendix 6, was used in the CBMS and the CS.

Fig. 6.10 shows that the providers are significantly better off by using the CBM, especially when this is compared with Fig. 6.9, and even after they have paid commission to the brokers.

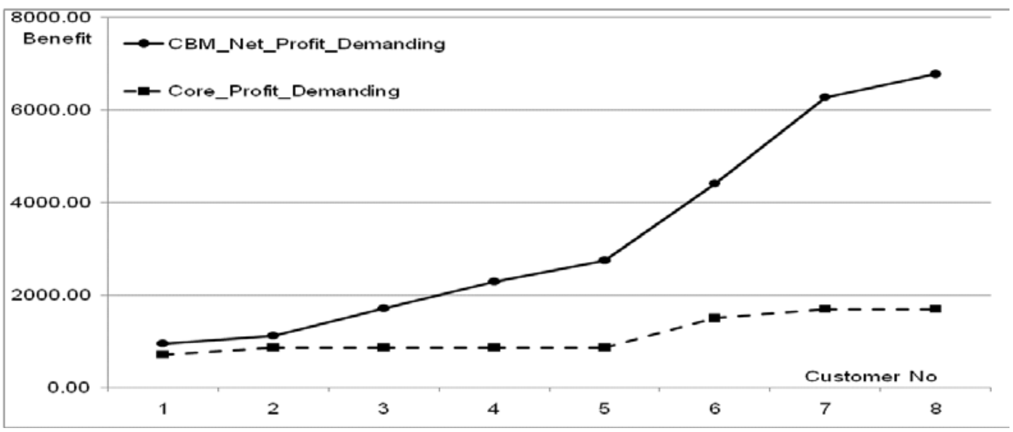


Figure 6.10 Providers' Profits with Demanding Customers

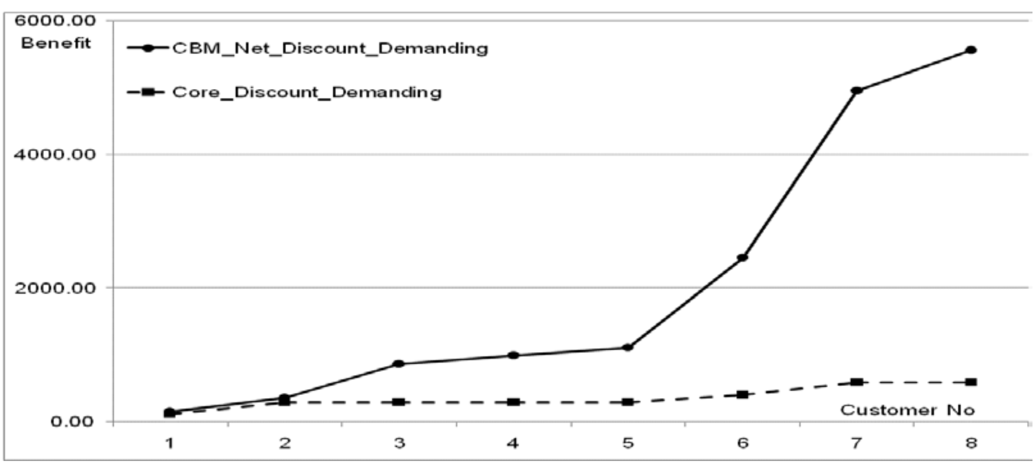


Figure 6.11 Demanding Customers' Discounts

In Fig. 6.11, with the demanding customers, the discount stays low in the core, but the net discount in the CBM keeps increasing when the number of the customers increases. This implies demanding customers can get the higher discounts they want in the CBM.

Table 6.8 Effectiveness in the CBM and in the Core

Effectiveness	Normal Buyers		Demanding Buyers	
	The CBM	*The Core*	*The CBM*	*The Core*
More Net Discount	√	-	√	-
More Profit	√	-	√	-
More Net Profit	√	√	√	-
More Total Benefit	√	-	√	-

Table 6.8 shows that the customers gain higher discounts in the CBM in both scenarios: the one with normal buyers, and the one with demanding buyers. Because the CBM can really attract customers and encourage them go through with their purchases, the providers can earn more profits in it, even after part of the profits goes to the brokers as commission. A wise provider will definitely choose to join the group-trading in the CBM rather than stay in the core of a traditional market.

Table 6.9 Effectiveness

Effectiveness	Data Protection	Fairness	More Discount	More Profit	More Total Benefit	Commission
The CBM	√	√	√	√	√	√
The Core	-	-	-	-	-	-

Table 6.9 summarises the effectiveness in the CBM and the core. In the above comparisons, only eight orders are used. This is because of the high complexity in the core. But in the next section, because the CBM is capable of handling a large coalition, all 198 orders generated by the TCG in the two scenarios are used and the results obtained in the CBM are discussed.

6.3 Effectiveness of the CBM in large Coalitions

As mentioned in chapter 5, there are three providers and three market-brokers in group-trading project S1, which is created by core-broker Ben. The CBM is built to deal with large coalitions. Without testing the CBM with a large amount of data, the evaluation would be incomplete and the effectiveness of the new model in a large coalition could be unconvincing. In subsection 6.3.1, the CBM is tested with 99 orders using the scenario of normal buyers. Within the order detail table in which every order is stored, there is a special field called 'expected discount'. This field allows customers to place the orders without committing to buy the items. The CBM will wait for the final discount to be settled and decide whether the purchase should go ahead or be dropped, by comparing the final and expected discount. When the market-broker makes the orders that come from his buyers' coalition into one market order, the highest of the expected discounts attached to each product, will be put on the market order, when the CBM performs the information-hiding process. In Table 6.10, order O25 is an example from a typical normal customer, who does not ask for high discount, just like the other orders in Appendix 5.

Table 6.10 A Normal Buyer

Order ID	Customer ID	Product ID	Quantity	Expected Discount
O25	C35	Ca	12	0.03
		Cb	14	0.19
		Cc	24	0.00
		Ra	22	0.15
		Rb	32	0.07

Table 6.11 A Demanding Buyer

Order ID	Customer ID	Product ID	Quantity	Expected Discount
H72	C182	Ca	6	0.37
		Cb	8	0.18
		Cc	15	0.17
		Ra	31	0.31
		Rb	8	0.17
		Rc	9	0.09

In subsection 6.3.2, the CBMS uses the 99 orders which come from the scenario of demanding buyers. A typical one would be Order H72 in Table 6.11, in which buyer C182 asks for an extremely high expected discount for every item. The order for each item will not be put forward unless the actual discount of the item has reached or gone beyond the level of the expected discount. With the results in these two scenarios it is possible to discover what the overall performance of the CBM will be.

6.3.1 Scenario 1: Normal Buyers

Fig. 6.12 shows the total benefits of the providers and buyers. At the point of 13 customers, the graphs reach their peaks. This means that the items are fully sold out at this point. It also implies that all the customers commit their purchases because they can get the expected discounts they want.

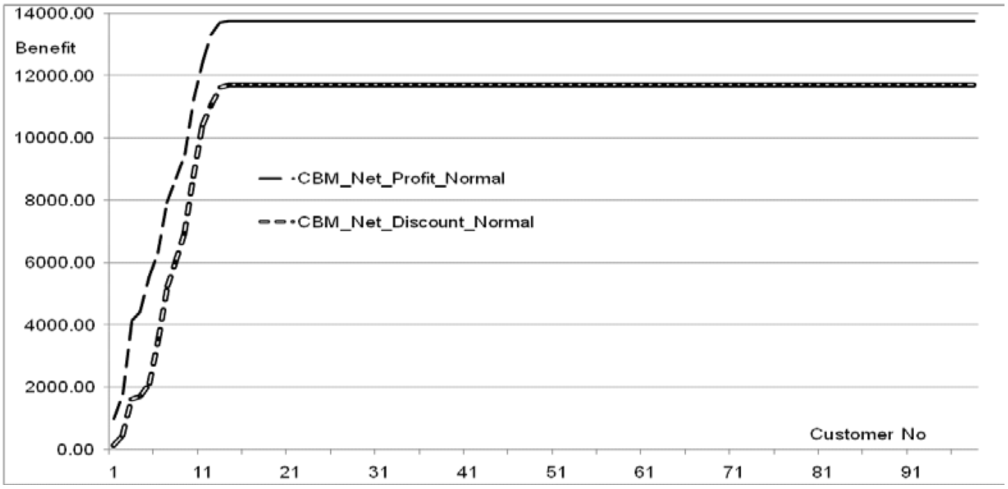


Figure 6.12 Total Benefits with Normal Customers

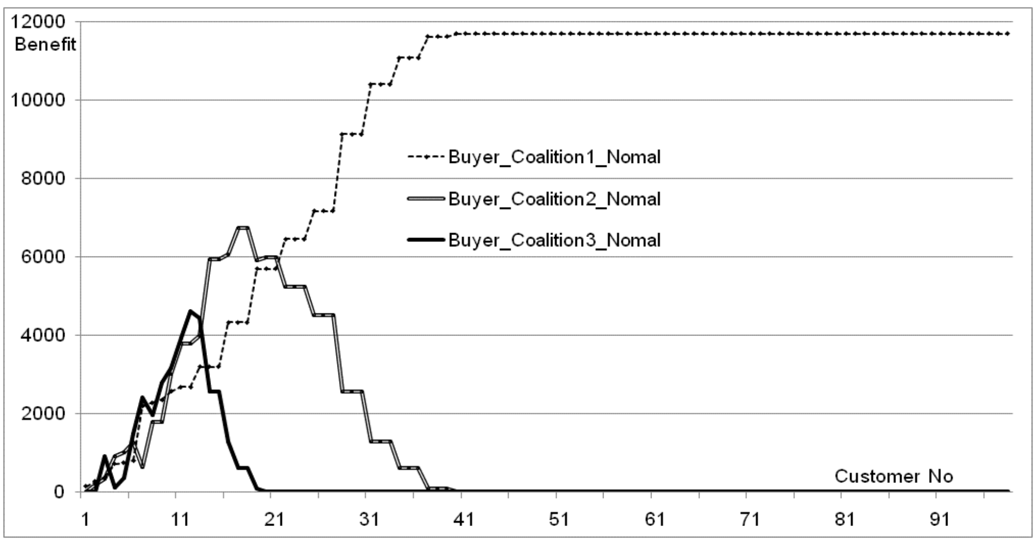


Figure 6.13 Normal Customers' Net Discounts

The system divides the total number of customers into 3 equal portions and assigns a portion to each market-broker. For instance, every market-broker has 23 clients when there are 69 customers in the system. Fig. 6.13 shows that the discounts for MB1's clients keep increasing and reaches its peak at the point of 40 customers. MB3 is the last one to submit his order and the graph shows that the sum of all the discounts of his clients is at its highest at the point of 13 customers, but the total discount becomes zero when there are more than 20 customers in the system. MB2's graph shows that the sum of all the discounts of his clients is greatest at the point of 17 customers, but none of his clients gets any product at all at the point of 40 customers, which means MB1 has 40÷3+1=14 customers. This shows that MB1 gets all the items at this point, if he has more than 14 clients, because he was the first to submit his order.

It is MB1's decision which of MB1's clients can have the items, if MB1 has more than 13 clients, but the principle should be FCFS. Those clients, who sent their orders to MB1 the earliest, should receive the offers from the providers. The CBM processes orders by means of FCFS. It is a quick way to manage the orders, but the consequence is that only the customers, whose market-broker submitted the market orders early, have a good chance of getting the products. So FCFS is good for the clients if they have an efficient market-broker. On the other hand, it is a disadvantage to buyers who order early, if their broker submits late. Because market-brokers hide the customers' information before they submit the orders, Ben does not know which customers ordered early. He has no way to secure a product for them. So market-brokers who delay the submission of their orders will receive plenty of complaints from their clients.

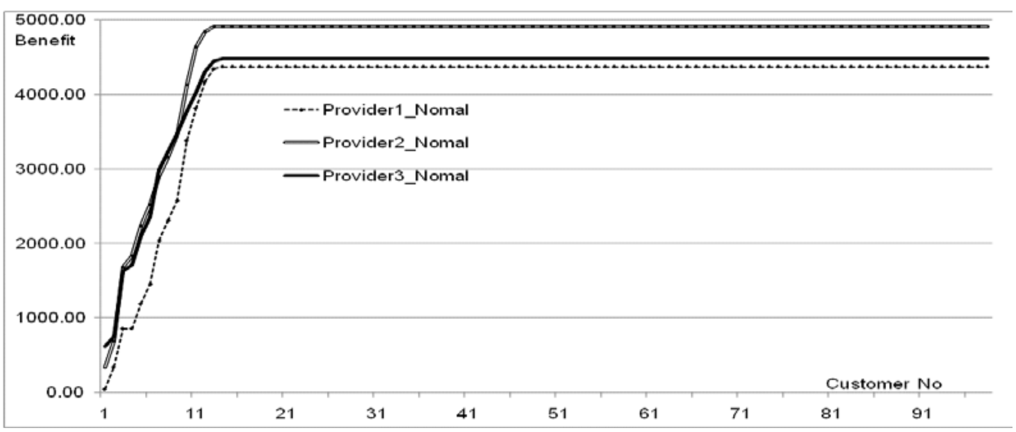


Figure 6.14 Provider's Net Profit with Normal Customers

Fig. 6.14 shows that the CBM is good for providers because their profits can increase rapidly when they use it. The results of the CBMS for the customers and providers in the other scenario are given in the next subsection.

6.3.2 Scenario 2: Demanding Buyers

Fig. 6.15 shows that the graphs reach their peaks at the point of 15 customers. This is 2 buyers more than in Fig. 6.12. This implies that the CBM can successfully convince the demanding customers to buy, but it takes a little more time than the normal buyers need. The larger the coalition is, the bigger the total benefit should be to traders. But the total benefits drop, when the number of customers is more than 22. The unusual results in this scenario are reflected in the strange appearances of the graphs.

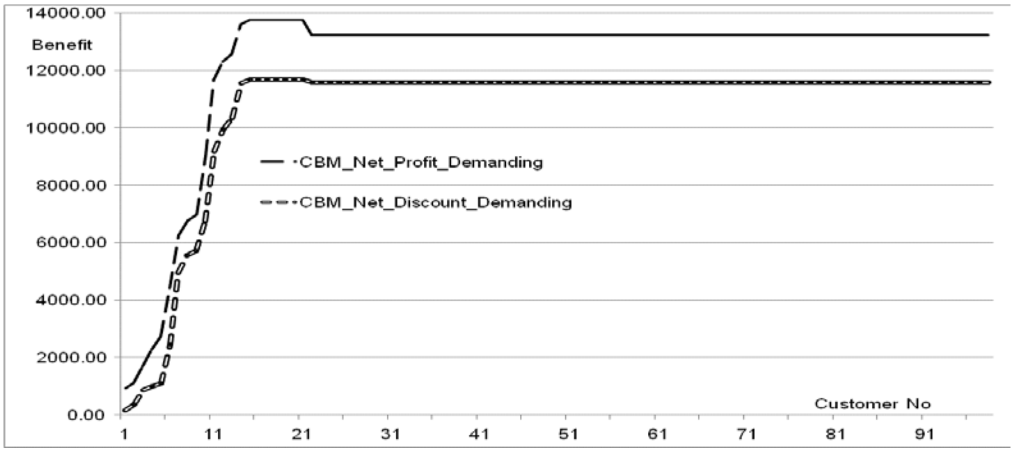


Figure 6.15 Total Benefits with Demanding Customers

Table 6.12 A Dead Product

Status	Product	Stock	Actual Discount	MB1 Expected Discount	MB2 Expected Discount	MB3 Expected Discount
21	Rc	41	10%	8%	16%	15%
22	Rc	41	0%	11%	16%	15%

A term 'dead product' is used in this thesis, which is a phenomenon when a product is available, but no buyers can have it. This is because every order has an over-high expected discount on it. Table 6.12 reveals the reason why this causes a dead product. Product Rc's stock is 41 and its volume discount is 10%. At the point of 21 customers, MB1 expects to have an 8% discount from Rc and he gets it, while at the point of 22 customers, the expected discounts of all the market-brokers are greater than 10%. So Rc becomes a dead product. Most of the buyers in the second scenario demand for extremely high discounts. As the buyers' coalition becomes larger, the chance for the coalition to have higher expected discounts in the market order will increase. It is easy for a core-broker to deal with the dead product problem. Ben may inform the market-brokers and ask them to alter the expected discounts. He may also ask the supplier to adjust the volume discount for that particular item.

Fig. 6.16 shows the graphs of MB2 and MB3 reach the peak at the point of 20 and 13 customers respectively. The discounts for MB1's clients keep increasing until at the point of 43 customers. MB1 gets all the items when he has 43÷3+1=15 customers. This result is not significantly different from the last scenario, i.e. 14 customers. It is a good sign for the participants, as it shows that demanding buyers continue to make deals just like normal customers do.

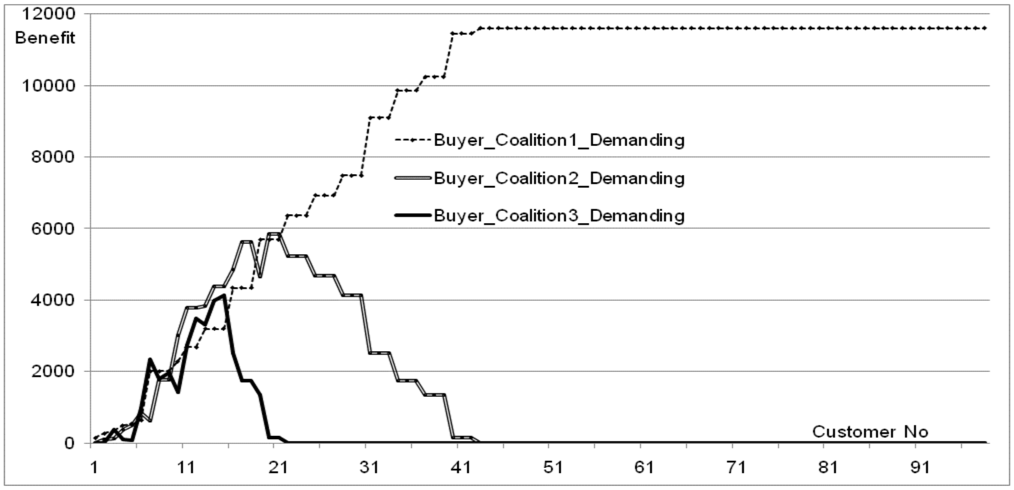


Figure 6.16 Demanding Customers' Net Discounts

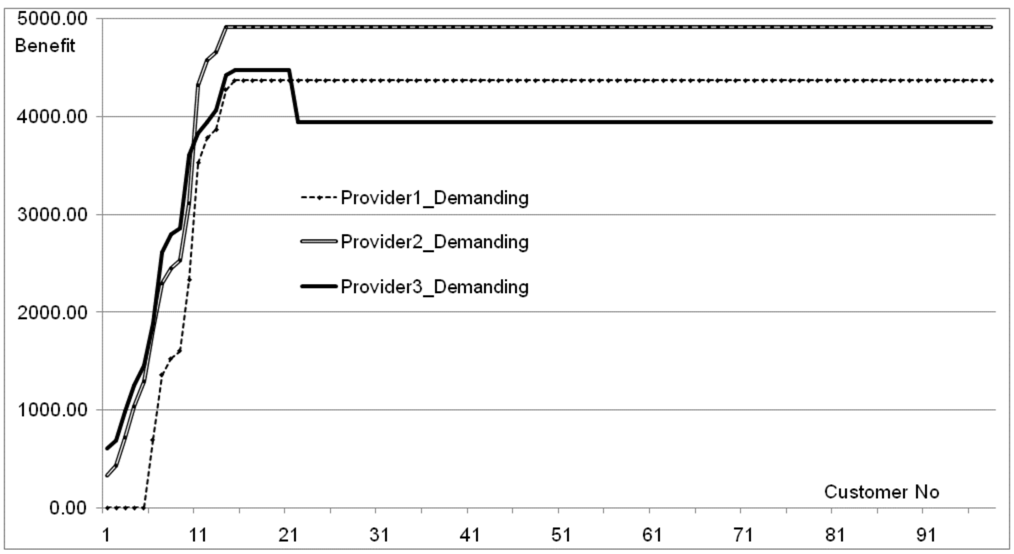


Figure 6.17 Provider's Net Profit with Demanding Customers

In Fig. 6.17, provider 3 has an unusual graph. It reaches its peak at the point of 15 customers, but it drops when the number of customers is more than 22 because of the dead product Rc. Provider 3 is the only supplier who provides product Rc, so the dead product reflects on his graph. The discounts for MB3's clients are zeroes in the beginning, which is shown on his graph in Fig. 6.17. It is normal that demanding customers do not buy if the price is too high for them. They begin to commit their purchases when the buyers' coalition is big enough to have certain bargain power and get higher discount.

The results in the two scenarios show that the CBM is capable of dealing with a large coalition. The CBM also shows its potential in attracting customers including demanding buyers, who want high discounts. Demanding buyers are quite common on the Internet and do not commit to their purchases easily. The CBM creates a win-win-win situation for customers, providers and brokers in the CBM.

6.4 Effectiveness and Efficiency of the CBM's Techniques

The CBM adopts ten techniques, namely price lists and orders with expected discount, brokers, Internet computing, information-hiding, distributed computing, collaboration, FCFS, volume discount, stability check and the Shapley value. In order to determine the above ten techniques are useful in the new model, they are examined independently in this section to see their impact to the process time, cost, buyers' discount, providers' profit, fairness and data protection in group-trading:

1. **Price lists & orders with expected discount** − in economics, marginal utility functions are commonly used to express how traders quantify relative prices of goods and services. Because its difficulty in collecting from traders makes it inapplicable in real world e-commerce, price lists and orders with expected discount are used in the CBM. Price lists, which contain retail prices and discounts for each product, can express the prices which the providers are willing to offer. Adding expected discounts in orders can allow customers to place orders without being committed to buy the items. This is a good way to collect the data about the price buyers are willing to pay. It saves time and cost in information collection for market-brokers.

   Disadvantage − in order to increase the chance for market orders to get the items, market-brokers' have to beware that there are over-high expected discounts on the customers orders.

2. **Brokers** − the CBM creates a different channel of trading for both customers and providers and brokers play important roles in the trading. They are introduced into the CBM to smooth the trading process and maintain a healthy level of competition in e-markets. They may effectively increase the benefits of the traders in group-trading. The personal information of customers can also be protected by them.

   Disadvantage − the commission for brokers is an extra expense for traders, but the results of the simulation system show that the brokers are worthy of such payments.

3. **Internet computing** − Internet technologies and programming enable the CBM to involve e-markets. Internet has been able to penetrate all parts of the globe 24 hours a day and can easily bring great number of potential buyers into markets. It is beneficial for buyers and providers to participate in group-trading on the Internet. The distributed nature of the Internet can also efficiently reduce the process time of trading.

   Disadvantage − involving multiple e-markets may be more costly than simply using one e-market.

4. **Information-hiding** − the personal information of market-brokers' clients can be protected from others by using this technique. Hiding customers' information and making orders of a coalition into a market order reduces the complexity dramatically.

   Disadvantage − the original times of customer orders are lost after the orders are combining. It is not fair to those customers who order early but their market-brokers submit market orders late.

5. **Distributed computing** − it can reduce the complexity in the core by using multi computers and e-markets and provide good results.

   Disadvantage − involving multiple computers may be more costly than simply using one machine.

6. **Collaboration** − without collaboration between the participants in group-trading, the CBM cannot function well and bring more benefits to buyers and providers.

7. **FCFS −** this is a straight forward way of managing orders and is a quick way to process orders.

   Disadvantage − in order to ensure their clients obtain the items, the market-brokers have to be efficient and submit their market orders as quickly as possible. The CBM may need to consider some solutions for being fair to the customers who order early, but whose broker submits late.

8. **Volume discount** − high discounts attract both normal and demanding buyers. The results of the simulation also indicate that this brings more profit to providers.
9. **Stability check** − it is an efficient way to ensure that a coalition is stable and not falling apart. A coalition, that passes this check, will have a best price for providers and buyers.

   Disadvantage − it takes little extra time to calculate the stability of coalitions, but the time is worthy.
10. **Shapley value** − the CBM distributes profits among providers by using this. The results suggest it is a fair distribution.

    Disadvantage – this increases computational complexity.

Table 6.13 CBM's Evaluations

Technique	Result	Effectiveness				Efficiency	
		More Discount	More Profit	Fairness	Data Protection	Less Time	Less Cost
1. Price Lists & Orders with Expected Discount	Information Collecting	–	–	╳	–	√	–
2. Brokers	Smooth Transaction	√	√	–	√	–	╳
3. Internet Computing	Multi-E-markets	√	√	–	–	√	╳
4. Information Hiding	Less Information	–	–	╳	√	√	–
5. Distributed Computing	Multi Computers	–	–	–	–	√	╳
6. Collaboration	Large Coalition	√	√	–	–	–	–
7. FCFS	Less Complexity	–	–	╳	–	√	–
8. Volume Discount	More Customers	√	√	–	–	–	–
9. Stability Check	Stable Set	√	√	–	–	╳	–
10. Shapley Value	Fair Distribution	–	–	√	–	╳	–

Table 6.13 summarises the results of these techniques in relation to effectiveness and efficiency. In this Table, √ is an yes and ╳ is a no. It shows these techniques have all successfully produced the desired result in the new model. The CBM therefore creates a win-win-win situation for customers, providers and brokers in e-markets.

6.5 Summary

A simulation system was developed to evaluate the new model. The system contained a test case generator (TCG), a core simulator (CS) and a CBM simulator (CBMS) and was written in C# in the Visual Studio 2008 development environment. The TCG was built to create data needed for the simulators. The CS was based on the concept of the core. The CBMS was constructed according to the pattern of the CBM. All the results in this chapter were produced in this system on a common personal computer with Windows Vista. Two sets of test data for the evaluations were produced by the TCG. The first set of 99 orders comes from a scenario of normal customers where buyers do not expect a high discount. The second set of 99 orders is based on a scenario of demanding customers where buyers demand a high discount.

Five criteria are used to judge between the core and CBM, namely distributed computing, computational complexity, incentive compatibility, efficiency and effectiveness. In distributed computing, the core might be used in an e-market, but it is difficult to apply it to multiple e-markets. The CBM enables a core-broker to make the best use more than one e-market. The computational complexity of both systems is evaluated. The big O notation of the CBM demonstrates that it is capable of reducing the computational complexity in a large coalition and dealing with a vast number of customers effectively and efficiently.

Three incentives: an equilibrium price, volume discounts and a fair distribution are to be judged for both the systems. An equilibrium price may not be reached in the core, but there is an equilibrium price for traders in the CBM. Although both systems can offer volume discounts to customers, the fair distribution of profit in the CBM does not happen in the core. The efficiency of the CBM and the core are judged by the time and cost which they use to complete tasks. The CBM is more efficient than the core in collecting the necessary information to locate a stable set. It successfully reduces the computational complexity and executing time in group-trading, but there are extra costs in doing so, including some expenses involving multiple e-markets and the commissions for the brokers.

There are effectiveness of data protection and fairness in the CBM. Because customers can get more discounts from group-buying and providers gain higher profits from more customers, the traders may get more benefits in the CBM than in the core especially in a large coalition. The results of the simulation system also show that the CBM can more effectively allure demanding buyers when comparing the results in the core. The outcomes show both the providers and customers are significantly better off by using the CBM.

The CBM is capable of handling a large coalition in the scenarios of normal customers and demanding customers are used. In the normal customers' scenario, the results of the system show that all the customers can get the expected discounts they want. The CBM is good for providers, because their profits can increase rapidly when they use it. In the demanding customers' scenario, the CBM can successfully convince the customers to buy, although it may take a little more time. The results support demanding buyers keep making deals in the CBM just like normal customers do. A problem referred to here as a 'dead product' happening in orders with over-high expected discounts can be resolved easily by core-brokers. The results in the two scenarios show that the CBM is capable of dealing with a large coalition. The CBM also shows its potential in attracting customers including demanding buyers, who can be common customers on the Internet and are not easy to commit to their purchases.

The CBM adopts ten techniques. An evaluation of these techniques was made based on the results of the CBM in relation to effectiveness and efficiency. They have all successfully produced the desired result in the CBM. In the next chapter, discussions about the CBM and the contributions of this dissertation are presented. The conclusion and suggested future works are also dealt with in the final chapter.

Chapter 7

Conclusions and Future Works

This research has created a new group-trading model. This aims not only to bring lower prices for buyers but to create higher profits for providers. While the survey of current e-markets in chapter 2 shows no sign of an online group-trading model, but there are plenty of joint-selling activities and many online group-buying sites. The former increases competitive advantages and benefits providers, and also provides ways for cartels to control price and thus is disadvantageous for customers. The latter have become very popular recently. A major problem of these models is that they lack ability to deal with the stability issue in coalitions, which therefore fall apart easily. The core, introduced in chapter 3, provides solutions to ensure a stable coalition, but certain problems of the core have hindered researchers from applying it to a real-world market.

Building an online group-buying model can be a real challenge. The new model presented here is based on the core and adopts the additional solution concepts shown in chapter 3. In the case study of chapter 5, the CBM successfully creates a win-win-win situation for customers, providers and brokers in e-markets. In previous chapter, the comparison between the results of the two systems shows the CBM is superior to the core in terms of distributed computing, computational complexity, and incentive compatibility. The results of the simulation system demonstrate that the CBM can attract customers and deal with online group-trading problems in a large coalition. An evaluation of the techniques in the CBM was made showing that all of them have produced the desired results in the CBM effectively and efficiently.

The new model has overcome a number of group-trading problems on the Internet. The six significant contributions of this research are listed in section 7.1. In order to make the model function properly, some conditions need to be met. Section 7.2 provides details of several assumptions used in the CBM. In the final section of this chapter, suggestions are made for the additional research needed in this field in the future.

7.1 Contributions of the Research

The main contribution of this research is the CBM, but during the process of creating this new model for group-trading in e-markets, six additional issues have emerged which also make a contribution to knowledge in this field:

1. **The advantages and problems of group-buying models –** there are four problems in group-buying models. The first problem is that they fail to overcome stability problems, so coalitions can fall apart easily. The second problem is that their markets are monopolies and they may fall foul of competition laws. The third problem is these models need to deal with high computational complexity when there are many customers perform group-buying in e-markets. Finally, providers on group-buying sites are liable to be overcharged. This research avoids the aforementioned problems and uses the following three methods which are expected to be effective in bringing a large number of customers onto group-buying websites:

   (a) Offering low price deals to customers.
   (b) Gaining benefits from using broking systems with fair and professional coordinators acting on behalf of both sellers and buyers.
   (c) Using the force of peer pressure to increase the size of buyers' coalitions.

   Another contribution of this research is uncovering some of the advantages and problems of group-buying models.

2. **The advantages and problems of joint-selling –** in this research, three reasons are advanced for using joint-selling,

   (a) It gives incentives to sellers: joint-selling increases the competitive advantage; achieves economies of scale and scope; reduces costs of transactions; contributes forming and maintaining a brand, for instance, and conducting advertising and initiating research together.
   (b) It gives incentives to buyers, new products, low prices due to low cost and better services through business partnering.
   (c) It reduces computational complexity: this greatly reduces the time taken to process trading transactions.

Joint-selling as developed in this research ensures that every seller has a fair share of the profits by using the Shapley value. Another contribution of this research is that it provides ways of taking part in joint-selling without violating competition laws thereby protecting the interests of consumers. A joint-selling agreement which restricts competition will not necessarily turn out to be a cartel. Agreements between companies leading to the development and improvement of products or services are encouraged and they are also good for consumers and markets. However, agreements to fix prices, limit production or sharing markets or customers, are considered out of bounds for the purposes of this research.

3. **The advantages and problems of the core concept –** The core has three problems: (a) it can be effective only when the coalition is small, (b) its input is not easy to collect and additionally (c) its output is not always stable. Consequently, it does not seem practical for use in e-markets. The CBM inherits two important advantages of the core. Firstly, it provides a way to find a stable set, which is also a Pareto efficiency allocation. Secondly it gives that set incentive compatibility.

   One important discovery of this research has been that the core is not applicable in the real-world e-markets especially for a large coalition because its problems.

4. **A stability check for a coalition –** in a stable coalition, there will be an equilibrium price, which is an important incentive for the participants. This best price is achieved when the quantity of goods that providers wish to supply matches the quantity that customers want to purchase. Detecting the stability of a coalition is crucial in this research. Without an equilibrium price, the members may lose interest in remaining in the coalition. However, determining the stability of the core is a NP-complete problem. A way to check the stability of a coalition has been given and any coalition that fails this check would be rejected by the CBM. Thus an important contribution of this research has been to use the stability check to ensure a coalition is stable and then to calculate an equilibrium price for its members.

5. **The use of brokers in group-trading –** in order to avoid unequal member allocations, which are a common problem on group-buying sites, the person organising the group-trading session should not be a member of a coalition. In addition, unprofessional leadership of a coalition leads to a lack of commitment

among its members, and so it is concluded that group leaders must be specialists. This makes a broker a perfect candidate to manage a group. Brokers are brought in to manage transactions and to keep the competition in e-markets healthy. If each broker finds customers locally, some handling expenses like shipping or tax can be saved. The model will work better with a large number of participants. If several brokers work together, they may be able to find more buyers. When brokers collaborate together, it would be possible to form a large coalition on a global level and thus to attract a large number of buyers.

One of the important contributions of this research is to involve brokers in the process of group-trading.

6. **The fees system of the CBM** – the main revenue of broking systems and brokers comes from fees for the transactions. In order to be able to set up the fees for the CBS and the commission for the brokers, the fees for 15 popular marketplaces were investigated. Generally speaking, there are three types of fee which sellers are charged. These are: final value fees, online store fees and insertion fees. In the CBM, there are only two fees, a session fee and an online store fee for the CBS site. The commission for the brokers consists of a handling fee and a final value fee.

   A contribution of this research is a fees system for the CBM based on the fees systems of some real-world online marketplaces.

Even though the model has overcome a number of problems and has made seven significant contributions to the area, some conditions need to be met in order for the model to function properly. The next section gives details of several assumptions used in the CBM.

7.2 Limitations of the CBM

It is accepted that several assumptions are made in the e-markets of the CBM. There are three different types of assumptions: *negligibility*, *heuristic*, and *domain* (Musgrave 1981). Negligibility and heuristic assumptions describe "simplifications and idealised cases of the real world respectively" (Lam 2010). The assumptions of the simple games in the beginning of chapter 2 relate to negligibility, while the presumptions of perfect competition in subsection 2.1.2 are heuristic. These two kinds of assumptions are too unrealistic to be used in a model such as the CBM, which is built to deal with real-world group-trading problems.

A domain assumption is "a hypothesis concerned with the domain of applicability of a theory; it is the statement that theory *T* applies only if factor *F* is absent" (Maki 2000). It specifies the conditions under which a particular theory will apply. It also plays an important role in model development because it appropriately sets out the boundary conditions which must be present if the model is to function properly. Eight domain assumptions in the model are described next.

The first assumption is about the information used in the CBM. There are four different levels of information: *public-level*, *member-level*, *project-level* and *private-level*. The public-level information contains three documents: the project specifications, the product descriptions, and the price lists. They are displayed on the CBS website by the core-brokers and can be viewed by anyone.

Member-level information can only be accessed by the members of the CBS site. Registering as a member on the site is free. Five tables, namely the project table, the project session table, the project providing table, the product table and the project price list table, are available for free download from the site by the members when they need them. Project-level information is the working data of a project and can only be shared between the brokers who work on the project. Private-level information is protected from people who do not own it. Providing information contains the stock and the unit price of a product from the suppliers. It is considered to be private and belongs to the core-brokers the suppliers work with, while the purchase details of the customers can only be accessed by their market-brokers. All the above information is stored in the CBM database and is provided in Appendix 4.

The second assumption is that the stock of the items may be limited. In the CBM, quantity of sales depends on the amount of stock held by a provider.

The third assumption relates to the way that the orders are organised. The CBM manages the orders on a First Come, First Served (FCFS) basis. An order that arrives first will be handled first. If an order is submitted late, the required items may no longer be available, especially when the supply of products falls short of demand; the market-brokers need to submit their order as quickly as they can.

The fourth assumption is that the project does not offer multi-product volume discount to customers. For example, a customer has 10% and 12% discounts for buying products A and B respectively. In the CBM, discounting for the customer is based on the popularity of a product rather than size of order. If the customer purchases product A and B together, the discounts for each individual product stay unchanged. They are dealt with on their own and no extra discount will be offered, even though they have been bought together.

The fifth assumption regards the products and services that customers receive. In the CBM, when customers pay for the orders, they receive electronic coupons from brokers. They can claim the real products and services from the providers printed on the coupons. Each coupon has a unique ID to ensure that one coupon may be redeemed only once.

The sixth assumption is that no extra fee for shipping will be charged during the processing of transactions. In the CBM, all customers must leave email to brokers. They receive electronic coupons via e-mail from the market-brokers, which they can print out and exchange for products and services, when it is convenient for them to do so. Some of Amazon and eBay sellers offer apparently cheap goods but then charge very large ‘postage fees’, which actually cover part of the cost of the item. Because the market-brokers are not allowed to make a shipping charge in the CBM, any shipping costs must be borne out of profits, if the goods must be sent by post. This may be necessary if the product is too large or heavy for customers to pick up.

The seventh assumption is about the commissions for brokers. The fees system of the CBM given in section 4.4 consists of four kinds of fees: a session fee, an online store fee, a handling fee and a final value fee. A session fee of £30 is paid by core-brokers every time they enter a listing for a session on a project on the site. An online store fee of the

CBS at £24.50 is a suggested monthly fee for market-brokers, who wish to open an online store on the site. The commission comes from two sources: a final value fee and a handling fee. The final value fee is paid by the providers to reward the brokers and is 7% of the final selling value. The handling fee is 10% of the extra discount, which the customer gains, after each of the brokers has processed the orders.

The eighth assumption relates to the method of payment. The CBM offers alternative payment methods including bank transfers, PayPal and utility & debit cards. Bank transfers are regarded as secure and are a common and efficient way of making payments today. PayPal is an alternative safe way but it involves additional cost. In the case study of chapters 5 and 6, the providers and the core-brokers receive money by bank transfer, while customers pay for their items via PayPal.

All systems are capable of improvement and some issues with the CBM can be identified. These issues are described in the next section as recommended improvements to the model and represent interesting avenues of future work.

7.3 Future Works

The ultimate goal of this research is to apply the CBM to perform group-buying tasks. This section outlines the main research recommendations to improve the CBM for the near future. They are:

- **Multi-product volume discount –** It may be advantageous to abandon the fourth assumption of this research. Offering multi-product a volume discount to customers is actually a common method in the real-world market for attracting more purchases. Most customers do not stand a great chance of obtaining much benefit from discounts like this when they shop individually. When market-brokers bundle orders together, they may succeed in receiving extra discount through multi-product purchases. There is no doubt that they will be able to attract more customers to join the buyers' coalitions if they can do this.

- **Fair distribution –** the CBM manages the orders by means of FCFS. The results of the simulation show that a late submitted order may get nothing, especially when the stock of a product is limited and its supply falls short of demand. If the policy is that people who order more are likely to get their orders fulfilled, it may encourage individual customers to make larger purchases. The Shapley value can be used here to decide how many items each customer may get, using the order amount as an initial estimate.
- **Real cases/situations –** one future work of this research is to fitting the CBM on an enterprise. The results of the simulation based on sample values/situations may not represent all cases. More comparisons between the core and the CBM based on real data from the practical scenarios need to be done. There should be more details to be considered, for instance, the differences between manufacturers, distributors and resellers have to be taken on board, in order to map these different types of provider onto the CBM.
- **Cooperation with e-trailers –** it is essential that a popular online shopping site is included in this model. It is the job of the market-brokers to find a suitable e-market. They must research current online sites and discover which rules, fees and related information apply to each e-market. The choice of e-markets for the project will have a dramatic effect on the outcome for the market-brokers. A list of e-markets and advice on how these online sites can be fitted into a group-trading project should be offered to the market-brokers on the CBS site. EBay is one of the popular online shopping sites in the world. It would be particularly interesting to include eBay in the CBM in the course of future research. The information about eBay in appendixes 1 – 3 would be a good basis for the future works.
- **Services –** it may be advantageous to consider selling composite services using the model. A service can be data, a database, a program or a system. New composite services can be produced easily by sharing and reusing existing services. It is beneficial for service providers to work together in coalitions, because if they do, they may use them to compose new composite services to attract potential buyers. Composite services can usually attract more buyers, because new promising services are always needed. Services may not appear in the same form for a very long time

and are usually supplied in a short-term context (Matear *et al*. 2000). It is crucial that service consumers should be able to have the services they want as soon as possible, because services are soon out of date (Matear *et al*. 2000). The CBM is efficient enough to deal with a large group of service consumers within a short time, and so can keep up with the changes. It has also shown its potential in handling online group-trading for composite services.

From the list above, it becomes clear that there will be two main targets for future research. One main target will be to create more incentives for participants. Another target will be to expand the CBM by including particular e-markets and selling a great diversity of products and services on them

References

About.com (n.d.) ‘Online Antique and Collectible Malls - Which One is Best for You?’ [Online] Available from <http://collectibles.about.com/library/articles/blcompareonlinemalls-htm.htm> [12 July 2011]

Albers, M. (2001) ‘Energy Liberalization and EC Competition Law.’ *Fordham International Law Journal* 25, (4) 909-945

Amazon (n.d.) ‘Fees and Pricing.’ [Online] Available from <http://www.amazon.com/gp/help/customer/display.html?nodeId=1161240> [11 July 2011]

Anand, K. and Aron, R. (2003) ‘Group-buying on the web: A comparison of price-discovery mechanisms.’ *Management Science* 49, 1546-1562

Andam, Z.R. (2003) *e-Commerce and e-Business*, Kuala Lumpur: UNDP Asia-Pacific Development Information Programme

Anderson, D. (2006) ‘Why I Switched to Blujay.com: Don't Pay eBay Fees When You Can List for Free.’ *Associated Content* 9 December [Online] Available from <http://www.associatedcontent.com/article/95104/why_i_switched_to_blujaycom_dont_pay.html> [11 July 2011]

Anderson, E. (2002) ‘Sharing the Wealth: When Should FirmsTreat Customers as Partners?’ *Management Science* 48, (8) 955–971

Andreessen, M. (1993) *NCSA Mosaic Technical Summary.* University of Illinois, Urbana: National Centre for Supercomputing Applications

Andrews, G. R. (2000) *Foundations of Multithreaded, Parallel, and Distributed Programming.* Boston, Massachusetts: Addison-Wesley

Arthur, O. and Sheffrin, S. (2003) *economics: Principles in action.* New Jersey: Pearson Prentice Hall.

Asch, S.E. (1956) Studies of Independence and Conformity: A Majority of One against Unanimous Majority. *Psychological Monographs*, 70-79

Ashley (2008) ‘eCRATER: An eBay Alternative.’ *Cybernet News* 10 Feb. [Online] Available from <http://cybernetnews.com/ecrater-an-ebay-alternative/> [11 July 2011]

Asselin F. and Chaib-draa B. (2006) ‘Performance of software agents in non-transferable payoff group buying.’ *Journal of Experimental & Theoretical Artificial Intelligence* 18, (1) 17-48

Atomic Mall (n.d.) ‘FAQs/How much does it cost?’ [Online] Available from <http://www.atomicmall.com/faq.php#sell6> [11 July 2011]

Aumann, R. (1987) *Game Theory*. New York: The New Palgrave

Aylesworth, M.M. (2003) ‘Purchasing Consortia in the public sector, models and methods for success.’ *In 88th Annual International Conference Proceedings*, Held May at Nashville, TN.

Bakos, J. (1998) ‘The Emerging Role of Electronic Marketplaces on the Internet.’ *Communications of the ACM*, (8) 35-42

Banks, J., Carson, J., Nelson, B. and Nicol, D. (2001) *Discrete-Event System Simulation*. Prentice Hall.

Bansal, H.S., and Voyer, P.A. (2000) ‘Word-of-mouth processes within a services purchase decision context.’ *Journal of Service Research* 3, (2) 166.

Baumol, W.J. (1982) ‘Contestable Markets: An Uprising in the Theory of Industry Structure.’ *American economic Review* (March): 1-15

BBC News (2010) ‘EBay profits boosted by PayPal success’ *BBC News* 21 July [Online] Available from <http://www.bbc.co.uk/news/business-10721734> [21 April 2011]

References

Beamish, A. (1995) *Communities on-line: Community-based computer networks Massachusetts.* Unpublished Master's thesis, The Massachusetts Institute of Technology, Dept. of Urban Studies and Planning

Berners-Lee, T. *et al.* (2005) *Uniform Resource Identifier (URI): Generic Syntax*. Internet Society. Request for Comments: 3986; STD 66 [Online] Available from <http://labs.apache.org/webarch/uri/rfc/rfc3986.html> [1 July 2011]

Bikhchandani, S. and Sharma, S. (2001) 'Herd Behaviour in Financial Markets.' *IMF Staff Papers* 47, (3) 279-310

Bloch, R.E., Perlman, S.P. and Brown, J.S. (2008) 'Group Purchasing Organisations' *Contracting Practices Under Antitrust Laws:Myth and Reality.* Mayer, Brown, Rowe & Maw Report.

Bonanza (2011) 'Bonanza Pricing.' [Online] Available from <http://www.bonanza.com/site_help/general/pricing?title=What+does+it+cost+to+sell+on+Bonanzle%253F> [11 July 2011]

Bondareva, O. (1963) 'Some application of linear programming to cooperative games'. *Problemy Kibernetiki* 10, 119-139

Bradley, S.P. and Kelley, P. (1999). 'eBay Inc.' Cambridge: Harvard Business School Press.

Byrne, J. (1993) 'The Virtual Corporation.' *Business Week.* Feb 8, 98-104.

Bucki, J. (2008) 'eBay and PayPal Receive National Technology Award.' About.com, Operations/Technology, [online] Available from <http://operationstech.about.com/b/2008/09/29/ebay-and-paypal-receive-national-technology-award.htm> [7 April 2011]

Burlington, M. A. (2002) *Introduction to Web Services Architecture*. Systinet Corp.

Burns, P. (2011) 3rd edn. *Entrepreneurship and Small Business*, Basingstoke, Hampshire :Palgrave Macmillan

Cailliau, R. and Gillies, J. (2000) *How the Web was Born: The Story of the World Wide Web*. Oxford: Oxford University Press

Carlson, N. (2011) 'Facebook Has More Than 600 Million Users, Goldman Tells Clients.' *Business Insider SAI* [online] Available from <http://www.businessinsider.com/ facebook-has-more-than-600-million-users-goldman-tells-clients-2011-1> [14 May 2011]

Champy, J. and Nohria, N. (2000) *The ARC of Ambition: Defining the Leadership Journey*. New York: Basic Books

Chang, Y.T. (2007) 'Auctions, group-buying let you select. Shopping on the Internet a great opportunity.' Electronic Commerce Times, [online] Available from <http://www.ectimes.org.tw/Shownews.aspx?id=9453> [4 February 2011]

Chen, Y. F. 'Herd Behavior in Purchasing Books Online.' Computers in Human Behaviour archive 24, (5) 1977-1992

Clark, D. (2001) 'Mobshop, a Pioneer in Group-buying on the Web, Discontinues Consumer Service.' *Wall Street Journal*, 15 January

Conlin, M. (2011) 'Groupon's fall to earth swifter than its fast rise.' *Yahoo! News* 21 Oct [online] Available from <http://news.yahoo.com/groupons-fall-earth-swifter-fast-rise-184713324.html> [29 October 2011]

Competition Commission (n . d .) 'About us.' [online] Available from <http://www.competition-commission.org.uk/about_us/index.htm> [15 May 2011]

CQout (n . d .) 'Basic Fees.' [Online] Available from <http://www.cqout.com/charges.asp>[11 July 2011]

Crudele, M. (2010) 'Groupon Case Study.' *Community Cultivator* [Online] Available from <http://www.o2p.org/2010/07/groupon-case-study/> [13 July 2011]

References

Crum, C. (2009) ‘eBay Competitor Bonanzle Continues Big-Time Growth’ *WebProNews* 13 May [online] Available from <http://www.webpronews.com/ebay-competitor-bonanzle-continues-big-time-growth-2009-05> [15 May 2011]

Curiel, I. (1997) ‘Cooperative Games and Solution Concepts.’ In Cooperative Game Theory and Applications. Netherlands: Kluwer Academic, 1-17

Deitel, P. J. and Deitel, H. M. (2007) *Internet & World Wide Web: How to Program.* 4th edn. New Jersey: Pearson Prentice Hall

Deng, X. and Papadimitriou, C.H. (1994) ‘On the complexity of cooperative solution concepts.’ *Mathematics of Operations Research* 19, (2) 257-266

Dictionary of Finance and Investment Terms (2007) New York: Barrons Educational Series, Inc.

Doucette, W.R. (1997) ‘Influences on member commitment to group purchasing organisations.’ *J. Business Research* 40,(3) 183-189.

EBay (n . d . a) ‘Buying Overview’ [Online] Available from <http://pages.ebay.com/education/buyingtips/index.html> [11 March 2011]

EBay (n . d . b) ‘EBay Explained’ [Online] Available from <http://pages.ebay.co.uk/help/ebayexplained/newtoebay/> [16 March 2011]

EBay (n . d . c) ‘EBay − The World's Online Marketplace.’ [Online] Available from <http://pages.ebay.co.uk/aboutebay/thecompany/companyoverview.html> [19 March 2011]

EBay (n . d . d) ‘EBay – Who we are.’ [Online] Available from <http://www.ebayinc.com/who> [25 March 2011]

EBay (n . d . e) ‘Fees for selling on eBay’ [Online] Available from <http://pages.ebay.co.uk/help/sell/fees.html> [21 March 2011]

EBay (n . d . f) ‘Groups’ [Online] Available from <http://community.ebay.co.uk/clubcategory.jspa?rw=true&categoryID=1900000000&anticache=1303618694708>[21 March 2011]

EBay (n . d . g) ‘Sell an Item − Getting Started’ [Online] Available from <http://pages.ebay.co.uk/help/sell/sell-getstarted.html> [21 March 2011]

EBay (n . d . h) ‘The Company.’ [online] Available from <http://pages.ebay.com/aboutebay/thecompany/companyoverview.html> [15 March 2011]

EBay Financial (2006) ‘eBay pulls out of Taiwan - Asia continues to be a tough battle.’ *ChannelAdvisor* eBay Strategies [online] Available from <http://ebaystrategies.blogs.com/ebay_strategies/2006/06/ebay_pulls_out_.html> [15 May 2011]

EBay, Inc. (2011) ‘Reports strong fourth quarter and full year 2010 results’, San Jose, California, [online] Available from <http://files.shareholder.com/downloads/ebay/1136100493x0x435896/9bd99676-b782-4784-87de-2899abe14a6d/eBay_Q42010EarningsRelease_Draft011911_Final.pdf> [5 April 2011]

EBid.net (n . d .) ‘Help : FAQ : Fees and Charges.’ [Online] Available from <http://uk.ebid.net/help_money.php> [11 July 2011]

Ecal (2011) ‘Auction Fee Calculator for eBay United Kingdom (eBay.co.uk) and PayPal Up-to-date with the latest eBay fee structure. ’ [Online] Available from <http://ecal.altervista.org/en/fee_calculator/ebay.co.uk/index.php> [11 June 2011]

Edgeworth, F.Y. (1881). *Mathemathical Psychics: An essay on the mathematics to the moral sciences.* London:Kegan Paul

Encarta World English Dictionary (2009) North American edn. London: Bloomsbury Publishing Plc.

References

Esposito, D. (2007) ‘A First Look at ASP.NET Extensions 3.5-History Points.’ [online] Available from <http://dotnetslackers.com/articles/aspnet/ AFirstLookAtASPNETExtensions35HistoryPoints.aspx> [3 May 2011]

Etsy (n . d .) ‘How Fees Work.’ [Online] Available from <http://www.etsy.com/sell/fees> [11 July 2011]

European Commission (2004) *EU competition policy and the consumer*. Luxembourg: Office for Official Publications of the European Communities

Faigle, U. *et al*. (1997) On the complexity of testing membership in the core of min-cost spanning tree games, *Game Theory* 26, 361-366.

Ferguson, D., Nikolaou,C., and Yemini,Y. (1989) ‘An Economy for Flow Control In Computer Networks.’ In *Proceedings of the 8th Infocom*. Held 23-27 April at Ottawa, Ontario, Canada. Los Alamitos:IEEE Computer Society Press:100-118

Forrester Research, Inc. (2010) ‘Forrester Forecast: Double-Digit Growth For Online Retail In The US And Western Europe’, CAMBRIDGE, Mass. [online] Available from <http://www.forrester.com/ER/Press/Release/0,1769,1330,00.html> [3 February 2011]

Foster, I. and Kesselman, C. (2004) *The grid: blueprint for a new computing infrastructure*. San Francisco:Elsevier Inc.

Fudenberg, D. and Tirole,J. (1991) *Game Theory. Cambridge.* MA: MIT Press

Garey,M.R. and Johnson,D.S. (1979) *Computers and Intractability: A Guide to the Theory of NP-Completeness*. New York:W.H. Freeman.

Ghosh, S. (2006) 1st edn. *Distributed Systems-An Algorithmic Approach* (Chapman & Hall/CRC Computer & Information Science Series), Boca Raton, FL:Chapman & Hall/CRC

Giaglis, G., Klein,S. and O'Keefe, R. (2002) ‘The role of intermediaries in electronic marketplaces: developing a contingency mode’, *Information Systems Journal*, (3) 231-246

Gillies, D.B. (1953) *Some theorems on n-person games*. Unpublished PhD thesis, Princeton University

Gillies, D.B. (1959) ‘Solutions to general non-zero-sum games.’ In *Contributions to the Theory of Games IV*. ed. by Tucker, A.W.; Luce, R.D.. Princeton: Princeton University Press: 47–85

Goldreich, O. (2010) *P, Np, and Np-Completeness.* Cambridge: Cambridge University Press.

Goldsmith, A. (2005) *Wireless Communications.* Cambridge: Cambridge University Press

Google (n . d .) ‘What is Google.org ?’ [Online] Available from <http://www.google.org/ about.html> [25 May 2011]

Gottlieb, B. (2000) ‘Does Group-Shopping Work? The economics of Mercata and Mobshop.’ *Slate* 26 July [online] Available from <http://www.slate.com/id/86925/> [28 May 2011]

Green, J. and Laffont, J.J. (1979) ‘On coalition incentive compatibility.’ *Review of economic Studies* 16, 233-254

Haffman, D.L. and Novak, T.P. (1996) ‘Marketing in Hypermedia Computer-Mediated Environments: Conceptual Foundations.’ *Journal of Marketing* 60, (3) 50-68

Hagel, J.III. and Armstrong, A.G. (1997) 1st edn. *Net Gain: Expanding Markets Through Virtual Communities.* Boston:Harvard Business Press

Hansen, M.T. *et al.* (2010) ‘The Best-Performing CEOs in the World’. Harvard Business Review. January, 2010. Boston, MA:Harvard Business School Publish

Harcourt, G. and Kerr, P. (2002) 1st edn. *Joan Robinson: Critical Assessments of Leading Economists*. New Jersey:Baker & Taylor Inc.

Harsanyi, J. (1967) ‘Games with Incomplete Information Played by "Bayesian" Players, I-III. Part I. The Basic Model’, *Management Science* 14, (3)Theory Series

Haurie, A. (1972) ‘On Pareto optimal decisions for a coalition of a subset of players.’ In Mendel, J.M. (ed.) *Proceedings of 1972 IEEE Conference on Decision and Control, including the 11th Symposium on Adaptive Processes.* Held 13-15 December at Fontainebleau Motor Hotel, New Orleans, LA. Los Alamitos:IEEE Computer Society Press:345-349

Hoare, C.A.R. (1962) ‘Quicksort.’ *Computer Journal* 5 (1): 10-15

Hord, S.M. (1986) ‘A synthesis of research on organisational collaboration.’ *Educational Leadership* 43, (5) 22-26.

Hong H. and Shum, M. (2002) ‘Increasing Competition and the Winner's Curse: Evidence from Procurement.’ *Review o economic Studies* 69, 871-898

Huang Y. M. and Ravishankar C. V. (1994) ‘Designing an Agent Synthesis System for Cross-RPC Communication.’ *IEEE Transactions On Software Engineering* 20, (3) 188-198

IOffer (n.d.) ‘iOffer Fees.’ [Online] Available from <http://www.ioffer.com/info/fees_and_utility_policy> [12 July 2011]

Jain, K. and Vohra, R. (2006) ‘On stability of the core.’ Manuscript [Online] Available from <http://www.kellogg.northwestern.edu/faculty/vohra/ftp/newcore.pdf> [12 May 2007]

Kahan, J. and Rapoport, A. (1984) *Theories of coalition formation*. Lawrence Erlbaum Associates, New Jersey:Hillsdale

Kanjilal, J. (2009) *ASP.NET 4.0 Programming*. New York: McGraw-Hill Osborne Media

Kannai, Y (1992) ‘The core and balancedness.’ In Aumann, Robert J.; Hart, Sergiu. Handbook of Game Theory with economic Applications, Vol 1. Amsterdam:Elsevier, 355-395.

Kannan, P.K. and Kopalle, P.K. (2001) ‘Dynamic pricing on the Internet: importance and implications for consumer behaviour.’ *Int J Electron Commerce* 5, (3) 63-83

Kauffman, R.J. and Wang, B. (2001) ‘New Buyers' Arrival Under Dynamic Pricing Market Microstructure The Case of Group-buying Discounts on the Internet.’ *Journal of Management Information Systems* 18, (2) 157-188

Kauffman, R.J. and Wang, B. (2002) ‘Bid together, buy together: on the efficacy of the group-buying business model in Internet-based selling.’ In: Lowry PB, Cherrington JO, Watson RR (eds) *Handbook of E-commerce in business and society*. Boca Raton: CRC Press

Kauffman, R.J., Lai, H. and Lin, H. (2010) ‘Consumer Adoption of Group-buying Auctions: an experimental study.’ *Journal of Information Technology and Management* 11, (4) 191-211

Khemani, R.S. and Shapiro, D.M. (1993) ‘Glossary of Industrial Organisation economics and Competition Law.’ *Commissioned by the Directorate for Financial, Fiscal and Enterprise Affairs*, Paris, France: OECD

Kidman, A. (2008) ‘eBay:pro-choice, but only when it suits.’ *APC* [Online] Available from <http://apcmag.com/ebay_prochoice_but_only_when_it_leads_to_a_profit.htm> [13 July 2011]

Kikuta, K. and Shapley, L.S. (1986) *Core stability in n-person games*. Manuscript.

Knuth, D. (1976) Big Omicron and big Omega and big Theta, *ACM SIGACT News* 8, (2) 18-24.

Kokemuller, N. (2011) ‘What Percentage Do Realtors Make on Commission?’ *eHow Contributor* 26 May [Online] Available from <http://www.ehow.co.uk/info_8494252_percentage-do-realtors-make-commission.html> [11 July 2011]

LetsBuyIt (2002) *Announcement.* Amsterdam: LETSBUYIT.COM N.V. 20 December

Ladner, R. E. (1975) ‘On the structure of polynomial time reducibility’ *Journal of the ACM (JACM)* 22 (1): 151–171

Lallana, E. *et al.* (2000) *An Introduction to e-Commerce*, Philippines: DAI-AGILE

Lam, S.Y. (2010). What Kind of Assumptions Need Be Realistic and How to Test Them: A Response to Tsang (2006). Strategic Management Journal 31, (6) 679-687.

Lin, I. Q. (2009) *Online Group-Buying Join Intention in Virtual Community*. Unpublished Master's thesis, National Sun Yat-sen University

Livingsocial (n . d .) 'About us' [Online] Available from <http://livingsocial.com/about> [21 May 2011]

Lucas, W. F. (1968) A game with no solution. *Bulletin of the American Mathematical Society* 74, pp.237–239

Lucas W. F. (1992) von Neumann-Morgenstern stable sets. In: Aumann RJ, Hart S (eds) *Handbook of Game Theory*, Vol. 1, pp.543-590, Elsevier, Amsterdam.

Luo, Z.Q. and Parnas, D.L. (1994) 'On the computational complexity of the maximum trade problem.' *Acta Mathematicae Applicatae Sinica* 10, (4) 434-440

Lynch, N. A. (1996), Distributed Algorithms, Morgan Kaufmann

MacDonald, M. (2007) 'The .NET Framework.' Second edn. *Beginning ASP.NET 3.5 in C# 2008. From Novice to Professional.* New York, NY: Springer-Verlag, Inc.

Maheswaran, R.T. and Basar, T. (2003) 'Coalition formation in proportionally fair divisible auctions.' *The Second International Joint Conference on Autonomous Agents & Multi agent Systems*, Held 14-18 July at Melbourne, Victoria, Australia: 25-32

Maki, U. (2000) 'Kinds of assumptions and their truth: shaking an untwisted F-twist.' *Kyklos 53*, (3) 317–336.

Marsden, P. (2011) *F-commerce FAQ - F-commerce helps you facilitate and execute sales transactions using Facebook*. [online] Available from <http://socialcommercetoday.com/downloads/f-commerce_FAQ.pdf> [11 May 2011]

Matear *et al.* (2000) 'Moderating Effects of Service Characteristics on the Sources of Competitive Advantage - Positional Advantage Relationship.' In O'Cass, A. (ed.) Visionary Marketing for the 21st Century. 'Facing the Challenge.' Held 28th November - 1st December at Griffith University. Gold Coast: Australian & New Zealand Marketing Academy: 783-786

Mattessich, P.W., Murray-Close, M. and Monsey, B.R. (2001) 2nd edn. *Collaboration: What makes it work* St. Paul, MN:Amherst H. Wilder Foundation.

Matsuo, T. *et al.* (2004) 'A Buyers Integration Support System in Group Buying,' *IEEE International Conference on E-Commerce Technology* (CEC'04), Held 06 July at San Diego, California: 111-118

McCain, R. (2003) *Game Theory: A Nontechnical Introduction to the Analysis of Strategy*, South-Western: Div of Thomson Learning

McCain, R. (2005) 'Cooperative Games and the Core.' [online] Available from <http://william-king.www.drexel.edu/top/eco/game/game-toc.html> [11 October 2006]

McKenna, M. (2002) *Testimony* [letter] to the United States Senate Committee, Judiciary: Novation, LLC

Middleware Resource Centre (2008) "What is Middleware?" Defining Technology, Inc. [Online] Available from <http://www.middleware.org/whatis.html> [27 July 2012]

Montlake, S. (2007) 'China's new shopping craze: "Team buying".' *The Christian Science Monitor*. 5 December [Online] Available from <http://articles.moneycentral.msn.com/SavingandDebt/FindDealsOnline/ChinasNewShoppingCrazeTeamBuying.aspx> [27 April 2011]

Moulin, H. (1995) *Cooperative Microeconomics: A game theoretic Introduction*. Princeton: Princeton University Press

Muse & Associates (2000) *The Role of Group Purchasing Organisations in the U.S. Health Care System*. Washington: Muse & Associates

Musgrave, A. (1981) ‘Unreal assumptions’ in economic theory: the F-twist untwisted. *Kyklos* 34, (3) 377-387

Musgrove, M. (2006) ‘First New York, Then D.C.? Craigslist to Charge Fees.’ *The Washington Post*. 4 February [Online] Available from <http://www.washingtonpost.com/wp-dyn/content/article/2006/02/03/AR2006020302749.html> [11 July 2011]

Nasdaq (n.d.a) ‘Amazon.com, Inc. (AMZN) Revenue & Earnings Per Share (EPS)’ *Nasdaq* Quotes & Research [online] Available from <http://www.nasdaq.com/aspx/revenueepssummary.aspx?symbol=AMZN&selected=AMZN> [20 June 2011]

Nasdaq (n.d.b) ‘eBay.com, Inc. (EBAY) Revenue & Earnings Per Share (EPS)’ *Nasdaq* Quotes & Research [online] Available from <http://www.nasdaq.com/aspx/revenueepssummary.aspx?symbol=EBAY&selected=EBAY> [20 June 2011]

Needle, D. (2001) ‘Group-buying Forges Ahead Despite Mercata Shut Down.’ *Internetnews.com* 4 Jan [online] Available from <http://www.internetnews.com/bus-news/article.php/551521/Group-Buying-Forges-Ahead-Despite-Mercata-Shut-Down.htm> [8 June 2011]

Neumann, J. and Morgenstern, O. (1944) *Theory of Games and economic Behaviour*. Princeton, Princeton University Press

Newman, M.W. and Landay, J.A. (2000) ‘Sitemaps, Storyboards, and Specifications: A Sketch of Web Site Design Practice.’ In Boyarski, D. and Kellogg, W. A. (ed.) *Proceedings of the 3rd conference on Designing interactive systems.* Held 17-19 Aug at Brooklyn, New York, New York: ACM Press: 263-274

Ng, Y. (1983). *Welfare economics*. London: Macmillan.

Nicholson, W. (2005) 9th edn. *Microeconomic Theory*. Cincinnati, Ohio: South Western College Pub

Nielsen, J. (1993) *Usability Engineering*. San Francisco: Morgan Kaufmann

Nielsen, J. (2000) *Designing Web Usability*. Indianapolis, IN: New Riders Publishing.

OECD (2004) *Roundtable on Competition and Regulation in Agriculture: Monopsony Buying and Joint-selling.* Paris: OECD

OECD (n.d.) ‘Members and partners’ [online] Available from <http://www.oecd.org/pages/0,3417,en_36734052_36761800_1_1_1_1_1,00.html> [15 August 2011]

OnlineAuction.com (n.d.) ‘OnlineAuction.com Auction Enhancement Fees.’ [Online] Available from <http://www.onlineauction.com/?page=help:main&content=user_fees> [11 July 2011]

Osborne, M. and Rubenstein, A. (1994) *A Course in Game Theory*. London: MIT Press

Owen, G. (1995) *Game theory*. New York, Academic Press

Palmer, J.W. (2002) ‘Web Site Usability, Design, and Performance Metrics.’ *Information Systems Research* 13, (2) 151-167

Pan, K.Y. (2010) *The Impact of Conformity and Transaction Cost Theory on Online Group-Buying Behaviour.* Unpublished Master’s thesis, Ming Chuan University

Panzarino, M. (2011) ‘Google launches local deal service Google Offers.’ *The Next Web* 26. May [online] Available from <http://thenextweb.com/google/2011/05/26/google-launches-local-deal-service-google-offers/> [11 June 2011]

Papadimitriou, C. H. (1994) *Computational complexity*. Reading, Mass.: Addison-Wesley.

PayPal (n.d.) ‘Transaction Fees for Domestic Payments.’ [online] Available from <https://www.paypal.com/uk/cgi-bin/webscr?cmd=_display-receiving-fees-outside> [15 May 2011]

Perez-Castrillo, D. and Wettstein, D. (2001) ‘Bidding for the Surplus: A Non-cooperative Approach to the Shapley Value.’ *Journal of economic Theory* 100, 274294

Porter, M. (1985) *Competitive advantage: Creating and Sustaining Superior Performance*, New York:Free Press

Quality Articles Editor (2011) ‘New Model In Group-buying Set to Shake Up Industry.’ *Quality Articles from Quality* 18 May [Online] Available from <http://www.qualityarticles.com/new-model-in-group-buying-set-to-shake-up-industry.htm> [26 May 2011]

Rahwan, T. and Jennings, N.R. (2007). ‘An algorithm for distributing coalitional value calculations among cooperative agents.’ *Artificial Intelligence (AIJ)* 171, (8–9)535-567.

Raice, S. (2011) ‘More Trouble for Groupon IPO’ *The Wall Street Journal* 14 September [Online] Available from < http://online.wsj.com/article/SB10001424053111903791504576589211214409214.html> [26 October 2011]

Ralph, P. and Wand, Y. (2009). ‘A proposal for a formal definition of the design concept.’ In Lyytinen, K., Loucopoulos, P., Mylopoulos, J., and Robinson, W. (ed.) Design Requirements Workshop (LNBIP 14), Heidelberg, Berlin: Springer-Verlag:103-136

Ravicher, D. (2000) ‘Facilitating Collaborative Software Development: The Enforceability of Mass-Market Public Software Licenses.’ *Virginia Journal of Law and Technology 5*, (3) 1522-1567 [online] Available from < http: // www.vjolt.net / vol5 / issue3 / v5i3a11-Ravicher.html > [14 March 2009]

Reeve, J. and Peerbhoy, D. (2007) ‘Evaluating the evaluation: Understanding the utility and limitations of evaluation as a tool for organizational learning.’ *Health Education Journal* 66, (2) 120–131

Regan, K. (2001) ‘Allen-Backed Mercata Bows Out’ *E-Commerce Times* 5 January

Robinson D. (2004) ‘The Common Gateway Interface (CGI) Version 1.1.’ *The Apache Software Foundation* Request for Comments 3875. 1 October [Online] Available from <http://tools.ietf.org/html/rfc3875> [11 May 2011]

Rouse, M. (2005) ‘Definition Groupware’ September, TechTarget [Online] Available from <http://searchdomino.techtarget.com/definition/groupware> [31 July 2012]

Ruby Lane (n.d.) ‘What does a Ruby Lane shop cost?’ [Online] Available from <http://kb.rubylane.com/question.php?ID=36> [11 July 2011]

Sandholm, T.W. and Lesser, V.R. (1997) ‘Coalitions among computationally bounded agents.’ *Artificial Intelligence* 94, (1) 99-137.

Sandholm, T. *et al.*. (1999) ‘Coalition structure generation with worst case guarantees.’ *Artificial Intelligence* 111, 209-238

Scarf, H. (1967) ‘The core of an N person game.’ *Econometrica* 38, 50-69

SEC (2007) *Form 10-K Annual Report*. United States Securities and Exchange Commission Washington: EDGAR [online] Available from <http://files.shareholder.com/downloads/ebay/625020273x0xS950134-07-4291/1065088/filing.pdf> [28 February 2009]

Shapley, L. (1953) ‘A value for n-person games.’ In Contributions to the Theory of Games II. ed. by Tucker, A. and Luce, R. Princeton: Princeton University Press: 307-317

Shehory, O. and Kraus, S. (1999) ‘Feasible Formation of coalitions among autonomous agents in non-super-additive environments.’ *Computational Intelligence* 15, (3) 218-251

Sillitoe, B. (2011) ‘Amazon & eBay-the top websites for UK shoppers.’ *RetailGazette daily retail news.* 2 June [Online] Available from <http://www.retailgazette.co.uk/ articles/20133-amazon-ebay-the-top-websites-for-uk-shoppers> [21 July 2011]

Skiena, S. S. (2008) *The Algorithm Design Manual*, Second Edition, Springer

Smith, J. and Comiskey, B. (1996) ‘Modulation and Information Hiding in Images.’ In *Proceedings of the First International Information Hiding Workshop*, Held May 30 - June 1 at Isaac Newton Institute, Cambridge, U.K.: 207-226

References

Steiner, I. (2010 a) ‘Seller's Choice: Merchants Rate Ecommerce Marketplaces.’ *AuctionBytes.com.* 24 January [Online] Available from <http://www.auctionbytes.com/cab/abu/y210/m01/abu0255/s02> [24 April 2011]

Steiner, I. (2010 b) ‘Seller's Choice Marketplace Ratings: eBay.’ *EcommerceBytes.com.* 24 January [Online] Available from <http://www.auctionbytes.com/cab/abu/y210/m01/abu0255/s09> [25 April 2011]

Steiner, I. (2010 c) ‘Seller's Choice Marketplace Ratings: Amazon.’ *EcommerceBytes.com.* 24 January [Online] Available from <http://www.auctionbytes.com/cab/abu/y210/m01/abu0255/s03> [19 July 2011]

Steiner, I. (2011) ‘eBay Fee Changes Hit Auction Sellers Hard.’ *AuctionBytes.com.* 20 March [Online] Available from <http://www.auctionbytes.com/cab/abu/y211/m03/abu0283/s03> [12 July 2011]

Stockford, P. (2008) ‘Why You Buy: Factors that Influence Your Purchase Decision.’ *NACC* 3, (12) 20 June 2008

Stigler, G.J. (1972) ‘The Adoption of Marginal Utility Theory’ *History of Political Economy* 4, (2) 571-586

Sullivan, A. and Sheffrin, S.M. (2003) *economics: Principles in Action*. Upper Saddle River, New Jersey: Pearson Prentice Hall

Sventek, J. S. (1992) ‘The Distributed Application Architecture’ In Petrie C. J. (ed.) *Proceedings of the First of International Conference on Enterprise Integration Modelling Technology*. Held 16-18 March 1992 at Nice, France. Cambridge, MA: MIT Press: 481-492

Sun, P. *et al.* (2006) ‘Core-based Agent for Service-Oriented Market.’ In Lee, T. and Zhou, M. (ed.) *Proceedings of 2006 IEEE International Conference on Systems, Man, and Cybernetics (SMC’06).* Held 8-11 October at The Grand Hotel, Taipei, Taiwan. Piscataway, New Jersey: the IEEE Inc.: 2970-2975

Sun, P. *et al.* (2009) ‘Extended Core for E-Markets.’ In Isaias, P., White, B. and Nunes, M. B. (ed.) *Proceedings of IADIS International Conference WWW/Internet 2009* Held 19-22 November at Rome, Italy, : IADIS Press: 437-444 (22% acceptance rate)

Sun, P., *et al.* (2012 b) ‘Evaluations of A Core Broking Model from the Viewpoint of Online Group Trading.’ In *Proceedings of The IEEE International Conference on Industrial Engineering and Engineering Management (IEEM 2012)* Held 10-13 December at Hong Kong Convention and Exhibition Centre, Hong Kong, IEEE Press: 1964-1968

Sun, P., *et al.* (2012 a) ‘A Core Broking Model for E-Markets.’ In *Proceedings of The 9th IEEE International Conference on e-Business Engineering* (*ICEBE 2012)* Held 9-11 September at Zhejiang University, Hangzhou, China: IEEE Press: 78-85 (19.7% acceptance rate)Sung, S.C. and Dimitrov, D. (2007) ‘On core membership testing for hedonic coalition formation games.’ *Oper. Res. Lett.*155-158

Swartz, J. (2010) ‘EBay CEO John Donahoe bets on tech to take on rivals.’ *USA TODAY* 19 December, [Online] Available from <http://www.usatoday.com/tech/news/2010-12-20-ebay20_CV_N.htm> [26 April 2011]

Tallai, Z. (2010) ‘Will Groupon Keep its Title as The King of Local Deals?’ *POP17* 4 September [Online] Available from <http://pop17.com/will-groupon-keep-its-title-as-the-king-of-local-deals-2/>[13 July 2011]

Taylor, M.D. (2006) *International competition law: a new dimension for the WTO?.* Cambridge University Press. 1.

Tedeschi, B. (2007) ‘EBay Moves to Recharge Its Auctions.’ 18 June *The New York edn*.:C5

The American Heritage Science Dictionary (2005) Boston: c Houghton Mifflin Company

The Economist (2001) ‘Europe: Letsbuyit.com--another Internet star—falls.’ *The Economist* 8 January [online] Available from <http://www.eiu.com/index.asp?layout=ib3PrintArticle&article_id=1586041158&printer=printer&rf=0> [28 April 2011]

The New Oxford Dictionary of English (2010) 3th edn. Oxford: Oxford University Press

TIAS.com (n . d .) ‘To Build A Store Using MakeAShop We Require The Following:’ [Online] Available from <http://www.tias.com/makeashop/ index.cgi?groupKey=1&page=requirements.html> [12 July 2011]

Tsvetovat, M. *et al.* (2000) 'Customer coalitions in the electronic marketplace.' In Sierra C, Gini M, Rosenschein J (ed.) *Proceedings of 4th international conference on autonomous agent.*, Held 3-7 June at Barcelona, Catalonia, Spain. New York: ACM Press: 263-264

Turban, E. *et al.* (1999) *Electronic Commerce: A Managerial Perspective*. New Jersey, Prentice Hall

UK Business Directory (n. d.) 'Home Directory' *UK Business Directory* [online] Available from [online] Available from <http://www.business-directory-uk.co.uk/> [07 July 2011]

VBulletin (n . d .) 'vBulletin Community Forum FAQ.' *vBulletin Community* [online] Available from <https://www.vbulletin.com/forum/faq.php?faq=vb3_board_usage> [28 May 2011]

VentureBeatProfiles (n . d .) 'eBay Competitors.' *VentureBeatProfiles* [online] Available from <http://venturebeatprofiles.com/company/profile/ebay/competitors> [18 June 2011]

Wang, H.H. (2010) 'How EBay Failed In China.' *Forbes* 12 September [online] Available from <http://blogs.forbes.com/china/2010/09/12/how-ebay-failed-in-china/?boxes=Homepagechannels> [20 June 2011]

Weiss, B. (2010) 'Groupon's $6 Billion Gambler' *The Wall Street Journal* 20 December The Weekend Interview: 12 [online] Available from <http://online.wsj.com/article_email/SB10001424052748704828104576021481410635432-lMyQjAxMTAwMDEwODExNDgyWj.html> [20 May 2011]

Wolverton, T. (2002) 'It's official: eBay weds PayPal.' *CNET News* 3 October [online] Available from <http://news.cnet.com/Its-official-eBay-weds-PayPal/2100-1017_3-960658.html> [24 April 2011]

WTO (n . d .) 'What is WTO' [online] Available from <http://www.wto.org/english/thewto_e/whatis_e/whatis_e.htm> [15 August 2011]

Xiang, Y. *et al.* (2005) 'Optimal design in collaborative design network.' In *Proceeding 4th Inter. Joint Conference on Autonomous Agents and Multi-agent Systems (AAMAS'05)*, Netherlands, 241-248

Wikinvest (n . d . a) 'Amazon.com » Revenue' *Wikinvest* [online] Available from <http://www.wikinvest.com/stock/Amazon.com_(AMZN)/Data/Revenue/> [20 June 2011]

Yamamoto, J. and Sycara, K. (2001) 'A Stable and Efficient Buyer Coalition Formation Scheme to E-Marketplaces.' *AGENT* 01, 576-583

Yarnold, P.R., Grimm, L.G. and Mueser, K.T. (1986) 'Social Conformity and Type A Behaviour Pattern.' *Perceptual and Motor Skills* 62, 99-104

Zauberman, G. *et al* (2009) 'Discounting time and time discounting: subjective time perception and intertemporal preferences.' *Journal Mark Res* 46, (4) 543-556

Zentes, J. and Swoboda, B. (2000) 'Allied groups on the road to complex networks.' *Technology in Society* 22, 133-150.

Zhang, J. *et al.* (2003) 'Ubidata: ubiquitous mobile file service.' Eighteenth ACM Symposium on Applied Computing. Held 9-12 March at Melbourne, Florida, USA. New York: ACM press: 893-900

Appendix 1 – EBay: an Online Broking System

EBay provides online marketplaces for the sale of goods and services, online payment services, and online communication offerings to a diverse community of individuals and businesses internationally. Because it is one of the most successful stories in e-commerce, eBay provides an excellent basis from which to develop ideas about building a good online model for group-trading. One of eBay' big successes arises from "being nothing more than an intermediary" (Burns 2011). The eBay website is a genuine online broking system. Only by viewing eBay from this standpoint, can its true nature be seen. Its online broking system is discussed here.

The complexion of the online trading industry is changing almost daily. Even though it is not easy to overcome the competitive and market challenges, eBay's management team has managed to run eBay successfully. It increased its size from approximately two million registered users at the end of 1998 to 2.2 million as of December 31, 2006 (SEC 2007). It has at the present time attracted more than 94.5 million active registered users, which are spread widely over more than 22 countries (EBay n.d.h). In 2010, its annual net revenues were US $9,156 million (EBay Inc. 2011). EBay is an excellent basis from which to develop ideas about building a good online shopping model. In this section, eBay is fully examined in order to harness some of its lessons in the new group-trading model for e-markets presented in this work.

Being the most popular online marketplace in the world, eBay provides online marketplaces for the sale of goods and services, online payment services, and online communication offerings to a diverse community of individuals and businesses internationally. An introduction to eBay helps to gain a brief idea of what it is. EBay, an American Internet company founded in 1995, pioneered online trading and has become one of the fastest growing shopping websites. EBay's site was launched on 4 September, 1995, as 'Auction Web' and was later renamed 'eBay'. EBay went public on 21 September, 1998. In that year, it had revenues of US $4.7 million and 2.2 million active registered users (Bradley and Kelley 1999). In this subsection, the shopping process on eBay is introduced. EBay provides the following eight topics to understand the eBay marketplace in more detail (EBay n . d . b):

1. **Membership and account –** every user must register to be a member first. Users pick a username for their accounts and provide basic information including name, address, phone number and email address.
2. **Categories and searching –** customers can search an item via categories, key words, popular products, themes or stores. The advanced search options can be used to further narrow their searches.
3. **Bidding and buying –** buyers can place a bid for the maximum amount that they are prepared to pay and then the eBay system will bid on their behalf. A notification will be sent via email when someone has been outbid. Some items can be bought with ‘buy it now’ prices, if their sellers allow this.
4. **Payment and postage –** the money can be transferred using traditional methods like cheque or money order. Or buyers may pay for items through their PayPal accounts without giving personal information to sellers directly.
5. **Feedback –** buyers and sellers leave feedback for their transactions. Other people will be able to refer to users’ feedback history to obtain a picture of their overall performance. Feedback is made up of comments, overall ratings and detailed seller ratings. Unlike the overall ratings, the detailed seller ratings are anonymous.
6. **Selling –** sellers choose a title, pictures and a category for selling an item. And then they input descriptions, shipping information, length of the auction, a starting price and payment options. A ‘reserve price’ is an optional acceptable selling price.
7. **Communication –** communication in the eBay market is via e-mail, but ‘eBay customer support’ can communicate with users using voice over Skype, and through traditional landlines and mobile phones. The ‘eBay resolution centre’ provides a communication channel for buyers and sellers to resolve transaction problems.
8. **Safety and security –** the ‘eBay safety centre’ is created to keep eBay safe and to build trust between buyers and sellers. If buyers pay for their items through PayPal, they are under the ‘eBay buyer protection’ scheme, which protects buyers from online fraud and helps them get their money back if transactions go wrong.

Everyone can visit the eBay website, but only members are allowed to shop on it. To register an account on eBay is free. Members can shop for almost anything on eBay using the following five steps: (a) find an item from a seller; (b) learn about the item; (c) review the seller's feedback; (d) bid for the item and (e) pay for the item (EBay n . d . a).

EBay allows everyday people who have a seller's account, to sell practically anything by performing the following three steps: (a) create a listing; (b) manage the listing and (c) carry out the transactions with the buyer (EBay n . d . g). Members may also sell their items to make some extra cash, but they must upgrade their accounts to seller's accounts first. This is free, but they must confirm their identity first. They then need to provide information to eBay about how they will pay their seller's fees. The sellers need to pay a monthly fee to own an eBay Store. This can help sellers setup their own brands and so encourage buyers to buy more.

A successful firm always has sound strategic management to keep the enterprise going and eBay is no exception in this respect. Only suitable strategies which come from good strategic management can give a company the ability to cope with changed circumstances arising from new technologies, new competitors, or a new environment. Good strategic management is so crucial because it provides a correct direction for an enterprise and keeps the enterprise going. No wonder eBay founder, Pierre Omidyar, has focused on designing a business model and overseeing eBay's strategic direction and growth. EBay's market dominance is sustained by its sound strategies (Burns 2011), made by the powerful executives of eBay.

Meg Whitman was one of the most successful executives of eBay. She served as President and Chief Executive Officer (CEO) of eBay from 1998 to 2008. On her first day in 1998, the eBay site crashed for eight hours (Champy and Nohria 2000). After a lot of painful changes, Whitman has successfully transformed eBay into a superb company. During her ten years with the company, she managed expansion from 30 employees and US $4 million in annual revenue to more than 15,000 employees and US $8 billion in annual revenue. No wonder that Whitman has received numerous awards and accolades for her work at eBay. The *Harvard Business Review* has named her the eighth-best-performing CEO of the past decade and she is the only woman of the top 100 performing CEOs (Hansen *et al*. 2010).

As a result of the relentless implementation of its strategic objectives, eBay had met with significant success. Not only was the company financially profitable from the first day, but it has won many prestigious honours and awards. Among the most significant was the US national medal of technology and innovation for advancing global entrepreneurship in 2008. EBay was the first Internet firm to receive this national technology award, from President Bush at the White House (Bucki 2008). EBay's sound strategic management sustains its position and has put it amongst world leaders in online broking for some time.

Unlike other e-commerce stores, eBay does not deliver goods - it operates purely as an intermediary between providers and consumers (Cabral and Hortaçsu 2005). The mediating website of eBay is actually an online broking system. An online broking system is an online system acting as a broker. How eBay has achieved success when attempting to handle the problems were raised when designing a broking system is the main focus here.

One of the biggest successes of eBay has been the development of a 'virtuous circle' to attract more buyers and sellers (Burns 2011). EBay is simply the trading platform. Buyers use eBay's online broking system to find the items they want, and to place their bids. A virtuous circle starts from a situation where 'more buyers attracted more sellers'. Sellers pay to setup their own auction. The circle then comes around to a position where 'more sellers cause higher level of competition'. It then reaches the point where a 'higher level of competition lowers the price of auctions'. The circle finally comes to 'low prices of items attract more customers'. Then it will iterate again and so the circle continues.

EBay is a virtual business, a "network of independent companies, suppliers, customers - even rivals, linked by information technology to share costs, skills and access one another's markets" (Byrne 1993). Virtual companies use networks as intermediaries to ally with other companies and create and distribute products beyond the limitation of their organisational boundaries or physical locations. Additionally, eBay has other successful strategies that ordinary virtual companies do not have.

One of the important strategies of eBay has been to make its site fully automatic, relying on software rather than people. Firstly, eBay tries to let its customers do all the manual operations. It sells advertising space to sellers. Sellers setup their stores and lists manually. Buyers operate their bids manually. Communications, shipping, payment and feedbacks are arranged between traders manually. EBay holds no stock and its involvement in the trade is minimal. In the trading process, users interact with the system only. The manual tasks for eBay take place mostly in Customer Services and Communications, which is its weak area, because eBay does not focus on that part at all.

Secondly, eBay tries to make the kernel of its business as ‘virtual’ as possible. It has bought software companies, such as iBazar, PayPal, Skype and StubHub, to gain exclusive use of their technologies and make the auction process more efficient. Strengthening its relationship with PayPal is part of this strategy. EBay basically generates revenues from sellers. Encouraging traders to use PayPal means that eBay also turn buyers into clients. EBay also earns off-site revenues when the PayPal account is used in non-eBay transactions. In addition, the competition within the eBay e-market is very stimulating for traders who enter it. With so many members, no other shopping site could have created such a healthy trading environment in its own right as the eBay site has.

Undoubtedly, the eBay market is one of the best trading places for traders. Individuals can find almost any goods they want. They can buy and sell products or services on the site with safety. The eBay site is an online broking system and it plays its broker role well. Its sound strategic management sustains its position and has put it amongst world leaders in online broking for some time. Fig. A1.1 shows that its annual revenues increase every year, but it also reveals the fact that its power to earn revenue has been weaker in the last three years. Poor Customer Services and Communications has been one of the biggest causes of the weakness. EBay has many competitors now (VentureBeatProfiles n.d.) and some of them have been getting stronger recently, such as Bonanzle (Crum 2009). It may be time for the directors of eBay to consider new strategies to sustain eBay's market dominance.

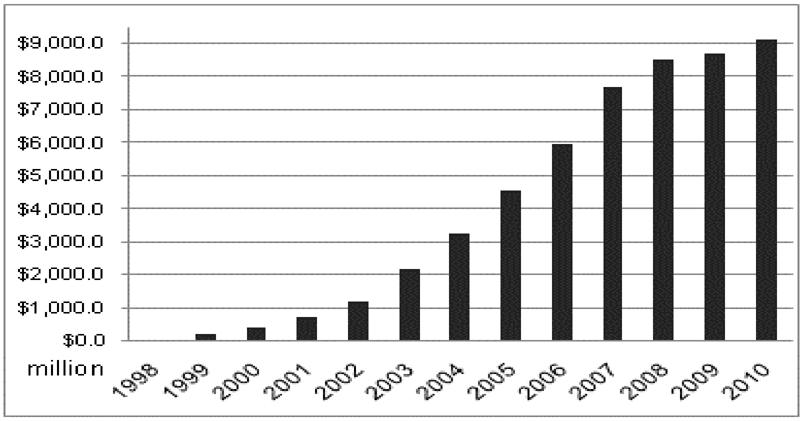


Figure A1.1 History of eBay's Revenue (Nasdaq n . d . b)

The research topic in this thesis is group-trading, but eBay does not provide group-trading for traders. Sellers can list as many identical items as they wish in one fixed price listing on eBay (EBay n . d . g), but this is not group-trading at all. People can connect with others who share similar interests through communities in eBay (EBay n . d . f). For instance, the members of 'simply stamp', a community for stamp-collectors, can chat and exchange stamps with each other, but they cannot perform any group-trading activity in these communities on the site. In other words, the answer to the initial question is a 'No', because the communities in eBay are not really designed for group-trading. EBay should definitely consider adopting group-buying for its business model, especially after it pulled out of Taiwan (EBay financial 2006). Things have not been going smoothly in China either (Wang 2010).); it should take note that online group buying is extremely popular there.

Appendix 2 – Fees System of eBay

EBay is a broking system and its main revenues come from the commissions on transactions. The revenue of the brokers comes from commission paid by the customers. Of course, higher commission usually brings better services from brokers, but if there are fewer customers they may object to paying such a high price for commission. Deciding a reasonable fee which will please both brokers and customers is a problem. Different companies have various different ways of charging. EBay's main revenues come from the commissions on transactions. EBay's fees and the details of eBay's commissions are discussed here. Some principles for setting up commissions in the model have benefited from eBay's practice here. When selling items on eBay, sellers pay certain fees to eBay. Although the fees are quite complex and based on various factors and scales, primarily they include 'insertion fees' and 'final value fees'.

Table A2.1 'Buy It Now' Insertion Fees

Category	Normal sellers	Basic shop	Other shop
All categories, except those listed below	£0.40	£0.20	£0.10
Media-related	£0.20	£0.10	£0.10
Property	£35	£35	£35
Mobile phones with contract	£7.95	£7.95	£7.95

Table A2.2 Auction-Style Insertion Fees

Category	Starting price	Insertion fee
All categories, except those listed below	**£0.01 - £0.99**	**No fee**
	£1.00 - £4.99	£0.15
	£5.00 - £14.99	£0.25
	£15.00 - £29.99	£0.50
	£30 - £99.99	£1
	£100 or more	£1.30
Media-related	£0.01 - £0.99	No fee
	£1.00 or more	£0.10
Property	Any price (single or multiple items)	£35 x number of items
Mobile phones with contract	Any price (single item)	£7.95
	Any price (multiple items)	£19.95

Insertion fees need to be paid whenever a seller lists an item on eBay, even if the item is not sold (EBay n . d . e). Before sellers list their items, they have to decide whether each item will be listed as an item with a fixed selling price or with final selling price decided by buyers in an auction, which begins at a low starting price. The seller will pay a 'Buy it now' insertion fee when the item has a fixed selling price. The eBay fees for sellers are varied in different countries. All the tables in this subsection are based on the eBay fees system in the UK. In Table A2.1, the various insertion fees for a fixed-price item are given. Sellers will pay auction style insertion fees, when they auction their items. In Table A2.2, the various insertion fees for auctions depend on the starting price.

As shown in Tables A2.1 and A2.2, items listed in the various categories have different insertion fees. EBay charges different insertion fees if items are categorised as *media-related*, *technology-related*, *mobile phones with contracts* or *property*. Media-related refers to items listed within the following categories: books, DVDs and games, with a sub-category of video games, and music. Technology-related refers to items listed within the following categories: mobile and home phones, computing, consumer electronics and photography. The range of eBay's insertion fees is large, ranging from £0.0 to £35 per item. The fees vary depending on the format under which the item is listed. So, eBay takes from £0.15 to a maximum rate of 3% for an ordinary listing.

EBay provides optional features for sellers to help increase the number of bids and to give them a better chance of selling their items successfully. The insertion fees for items can be higher, if the sellers choose to use these optional features to help their selling. EBay encourages sellers to list an item at a low starting price. The insertion fee is zero when the starting price of an item is between £0.00 and £0.99. EBay also encourages sellers who have an eBay store, to list their items at a fixed selling price. In Table A2.2, the low insertion fees for eBay shops are given. There are certain requirements for sellers who wish to open a shop on eBay. There are three types of shop: 'basic', 'featured' and 'anchor'. The requirements for a 'basic shop' on eBay are less stringent than for the other the kinds of shop. Thus it is easier for sellers to apply for a 'basic shop' rather than another type of shop but a 'basic shop' has higher insertion fees than the other shops.

A low starting price encourages people to bid, but a reserve price can protect sellers from selling an item for too little. When a seller sets the insertion fee for an auction-style listing it is dependent on the reserve price and not the starting price. The item will not be sold until the bidding meets the reserve price. Until the bidding reaches the reserve price, the listing will display 'reserve not met' under the current bid. There is no obligation to sell to the highest bidder until the reserve is met. Reserve prices must be set at £50 or more. Table A2.3 shows that the insertion fee is 3% of the reserve price.

Table A2.3 Auction-Style Insertion Fees (with Reserve Price)

Category	Reserve price	Insertion fee
All categories, except those listed below	**£50 - £99.99**	**£1 + 3%**
	£100 or more	£1.30 + 3%
Media	£50 or more	£0.10 + 3%
Mobile phone with contracts	£50 or more (single item)	£7.95 + 3%
	£50 or more (multiple item)	£19.95 + 3%
Property	£50 or more (single item)	£35 + £2

Table A2.4 'Buy It Now' Final Value Fees

Category	Final selling price	Final value fee
All categories, except those listed below	**£0.99 - £49.99**	**9.9% of the final selling price up to £49.99**
	£50 - £599.99	£4.95 + 5.9% of the final selling price of £50 or more
	£600 or more	£37.40 + 1.9% of the final selling price of £600 or more
Media-related	£0.99 or more	9% of the final selling price
Technology-related	£0.99 - £29.99	5.25% of the final selling price up to £29
	£30 - £99.99	£1.57 + 3% of the final selling price of £30 or more
	£100 - £199.99	£3.67 + 2.5% of the final selling price of £100 or more
	£200 - £299.99	£6.17 + 2% of the final selling price of £200 or more
	£300 - £599.99	£8.17 + 1.5% of the final selling price of £300 or more
	£600 or more	£12.67 + 1% of the final selling price of £600 or more
Mobile phones with contracts	£0.99 or more	No fee
Property	£0.99 or more	No fee

When an item sells, the seller will be charged a final value fee based on a percentage of the item's final selling price (EBay n.d.e), which does not include shipping and handling costs. The final selling price for a fixed-price item is known as the 'buy it now' price. In Table A2.4, the different final value fees for fixed-price items in the various categories are given. In Table A2.5, the various different final value fees for items sold in auction style are given, according to the different categories. So, the final value fee is from 0.75% to 10% of the final price.

Table A2.5 Auction-Style Final Value Fees

Category	Final selling price	Final value fee
All categories, except those listed below	£0.01 or more	10% of the final selling price (up to a maximum of £40)
Mobile phones with contract	£0.01 or more	No fee
Property	£0.01 or more	No fee

The final selling price of an item decides the actual final value fees that the seller has to pay to eBay. In a 'Buy it now' list, the final selling price is setup at the beginning of the transaction. On the other hand, in an auction style list, the final selling price of the item is not revealed until the end of the auction. The buyer who has the highest maximum bid will be the winner of an auction style item. Because the eBay system places bids on behalf of buyers, the final selling price is usually less than the highest price that the bidder is willing to pay. If sellers are selling their items at a fixed price, as part of the listing process they can choose Best Offer. With Best Offer, sellers give buyers a chance to negotiate the price. Just like an auction style item, the final selling price of the item is not decided until the end of the transaction.

Table A2.6 PayPal Fees

Purchase payments received (monthly)	Fee per transaction
£0.00 - £1,500.00	**3.4% + £0.20**
£1,500.01 - £6,000.00	2.9% + £0.20
£6,000.01 - £15,000.00	2.4% + £0.20
£15,000.01 - £55,000.00	1.9% + £0.20
above £55,000.00	1.4% + £0.20

When sellers receive a payment in their PayPal account, they are charged an additional fee by PayPal. Sending a payment via PayPal to another trader on the eBay market is free, but the one who receives the payment needs to pay 'PayPal fees' to eBay. Table A2.6 shows that the standard rate for receiving payments for goods and services is 3.4%, but if a person receives more than £1,500.00 per month, the fees can be as low as 1.4%, based on the volume of sales in the previous month (PayPal n . d .).

The most widespread way to pay or to receive payment for a transaction on eBay is via PayPal. It is the easiest and fastest way to pay when compared to other online payment methods. Most people choose PayPal, because it is safer. It provides protection for its users as they make their purchases. If there is a problem, they can get their money back. In addition to eBay fees, sellers must pay an extra 1.4~3.4%, if buyers pay via PayPal. Table A2.7 is an example about an auction-style item with a reserve price £99.99. The item has a starting price £14 and a final selling price £150.

Table A2.7 An Example

Format	Category	Starting Price	Reserve Price	Final Selling Price	Shipping & Handling
Auction style	Basic fees	£14	£99.99	£150	£30

Table A2.8 Result of the Example

Insertion Fee	Final Value Fee	PayPal Fees	Total
£4	£15	£6.32	£21.32

Table A2.8 shows the results of the example. The insertion fee is £1+£99.99×3%=£4. The final value fee is £150×10%=£15. The PayPal fee is £0.2+£180×3.4%=£6.32. So the total fee for the seller is £21.32. The ecal website offers a free online tool to calculate and compare a seller's eBay and PayPal fees (Ecal 2011). This site may save some money for the sellers if they try it before they list an item on the eBay site.

EBay fees for a transaction include insertion fees and final value fees. The insertion fee is up to 3% of the starting price. Sellers who have eBay shops get reduced rates on insertion fees. The final value fee is from 0.75% to 10% of the final selling price in the UK. EBay's final value fees will begin depending on Total Value (TV) (Steiner 2011). TV is the total price of an item including shipping fees and handling costs. In Table A2.9, the final value fee is (£150+£30)×10%=£18. So the fees for sellers will be higher than before.

Table A2.9 Result of the Example (TV)

Insertion Fee	Final Value Fee	PayPal Fees	Total
£4	£18	£6.32	£24.32

Amongst the fifteen shopping sites analysed in chapter 3 and also referred to below, eBay charges a higher than average final value fee. It charges users the highest online store fee, £349 as well. In most of the shopping venues, listing an item is free. EBay seems to be the only site which charges different insertion fees for different listing formats. It does not seem fair to ask the seller to pay for insertion fees and final value fees at the same time. About PayPal fees, critics also say that this is a way for eBay to "double dip" on its fees (Kidman 2008).

Appendix 3 – Performance of the eBay Website

The overall performance of an e-commerce website, and how well it meets people's expectations, may have a dramatic effect on whether customers want to come to the website to shopp. EBay today owns the largest marketplace in the world and is possibly the most successful web-based enterprise in existence. No other online company has ever attracted so many buyers and sellers to an e-marketplace. As it is the most popular e-market in the world, its website is a useful model to study when building an e-market. The performance of the eBay website is brought to the fore and examined by some of the criteria suggested by researchers of e-commerce websites. The results of an open Auctionbytes.com survey are discussed here. This will give a clearer idea of how good the performance of the eBay website is.

Developing websites that meet users' requirements is critical for all managers and designers. Website design can benefit from the application of usability principles (Nielsen 2000). It is necessary to have a closer look at the website to decide whether its Web design add utility to the success of eBay.

Usability is the measurement of how easy it is for users to use a website. It can also measure the time users take to accomplish a particular task. Or it may be the degree of satisfaction users experience after executing an operation as well. These principles suggest the need for easy-to-use navigation, frequent updating, minimal download times, relevance to users and high-quality content that takes advantage of the capabilities of the online medium (Nielsen 1993). The criteria of usability for the eBay website, therefore, include ease of reading, of searching and of getting a user's tasks done, clarity of interaction, arrangement of information, consistency, layout and speed.

The usability of the eBay site seems to be all right for most of users. The speed of downloading photos on the site can sometimes be quite slow. Perhaps, this is due to too much traffic on the site. An open survey gives an even clearer idea of how good the performance of the eBay website is.

On 24th of January in 2010, an open survey of online marketing companies was made by Auctionbytes.com. Over 1,400 sellers were asked to rank 15 marketplaces on a scale of 1-10 based on five criteria: Profitability, Customer Service, Communication, Ease of Use and Recommendation (Steiner 2010 a). Over 98% completed the survey. The results contain much useful information and reveal the general view of sellers about the different e-marketplaces and the eBay website in particular. The results show that online sellers are a tough crowd, sixes and sevens were generally the highest grades received on a scale of 1 to 10. The average scores of each criterion in the survey are shown in Table A3.1.

Table A3.1 Auctionbytes.com Survey in 2010

The result implies that the eBay website is not high in usability as a selling venue either. EBay was ranked on Ease of Use poorly, only twelfth out of fifteen as a recommended selling site. One respondent said “this is absolutely the best site for the small to medium sized seller to start and operate a business”, while another said it is “a little harder to figure out for beginners as far as trying to list an item” is concerned (Steiner 2010 b). Sellers complained that the site was slow-to-load. EBay got a rating 5.27 (Steiner 2010 b). This indicates that the site has all the necessary functions for users. However, as the largest marketplace, eBay clearly needs to address a number of problems in usability.

EBay gets the most sales and had the highest number of respondents who had experienced selling there. The number of eBay sellers is twice more than the second highest number on Craigslist. The result reflects the fact that selling goods on eBay is popular. However, in the survey, eBay was one of the lowest ranked marketplaces, and was the weakest in terms of Customer Service and Communication (see Table A3.1). The great volume of customers is putting a terrific strain on eBay's customer service. Some sellers commented that fees were eating into their margins. From the 800 comments of respondents, "it was difficult to find any that didn't include some anger or angst" about eBay (Steiner 2010 b).

In 2010, the goods sold on eBay totalled US $62 billion - more than US $2,000 every second (EBay n.d.d). The respondents ranked eBay ten out of fifteen (see Table A3.1) and rated its Profitability as 4.83 out of 10 (Steiner 2010 b). It is definitely not the profit that makes sellers want to sell on the site. Sellers on the eBay site earn little profit, so that more and more consumers come to the site and hunt for bargains. It is probably the gigantic base of buyers that motivates sellers to list their products for auction on the site.

Of course, with a huge customer base, eBay has encountered many different problems. In order to overcome the problems of usability on the eBay website, eBay has been making a series of upgrades, intended to make the site more friendly to buyers, especially after the company expanded beyond its auctions business into an Internet telephone service with its acquisition of Skype, event ticketing with StubHub and comparison shopping with Shopping.com. Whitman said "We have to make sure our old users stay with us, but we're going to be more bold around product changes than we've been in the past" (Tedeschi 2007).

According to the survey, eBay's recent changes do not meet customers' needs. Sellers complained that the site has had too many changes. A number of respondents even said they would have given eBay a rating of ten on Ease of Use 3 to 5 years ago. Of course, 1134 respondents could not speak for millions of sellers on the eBay site, but eBay should regard it as a warning. However many big sellers such as Sheng have benefited from the changes (Swartz 2010). "I have seen more dramatic changes in the last three years at eBay than in the previous 10 years" said Sheng (Swartz 2010), who was the first eBay seller to hit 2 million in his user feedback comments.

In spite of many complaints from sellers, eBay has made some good changes from which it has derived considerable benefit in an era of social media and real-time customer service. EBay has done a "remarkable job" focusing on innovation and opening the

PayPal platform, says former eBay executive Maynard Webb (Swartz 2010). "As a company, we needed to be more customer-driven and technology-driven" John Donahoe said (Swartz 2010). Since Donahoe took over as CEO in early 2008, eBay had made its name in innovation with new technology including (a) improving the site's e-commerce technology; (b) expanding eBay's mobile capability; (c) Orchestrating a series of acquisitions that reinvigorated the hardy online auction pioneer; and (d) Opening up PayPal (Swartz 2010).

PayPal is an e-commerce business allowing money transfers to be made through the Internet. On October 3, 2002, PayPal became a wholly owned subsidiary of eBay (Wolverton 2002). Encouraging customers to use the PayPal service is one of eBay’s policies. EBay will only accept PayPal in payment for some particular categories. In July 2010, BBC News announced that “auction site operator eBay has reported a 26% rise in profits for the last three months thanks largely to increased use of its PayPal service” (BBC News 2010). PayPal - the easy way for buyers to pay online - seems to be well accepted by users and brings more benefits to eBay

The results of the survey show that the superiority that the eBay website has over other websites may not be a consequence of its website design. It also suggests eBay needs to improve its poor customer service and communication.

Appendix 4 – CBM's Database

The database in the CBM is designed so that the core-brokers and market-brokers can manage and store all the data they will need to fulfil their tasks in the group-trading. Fig. A6.1 is an Entity - Relationship diagram of the CBM.

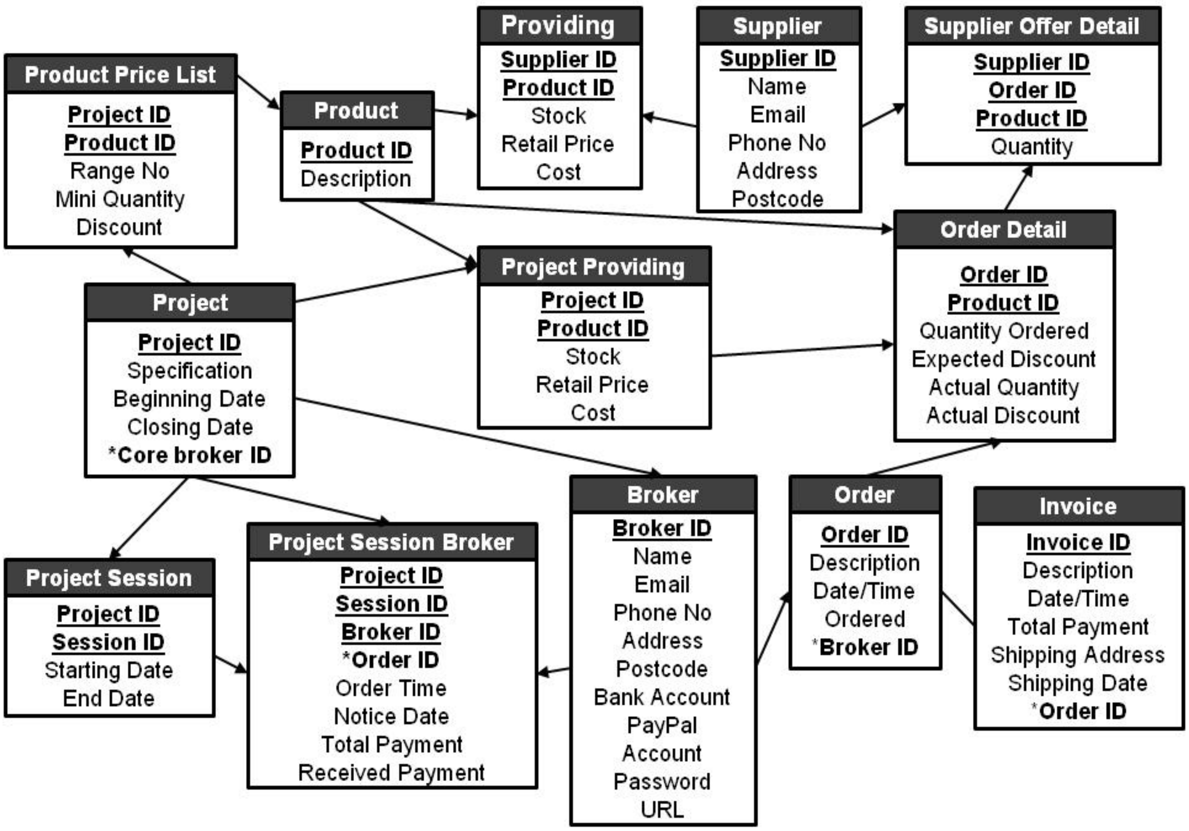


Figure A4.1 Entity-Relationship Diagram

It is comprised of the 13 entities. Except the relationship between entities 'order' and 'invoice', which is one on one, the other relationships are all one to many. For example, one project can have many project sessions. The physical tables are described as follows:

- **Project table –** the project information containing a project ID, a project specification, a project initiation date, a project closing date and the ID of the core-broker initiating the project. Users may find the details of the broker in the broker table by using the core-broker's ID.

- **Providing table –** this table holds the information about the products from the suppliers. These may be products not included in a particular bundle selling project. The composite key of this table consists of a supplier ID and a product ID. The other fields are the stock, the retail price and the cost of a product, which is the minimum amount that the supplier will charge. Clearly the actual selling price of a product cannot be less than the cost of a product, if brokers and providers are to make a profit.
- **Project providing table –** this table holds the information about products in a bundle selling project whereas the previous table listed all the available products. So the data in this table can be finalised only after the core-broker has made an agreement with each of the suppliers of the project. A bundle selling project can have multiple products and therefore this table has a composite key, which consists of a project ID and a product ID. The remaining fields in this table are the stock, the retail price and the cost of a product.
- **Project session table –** there may be many selling sessions in one project. Its composite key consists of a project ID and a session ID. It also has fields for the starting date and the end date of a session.
- **Supplier table –** this table can only be accessed by the core-broker of a project. All core-brokers have one supplier table of their own to store the information of the possible supplier they may be considering for a project. The key of this table is the ID of a supplier. This table should contain fields for the name, the email, the phone number, the address and the postcode of a supplier.
- **Product table –** the key of this table is the ID of a product. This table contains fields for the product description.
- **Project price list table –** there are different discounts that depend on the quantity of items purchased. As an example, Table A5.1 shows that if between five and ten items are purchased, there will be a 5% discount for product Cup in project PA, but if it is between eleven and twenty, 12% discount will apply. The larger the quantity of a product on an order, the higher the discount the buyers may get. The composite key of this table is the project ID and the product ID for each discount range. There are three additional fields in this table: the range number, the minimum quantity and the discount for the range.

Table A4.1 Volume Discount for a Product

Project ID	Product ID	Range Number	Minimum Amount	Discount
PA	Cup	1	5	5%
PA	Cup	2	11	12%

- **Broker table –** this table stores the basic information about the brokers. Its key is the ID of a broker. It contains fields for the name, the email, the phone number, the address, the postcode, the bank account, the PayPal account, the password and the URL of a broker. Brokers can log into the CBS by using their broker ID and password. In the CBM, brokers receive money via bank accounts, and market-brokers receive customer's payment via PayPal accounts, so these account fields cannot be empty.
- **Project session broker table –** in a project session, the core-broker can have several market-brokers. Therefore, it has a composite key, which consists of a project ID, a session ID and a broker ID. It also has fields for order ID, order time, notice date, total and received payment from each market-broker.
- **Supplier offer detail table –** a product in an order may be offered by more than one supplier. The primary key of this table consists of three fields: supplier ID, order ID and product ID. It has another field for the quantity of the product offered by the supplier.
- **Order table –** the information that is stored under an order, contains an order ID, a description about the order, the date/time ordered, the shipping address of the order, and the ID of the market-broker to whom the order belongs. The date/time ordered is the actual date/time when the market-brokers submit their orders to the core-broker. In the CBM, when the customers have paid, they will receive coupons from the market-brokers at the shipping address. If the shipping address of the order is empty, it will be filled with the address of the customer in the customer table automatically.
- **Order detail table –** an order may contain multiple products and therefore this table has a composite key, consisting of an order ID and a product ID. The remaining fields in this table are the quantity ordered, the expected discount, the actual quantity and the actual discount of a product. The actual quantity and discount are blank at the beginning.

- **Invoice table –** the information stored under an invoice contains an invoice ID. The invoice consists of a description, a date/time, a total payment, a shipping address, a shipping date, an order ID and the market-broker ID to whom the invoice is sent.

Every market-broker needs to store the information about customers and the order from the customers in the local database, which is accessed by this market-broker only and has the following four tables:

- **Customer table –** this table stores the basic information about customers and can only be accessed by the market-broker who created it. The market-broker will wish to keep the information in this table from others. Its key is the ID of a customer. It contains fields for the name, email, PayPal account, phone number, address and postcode. In the CBM, customers send money via PayPal accounts, so the PayPal account field cannot be empty.
- **Customer Order table –** the information that is stored under an order, contains an order ID, a description about the order, the date/time ordered, the shipping address of the order, and the ID of the market-broker to whom the order belongs. The date/time ordered is the actual date/time when the market-brokers submit their orders to the core-broker. In the CBM, when the customers have paid, they will receive coupons from the customers at the shipping address. If the shipping address of the order is empty, it will be filled with the address of the customer in the customer table automatically.
- **Customer Order detail table –** an order may contain multiple products and therefore this table has a composite key, consisting of an order ID and a product ID. The remaining fields in this table are the quantity ordered, the expected discount, the actual quantity and the actual discount of a product. The actual quantity and discount are blank at the beginning.
- **Customer Invoice table –** the information stored under an invoice contains an invoice ID. The invoice consists of a description, a date/time, a total payment, a shipping address, a shipping date, an order ID and the customer ID to whom the invoice is sent.

Appendix 5 – Orders from Normal Customers

Order ID	Customer ID	Product ID	Quantity	Expected Discount
O01	C1	Cb	1	0.00
		Cc	6	0.01
		Cd	20	0.01
		Rb	23	0.10
		Rc	23	0.02
O02	C2	Ca	3	0.03
		Cb	5	0.06
		Cc	10	0.07
		Ra	9	0.05
		Rb	9	0.16
		Rc	6	0.00
O03	C3	Ca	13	0.16
		Cb	18	0.17
		Cd	1	0.01
		Ra	4	0.01
		Rb	29	0.09
		Rc	9	0.02
O04	C4	Cc	3	0.03
		Cd	4	0.00
		Rb	32	0.00
		Rc	41	0.08
O05	C5	Ca	1	0.19
		Cb	20	0.16
		Cd	37	0.04
		Rb	49	0.17
O06	C6	Ca	17	0.16
		Cb	25	0.05
		Cd	4	0.02
		Rb	22	0.01
O07	C7	Ca	29	0.10
		Cb	3	0.13
		Cc	19	0.07
		Cd	4	0.00
		Rb	15	0.07
O08	C8	Ca	12	0.09
		Cb	7	0.02
		Cc	8	0.09
		Ra	3	0.02
		Rb	31	0.12
		Rc	35	0.01
O09	C9	Ca	7	0.05
		Cb	12	0.07
		Cc	22	0.06
		Cd	22	0.00
		Rb	41	0.10
		Rc	36	0.09
O10	C20	Ca	27	0.04
		Cb	4	0.07
		Ra	28	0.13
		Rc	25	0.04
O11	C21	Cb	9	0.09
		Cc	20	0.09
		Ra	39	0.20
		Rc	39	0.09
O12	C22	Ca	12	0.14
		Cb	25	0.15
		Cc	26	0.05
		Cd	41	0.02
		Ra	5	0.14
		Rb	23	0.02
		Rc	36	0.06
O13	C23	Ca	14	0.14
		Cb	9	0.01
		Cd	21	0.02
		Ra	10	0.11
		Rb	48	0.09
		Rc	21	0.01

Order ID	Customer ID	Product ID	Quantity	Expected Discount
O14	C24	Ca	27	0.07
		Cb	23	0.02
		Cd	18	0.02
		Ra	18	0.00
		Rb	5	0.07
		Rc	28	0.03
O15	C25	Ca	9	0.00
		Cb	22	0.09
		Cc	18	0.09
		Cd	34	0.02
		Ra	23	0.01
		Rb	22	0.00
		Rc	16	0.00
O16	C26	Ca	28	0.19
		Cb	15	0.01
		Cd	18	0.04
		Rb	33	0.17
		Rc	37	0.07
O17	C27	Ca	19	0.04
		Cb	7	0.14
		Cc	11	0.02
		Cd	35	0.02
		Ra	29	0.01
		Rb	43	0.14
		Rc	38	0.05
O18	C28	Ca	2	0.07
		Cc	30	0.02
		Cd	3	0.04
		Ra	24	0.12
		Rb	34	0.09
		Rc	6	0.08
O19	C29	Cb	13	0.00
		Cd	30	0.02
		Ra	1	0.13
		Rb	23	0.04
		Rc	39	0.05
O20	C30	Ca	31	0.12
		Cb	6	0.11
		Cc	26	0.05
		Cd	38	0.01
		Ra	12	0.15
		Rb	43	0.10
O21	C31	Ca	15	0.16
		Cb	3	0.06
		Cc	22	0.08
		Cd	45	0.04
		Rb	18	0.13
		Rc	31	0.07
O22	C32	Cc	5	0.07
		Cd	43	0.00
		Ra	7	0.02
		Rb	32	0.13
O23	C33	Ca	23	0.14
		Cc	15	0.07
		Cd	46	0.01
		Ra	16	0.04
		Rb	20	0.01
		Rc	20	0.00
O24	C34	Ca	10	0.12
		Cc	23	0.00
		Ra	35	0.03
		Rb	5	0.06

Appendix 5 Orders from Normal Customers

Order ID	Customer ID	Product ID	Quantity	Expected Discount
O25	C35	Ca	12	0.03
		Cb	14	0.19
		Cc	24	0.00
		Ra	22	0.15
		Rc	32	0.07
O26	C36	Ca	25	0.15
		Cb	1	0.04
		Cd	24	0.03
		Ra	42	0.10
		Rc	32	0.06
O27	C37	Ca	27	0.18
		Cb	6	0.04
		Cc	20	0.03
		Cd	43	0.01
		Ra	23	0.09
		Rb	9	0.10
		Rc	40	0.00
O28	C38	Cb	24	0.13
		Cd	8	0.00
		Ra	42	0.00
		Rb	5	0.04
O29	C39	Cb	24	0.15
		Cc	1	0.04
		Cd	25	0.03
		Ra	15	0.16
		Rb	13	0.08
		Rc	36	0.04
O30	C40	Cb	23	0.10
		Cc	25	0.05
		Cd	28	0.03
		Ra	24	0.05
		Rb	40	0.09
		Rc	7	0.08
O31	C41	Ca	30	0.07
		Cc	6	0.00
		Ra	22	0.09
		Rb	10	0.08
		Rc	12	0.03
O32	C42	Ca	26	0.00
		Cb	4	0.15
		Cc	7	0.07
		Cd	43	0.01
		Rb	17	0.08
O33	C43	Ca	8	0.12
		Cb	24	0.13
		Cd	33	0.00
		Ra	37	0.17
		Rc	6	0.06
O34	C44	Cb	1	0.06
		Cd	41	0.03
		Rc	38	0.06
O35	C45	Ca	3	0.06
		Cb	25	0.17
		Cc	26	0.06
		Cd	2	0.04
		Ra	22	0.11
		Rb	14	0.12
		Rc	25	0.07
O36	C46	Cb	14	0.10
		Cc	11	0.02
		Cd	6	0.03
		Ra	16	0.02
		Rb	15	0.17
		Rc	23	0.07
O37	C47	Ca	16	0.17
		Cb	11	0.11
		Cc	26	0.00
		Cd	39	0.02
		Ra	42	0.04
		Rc	11	0.01

Order ID	Customer ID	Product ID	Quantity	Expected Discount
O38	C48	Ca	23	0.11
		Cb	24	0.07
		Cc	14	0.00
		Cd	19	0.03
		Ra	13	0.11
		Rc	8	0.05
O39	C49	Ca	26	0.16
		Cb	9	0.16
		Cd	12	0.03
		Rb	42	0.10
		Rc	39	0.05
O40	C50	Ca	6	0.07
		Cb	10	0.16
		Cc	27	0.01
		Cd	46	0.04
		Ra	1	0.00
		Rb	17	0.10
		Rc	5	0.09
O41	C51	Ca	10	0.17
		Cb	9	0.03
		Cc	21	0.02
		Cd	35	0.00
		Ra	31	0.03
		Rb	27	0.00
		Rc	28	0.00
O42	C52	Ca	11	0.02
		Cb	11	0.18
		Cd	10	0.00
		Rb	39	0.03
		Rc	22	0.09
O43	C53	Ca	19	0.09
		Cb	7	0.09
		Cd	7	0.01
		Ra	10	0.12
		Rb	43	0.12
		Rc	32	0.02
O44	C54	Ca	17	0.06
		Cb	1	0.16
		Cc	8	0.08
		Cd	17	0.00
		Ra	16	0.09
		Rb	17	0.07
		Rc	21	0.04
O45	C55	Ca	21	0.03
		Cb	6	0.10
		Cc	17	0.07
		Cd	19	0.01
		Ra	32	0.02
		Rb	46	0.05
		Rc	30	0.02
O46	C56	Ca	22	0.16
		Cd	15	0.04
		Rb	38	0.13
		Rc	15	0.05
O47	C57	Ca	32	0.17
		Cc	24	0.08
		Cd	21	0.00
		Ra	7	0.06
		Rc	27	0.02
O48	C58	Ca	13	0.01
		Cb	23	0.01
		Cd	10	0.03
		Ra	14	0.00
		Rb	10	0.08
O49	C59	Cb	17	0.17
		Cc	4	0.08
		Cd	11	0.04
		Rb	22	0.16
		Rc	27	0.05
O50	C60	Ca	14	0.14
		Cb	6	0.01
		Cc	8	0.01
		Cd	9	0.04
		Rb	30	0.05
		Rc	3	0.03

Appendix 5 Orders from Normal Customers

Order ID	Customer ID	Product ID	Quantity	Expected Discount
O51	C61	Ca	10	0.00
		Cb	6	0.06
		Cc	26	0.06
		Ra	23	0.03
		Rb	34	0.15
		Rc	39	0.06
O52	C62	Ca	32	0.13
		Cb	12	0.02
		Cc	11	0.07
		Ra	26	0.04
		Rc	20	0.01
O53	C63	Ca	7	0.00
		Cb	1	0.19
		Cc	16	0.09
		Cd	18	0.00
		Ra	37	0.03
		Rc	19	0.06
O54	C64	Cb	5	0.11
		Cd	49	0.01
		Rb	41	0.10
		Rc	3	0.07
O55	C65	Ca	5	0.01
		Cb	2	0.18
		Cd	23	0.02
		Ra	42	0.13
		Rb	5	0.17
O56	C66	Ca	24	0.06
		Cd	27	0.02
		Ra	39	0.09
		Rb	35	0.16
O57	C67	Ca	27	0.13
		Cc	21	0.07
		Cd	36	0.03
		Ra	41	0.03
O58	C68	Cb	5	0.04
		Cc	13	0.00
		Cd	26	0.04
		Ra	16	0.08
		Rb	15	0.14
O59	C69	Cb	1	0.01
		Cc	18	0.05
		Cd	35	0.01
		Ra	21	0.03
		Rb	5	0.07
O60	C70	Ca	7	0.16
		Cb	2	0.08
		Cc	6	0.01
		Cd	10	0.01
		Ra	1	0.09
		Rb	14	0.02
		Rc	10	0.00
O61	C71	Cb	14	0.18
		Cc	18	0.09
		Cd	28	0.01
		Ra	42	0.00
		Rc	29	0.08
O62	C72	Cb	25	0.02
		Cc	31	0.05
		Cd	17	0.03
		Ra	5	0.17
		Rb	19	0.00
		Rc	15	0.08
O63	C73	Ca	13	0.13
		Cb	17	0.10
		Ra	20	0.05
		Rb	37	0.03
		Rc	8	0.00
O64	C74	Ca	27	0.04
		Cb	4	0.15
		Cc	5	0.04
		Cd	9	0.00
		Ra	20	0.04
		Rc	20	0.05

Order ID	Customer ID	Product ID	Quantity	Expected Discount
O65	C75	Ca	8	0.12
		Cb	8	0.12
		Cc	9	0.08
		Cd	36	0.01
		Ra	7	0.10
		Rb	16	0.01
		Rc	30	0.01
O66	C76	Ca	16	0.12
		Cb	5	0.15
		Cc	1	0.03
		Cd	38	0.00
		Ra	26	0.12
		Rb	31	0.00
		Rc	16	0.04
O67	C77	Cb	6	0.06
		Cd	21	0.04
		Ra	37	0.02
		Rb	35	0.10
		Rc	7	0.05
O68	C78	Ca	29	0.14
		Cb	6	0.04
		Cc	19	0.02
		Cd	18	0.04
		Ra	39	0.06
		Rb	25	0.04
		Rc	29	0.03
O69	C79	Ca	31	0.15
		Cb	24	0.07
		Cc	3	0.02
		Cd	4	0.04
		Ra	1	0.01
		Rb	49	0.04
		Rc	21	0.06
O70	C80	Ca	22	0.04
		Ra	8	0.07
		Rb	12	0.05
O71	C81	Ca	12	0.00
		Cb	18	0.17
		Cc	23	0.01
		Cd	47	0.00
		Ra	1	0.06
		Rb	7	0.01
		Rc	4	0.00
O72	C82	Ca	14	0.05
		Cb	3	0.09
		Cc	16	0.07
		Cd	1	0.03
		Ra	8	0.16
		Rb	5	0.09
O73	C83	Ca	9	0.10
		Cc	3	0.00
		Cd	12	0.00
		Ra	8	0.02
		Rb	18	0.08
		Rc	28	0.06
O74	C84	Cb	7	0.18
		Cc	31	0.00
		Cd	14	0.00
		Rb	33	0.03
O75	C85	Ca	20	0.17
		Cb	13	0.05
		Cc	29	0.09
		Cd	33	0.03
		Ra	8	0.05
		Rb	37	0.04
		Rc	25	0.03
O76	C86	Ca	30	0.02
		Cd	33	0.03
		Ra	16	0.05
		Rb	24	0.02
		Rc	22	0.03

Appendix 5 Orders from Normal Customers

Order ID	Customer ID	Product ID	Quantity	Expected Discount
O77	C87	Ca	7	0.02
		Cb	3	0.01
		Cd	20	0.02
		Ra	18	0.03
		Rb	23	0.14
		Rc	36	0.03
O78	C88	Ca	7	0.02
		Cc	8	0.00
		Ra	38	0.10
		Rb	1	0.08
O79	C89	Ca	8	0.06
		Cb	16	0.15
		Cc	3	0.03
		Cd	7	0.00
		Ra	42	0.12
		Rb	2	0.02
		Rc	36	0.05
O80	C90	Ca	17	0.16
		Cb	13	0.04
		Cc	19	0.03
		Cd	7	0.01
		Rb	34	0.11
		Rc	2	0.03
O81	C91	Ca	1	0.14
		Cb	22	0.12
		Cc	12	0.04
		Ra	17	0.13
		Rb	22	0.09
O82	C92	Cb	10	0.05
		Cd	15	0.00
		Ra	42	0.16
		Rb	38	0.13
		Rc	29	0.00
O83	C93	Cd	48	0.01
		Ra	33	0.10
		Rb	28	0.07
		Rc	13	0.03
O84	C94	Ca	5	0.16
		Cb	16	0.02
		Cd	4	0.03
		Ra	9	0.08
		Rb	22	0.11
		Rc	39	0.01
O85	C95	Ca	21	0.18
		Cb	20	0.14
		Cc	20	0.00
		Ra	28	0.15
		Rb	18	0.03
O86	C96	Ca	18	0.18
		Cb	15	0.13
		Cd	37	0.00
		Ra	4	0.12
		Rb	23	0.11
		Rc	32	0.04
O87	C97	Ca	12	0.12
		Cc	31	0.08
		Cd	24	0.04
		Ra	31	0.15
		Rb	36	0.08
		Rc	6	0.06
O88	C98	Cb	15	0.00
		Cc	28	0.03
		Ra	32	0.15
		Rb	21	0.16
		Rc	8	0.05
O89	C99	Ca	20	0.02
		Ra	31	0.00
		Rb	5	0.06
		Rc	3	0.07

Order ID	Customer ID	Product ID	Quantity	Expected Discount
O90	C100	Cb	23	0.13
		Cc	19	0.00
		Rb	37	0.08
		Rc	12	0.00
O91	C101	Ca	25	0.05
		Cb	23	0.00
		Cc	11	0.00
		Cd	1	0.03
		Ra	27	0.13
		Rb	8	0.13
		Rc	16	0.00
O92	C102	Cb	18	0.10
		Cd	9	0.00
		Ra	39	0.15
		Rb	6	0.04
		Rc	15	0.02
O93	C103	Cb	2	0.14
		Cd	9	0.02
		Rb	46	0.04
		Rc	20	0.04
O94	C104	Cb	7	0.18
		Cc	15	0.00
		Cd	14	0.01
		Ra	31	0.04
		Rb	12	0.03
		Rc	27	0.07
O95	C105	Ca	5	0.01
		Cb	18	0.03
		Cc	13	0.08
		Cd	21	0.00
		Ra	16	0.10
		Rb	29	0.07
		Rc	26	0.05
O96	C106	Ca	15	0.10
		Cb	13	0.16
		Cc	19	0.08
		Cd	48	0.03
		Ra	14	0.06
		Rb	32	0.07
		Rc	35	0.07
O97	C107	Ca	28	0.19
		Cb	6	0.18
		Cc	7	0.05
		Ra	14	0.13
		Rb	35	0.12
		Rc	40	0.00
O98	C108	Ca	21	0.16
		Cb	3	0.03
		Cc	6	0.08
		Cd	38	0.01
		Ra	27	0.09
		Rb	21	0.16
		Rc	32	0.05
O99	C109	Ca	18	0.08
		Cb	10	0.01
		Ra	1	0.12
		Rc	9	0.05

Appendix 6 – Orders from Demanding Customers

Order ID	Customer ID	Product ID	Quantity	Expected Discount
H01	C11	Cb	1	0.21
		Cc	6	0.16
		Cd	20	0.02
		Rb	23	0.10
		Rc	23	0.02
H02	C12	Ca	3	0.33
		Cb	5	0.26
		Cc	10	0.17
		Ra	9	0.25
		Rb	9	0.16
		Rc	6	0.03
H03	C13	Ca	13	0.36
		Cb	18	0.27
		Cd	1	0.06
		Ra	4	0.31
		Rb	29	0.19
		Rc	9	0.02
H04	C14	Cc	3	0.13
		Cd	4	0.01
		Rb	32	0.20
		Rc	41	0.08
H05	C15	Ca	1	0.39
		Cb	20	0.26
		Cd	37	0.09
		Rb	49	0.19
H06	C16	Ca	17	0.36
		Cb	25	0.25
		Cd	4	0.02
		Rb	22	0.11
H07	C17	Ca	29	0.31
		Cb	3	0.23
		Cc	19	0.17
		Cd	4	0.02
		Rb	15	0.17
H08	C18	Ca	12	0.39
		Cb	7	0.22
		Cc	8	0.19
		Ra	3	0.32
		Rb	31	0.22
		Rc	35	0.11
H09	C19	Cb	9	0.26
		Cc	3	0.19
		Cd	21	0.05
		Ra	12	0.33
		Rb	17	0.24
		Rc	32	0.11
H10	C110	Ca	2	0.38
		Cb	18	0.28
		Cc	28	0.12
		Cd	30	0.04
		Rb	32	0.21
		Rc	28	0.16
H11	C111	Ca	6	0.35
		Cb	7	0.28
		Cc	21	0.15
		Cd	21	0.03
		Ra	40	0.31
		Rb	38	0.19
H12	C112	Ca	12	0.38
		Cb	2	0.21
		Cd	12	0.09
		Ra	42	0.26
		Rb	13	0.16
H13	C113	Ca	10	0.32
		Ra	13	0.29
		Rb	6	0.16
		Rc	35	0.09
H14	C114	Ca	29	0.28
		Cc	9	0.13
		Cd	33	0.04
		Ra	31	0.27
		Rb	17	0.17
		Rc	15	0.11
H15	C115	Ca	18	0.28
		Cb	11	0.24
		Cc	13	0.14
		Cd	30	0.06
		Ra	23	0.24
		Rb	5	0.18
H16	C116	Ca	11	0.36
		Cc	15	0.09
		Ra	3	0.34
		Rb	32	0.21
		Rc	2	0.10
H17	C117	Ca	19	0.36
		Cb	1	0.28
		Rb	30	0.18
		Rc	14	0.11
H18	C118	Ca	11	0.39
		Cb	1	0.18
		Cc	5	0.19
		Cd	37	0.03
		Ra	7	0.28
		Rb	33	0.17
		Rc	5	0.15
H19	C119	Ca	27	0.34
		Cb	23	0.28
		Cc	3	0.12
		Cd	42	0.09
		Ra	39	0.27
		Rb	2	0.20
		Rc	21	0.09
H20	C120	Ca	20	0.32
		Cb	6	0.20
		Cc	21	0.15
		Cd	16	0.04
		Ra	28	0.30
		Rb	10	0.17
		Rc	12	0.14
H21	C121	Ca	7	0.37
		Cc	5	0.11
		Cd	19	0.05
		Ra	30	0.32
		Rc	17	0.13
H22	C32	Cb	22	0.27
		Cc	6	0.15
		Cd	12	0.09
		Rb	24	0.21
		Rc	6	0.13
H23	C123	Ca	28	0.30
		Cb	12	0.29
		Cc	32	0.10
		Cd	23	0.03
		Rb	1	0.17
		Rc	23	0.10
H24	C124	Ca	18	0.34
		Cb	1	0.25
		Cd	5	0.09
		Ra	29	0.29
		Rb	47	0.22
		Rc	1	0.12
H25	C125	Ca	21	0.36
		Cb	4	0.25
		Cd	21	0.06
		Ra	2	0.23
H26	C126	Ca	20	0.34
		Cb	14	0.18
		Cd	7	0.06
		Ra	4	0.33
		Rb	23	0.19
		Rc	8	0.08
H27	C127	Ca	15	0.27
		Cd	15	0.06
		Rb	2	0.22
		Rc	30	0.09
H28	C128	Ca	7	0.29
		Cb	14	0.27
		Cc	26	0.11
		Cd	2	0.04
		Ra	37	0.33
		Rb	38	0.16
H29	C129	Ca	11	0.32
		Cc	13	0.13
		Cd	44	0.03
		Ra	42	0.33
		Rb	8	0.24
		Rc	13	0.10

Appendix 6 Orders from Demanding Customers

Order ID	Customer ID	Product ID	Quantity	Expected Discount
H30	C140	Ca	14	0.28
		Cb	23	0.20
		Cc	3	0.08
		Ra	5	0.31
		Rb	27	0.15
		Rc	33	0.11
H31	C141	Cb	7	0.27
		Cc	28	0.09
		Cd	48	0.07
		Ra	10	0.30
		Rb	5	0.17
		Rc	4	0.10
H32	C142	Cb	11	0.28
		Cc	27	0.19
		Cd	28	0.08
		Ra	39	0.29
		Rb	44	0.15
H33	C143	Cb	25	0.23
		Cc	19	0.13
		Cd	49	0.08
		Ra	15	0.28
		Rc	4	0.17
H34	C144	Ca	22	0.30
		Cc	25	0.17
		Cd	44	0.06
		Rc	29	0.11
H35	C145	Ca	3	0.38
		Cb	24	0.27
		Cd	15	0.09
		Ra	24	0.31
		Rb	28	0.22
		Rc	3	0.12
H36	C146	Ca	3	0.28
		Cb	20	0.24
		Cc	18	0.15
		Ra	19	0.33
		Rb	8	0.18
		Rc	15	0.14
H37	C147	Ca	2	0.30
		Cb	6	0.26
		Cc	22	0.14
		Cd	19	0.07
		Ra	18	0.26
		Rb	9	0.22
		Rc	18	0.16
H38	C148	Ca	19	0.30
		Cb	6	0.17
		Cc	15	0.13
		Cd	4	0.03
		Ra	36	0.29
		Rb	6	0.15
		Rc	8	0.14
H39	C149	Ca	5	0.27
		Cb	10	0.25
		Cd	31	0.05
		Ra	9	0.33
		Rc	38	0.14
H40	C150	Ca	15	0.34
		Cb	3	0.28
		Cd	48	0.04
		Ra	19	0.26
		Rb	36	0.15
		Rc	11	0.09
H41	C151	Ca	7	0.37
		Cb	10	0.25
		Cd	6	0.06
		Ra	31	0.30
		Rb	31	0.22
H42	C152	Ca	30	0.33
		Cb	25	0.28
		Cc	14	0.13
		Cd	20	0.05
		Ra	6	0.27
		Rb	50	0.16
		Rc	26	0.08

Order ID	Customer ID	Product ID	Quantity	Expected Discount
H43	C153	Ca	12	0.30
		Cb	23	0.17
		Cc	5	0.13
		Cd	49	0.06
		Ra	11	0.27
		Rb	20	0.16
		Rc	11	0.08
H44	C154	Ca	23	0.35
		Cb	2	0.21
		Cd	9	0.03
		Ra	5	0.33
		Rb	19	0.23
		Rc	25	0.08
H45	C155	Ca	13	0.28
		Cb	15	0.17
		Cd	48	0.06
		Ra	26	0.30
		Rb	18	0.21
		Rc	5	0.12
H46	C156	Cb	6	0.22
		Cd	23	0.07
		Rc	29	0.12
H47	C157	Ca	32	0.27
		Cb	12	0.22
		Cc	23	0.18
		Cd	50	0.04
		Ra	29	0.28
		Rb	50	0.17
H48	C158	Ca	32	0.34
		Cb	21	0.22
		Cc	5	0.18
		Cd	46	0.07
		Ra	18	0.23
		Rb	38	0.17
		Rc	17	0.16
H49	C159	Cb	24	0.17
		Cc	9	0.13
		Cd	24	0.07
		Rb	44	0.19
		Rc	11	0.16
H50	C160	Ca	28	0.38
		Cb	8	0.28
		Cc	3	0.10
		Cd	30	0.06
		Ra	34	0.31
		Rb	33	0.23
		Rc	18	0.11
H51	C161	Ca	14	0.33
		Cb	15	0.23
		Cc	7	0.08
		Cd	6	0.08
		Ra	18	0.34
		Rb	40	0.21
		Rc	25	0.11
H52	C162	Ca	15	0.38
		Cb	11	0.29
		Cc	10	0.07
		Cd	36	0.07
		Ra	23	0.34
		Rc	1	0.12
H53	C163	Cb	6	0.23
		Cc	30	0.09
		Ra	9	0.27
		Rc	21	0.09
H54	C164	Ca	8	0.33
		Cc	16	0.10
		Cd	47	0.09
		Rb	16	0.19
		Rc	19	0.17

Appendix 6 Orders from Demanding Customers

Order ID	Customer ID	Product ID	Quantity	Expected Discount
H55	C165	Ca	29	0.36
		Cb	9	0.18
		Cc	26	0.16
		Cd	29	0.04
		Ra	20	0.26
		Rb	32	0.19
		Rc	3	0.08
H56	C166	Ca	12	0.28
		Cb	22	0.18
		Cc	10	0.15
		Cd	3	0.03
		Ra	38	0.27
		Rb	29	0.24
		Rc	17	0.09
H57	C167	Cc	18	0.08
		Cd	27	0.07
		Ra	39	0.33
		Rb	20	0.23
		Rc	13	0.09
H58	C168	Ca	30	0.36
		Cb	24	0.18
		Cd	20	0.03
		Ra	36	0.26
		Rc	27	0.15
H59	C169	Ca	25	0.28
		Cb	10	0.28
		Cc	1	0.13
		Cd	1	0.09
		Ra	1	0.25
		Rb	41	0.16
		Rc	11	0.16
H60	C170	Cb	14	0.25
		Cd	1	0.04
		Ra	14	0.29
		Rb	44	0.21
		Rc	23	0.08
H61	C171	Ca	21	0.37
		Cb	8	0.26
		Cc	8	0.17
		Cd	40	0.08
		Ra	13	0.29
		Rb	28	0.24
		Rc	39	0.17
H62	C172	Ca	14	0.36
		Cb	3	0.28
		Cc	11	0.15
		Cd	42	0.09
		Ra	26	0.27
		Rb	35	0.21
		Rc	21	0.14
H63	C173	Ca	18	0.39
		Cc	27	0.08
		Cd	5	0.05
		Ra	33	0.24
		Rb	33	0.20
H64	C174	Ca	15	0.27
		Cb	25	0.19
		Cd	29	0.08
		Ra	4	0.34
H65	C175	Cb	25	0.26
		Cd	3	0.06
		Ra	20	0.23
		Rc	28	0.09
H66	C176	Ca	27	0.28
		Cb	1	0.28
		Cc	15	0.13
		Cd	10	0.07
		Ra	13	0.29
		Rb	22	0.19
		Rc	40	0.16
H67	C177	Ca	21	0.27
		Cb	8	0.27
		Cc	31	0.12
		Cd	6	0.08
		Rb	14	0.23

Order ID	Customer ID	Product ID	Quantity	Expected Discount
H68	C178	Ca	12	0.39
		Cc	9	0.13
		Cd	43	0.03
		Ra	31	0.26
		Rb	18	0.21
		Rc	14	0.13
H69	C179	Ca	16	0.32
		Cb	2	0.26
		Cd	35	0.06
		Ra	22	0.26
		Rb	42	0.18
		Rc	37	0.08
H70	C180	Ca	32	0.30
		Cb	10	0.26
		Cc	7	0.10
		Ra	13	0.25
H71	C181	Ca	2	0.29
		Cb	6	0.20
		Cc	30	0.16
		Cd	2	0.07
		Ra	28	0.30
		Rb	29	0.23
		Rc	7	0.17
H72	C182	Ca	6	0.37
		Cb	8	0.18
		Cc	15	0.17
		Ra	31	0.31
		Rb	8	0.17
		Rc	9	0.09
H73	C183	Cb	18	0.26
		Cc	5	0.08
		Cd	8	0.06
		Ra	38	0.29
		Rb	14	0.16
		Rc	35	0.10
H74	C184	Ca	13	0.38
		Cc	27	0.09
		Ra	31	0.33
		Rb	45	0.17
		Rc	17	0.15
H75	C185	Ca	7	0.35
		Cb	25	0.25
		Cc	6	0.07
		Cd	32	0.07
		Ra	35	0.33
		Rb	20	0.17
		Rc	24	0.16
H76	C186	Ca	28	0.38
		Cb	16	0.22
		Cc	29	0.17
		Ra	26	0.31
		Rb	13	0.17
H77	C187	Ca	1	0.38
		Cb	20	0.18
		Cc	16	0.14
		Ra	21	0.31
		Rb	39	0.23
		Rc	20	0.16
H78	C188	Cc	12	0.09
		Cd	33	0.09
		Ra	1	0.28
		Rb	7	0.22
		Rc	26	0.12
H79	C189	Ca	30	0.30
		Cb	4	0.18
		Cd	18	0.03
		Rb	29	0.15
		Rc	32	0.13
H80	C190	Ca	3	0.39
		Cb	13	0.18
		Cd	45	0.06
		Ra	26	0.31
		Rb	32	0.23
		Rc	26	0.11

Appendix 6 Orders from Demanding Customers

Order ID	Customer ID	Product ID	Quantity	Expected Discount
H81	C191	Ca	19	0.31
		Cb	21	0.28
		Cc	27	0.15
		Cd	12	0.05
		Ra	13	0.30
		Rb	39	0.18
		Rc	8	0.08
H82	C192	Cb	25	0.22
		Cc	7	0.08
		Cd	28	0.04
		Ra	37	0.25
		Rb	21	0.20
		Rc	17	0.12
H83	C193	Ca	15	0.34
		Cb	8	0.19
		Cc	14	0.08
		Cd	11	0.08
		Ra	19	0.32
		Rb	3	0.16
		Rc	1	0.17
H84	C194	Ca	14	0.39
		Cb	4	0.28
		Cc	25	0.18
		Cd	16	0.09
		Ra	30	0.26
		Rb	17	0.21
		Rc	25	0.12
H85	C195	Ca	10	0.35
		Cb	6	0.21
		Cd	36	0.09
		Ra	2	0.30
		Rb	36	0.17
		Rc	24	0.11
H86	C196	Cb	1	0.19
		Cc	27	0.15
		Cd	30	0.09
		Ra	37	0.30
		Rb	32	0.21
H87	C197	Ca	25	0.29
		Cb	18	0.29
		Cc	10	0.18
		Cd	9	0.09
		Ra	12	0.33
H88	C198	Ca	21	0.35
		Cc	2	0.08
		Cd	39	0.06
		Rb	35	0.15
		Rc	31	0.12
H89	C199	Ca	23	0.36
		Cb	16	0.22
		Cc	29	0.09
		Ra	34	0.32
		Rb	37	0.22
H90	C200	Ca	25	0.31
		Cc	12	0.19
		Cd	4	0.04
		Ra	16	0.23
		Rb	13	0.23
		Rc	30	0.10
H91	C201	Cb	1	0.22
		Rb	15	0.15
		Rc	21	0.14
H92	C202	Ca	26	0.31
		Cb	20	0.23
		Cd	34	0.08
		Rb	21	0.23
		Rc	2	0.13

Order ID	Customer ID	Product ID	Quantity	Expected Discount
H93	C203	Ca	4	0.34
		Cc	7	0.17
		Cd	48	0.05
		Ra	22	0.27
		Rb	33	0.16
H94	C204	Cc	6	0.14
		Cd	11	0.04
		Ra	5	0.33
		Rb	38	0.17
		Rc	18	0.11
H95	C205	Ca	6	0.27
		Cb	23	0.20
		Cc	14	0.13
		Cd	11	0.07
		Ra	21	0.27
		Rb	29	0.23
		Rc	26	0.13
H96	C206	Ca	21	0.33
		Cb	18	0.28
		Cc	5	0.14
		Cd	24	0.08
		Rb	19	0.22
		Rc	1	0.09
H97	C207	Ca	6	0.29
		Cb	1	0.18
		Cc	1	0.15
		Cd	49	0.07
		Ra	13	0.28
		Rb	28	0.21
		Rc	32	0.14
H99	C209	Ca	30	0.38
		Cb	18	0.27
		Cc	3	0.09
		Cd	4	0.05
		Ra	1	0.29
		Rb	26	0.15
		Rc	18	0.09

Appendix 7 – Interfaces of the TCG

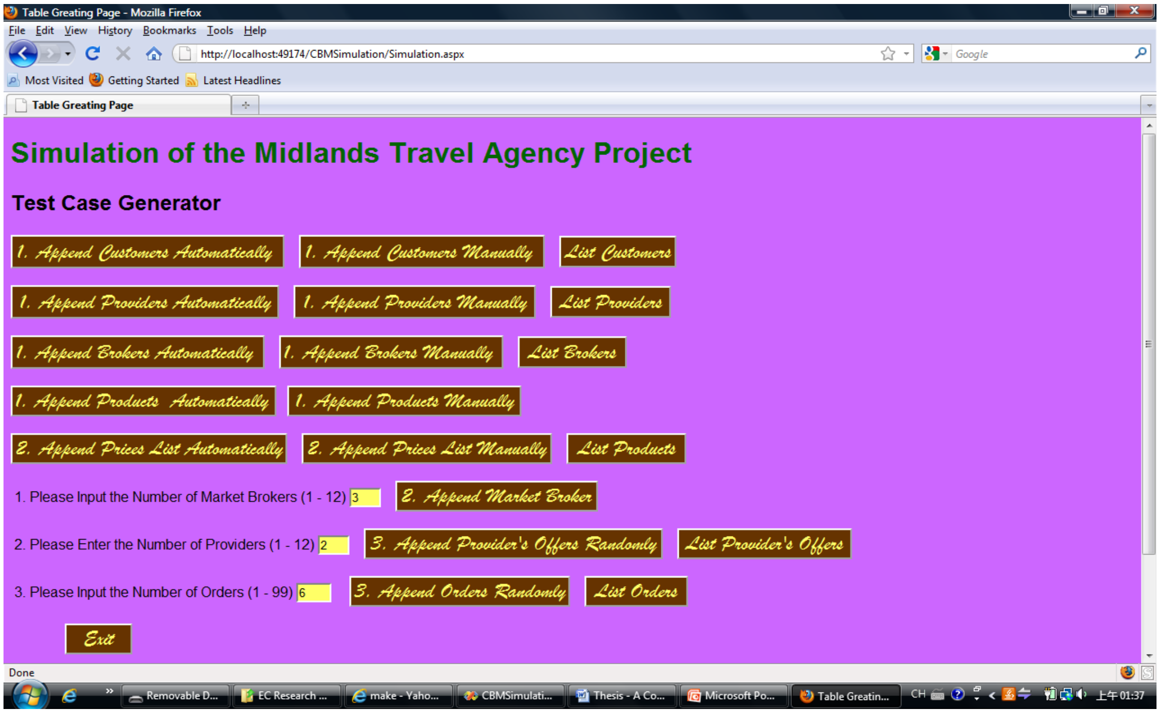


Figure A7.1 Main Menu of the TCG

When users choose to input customers' personal details manually by pushing button 'Append Customers Manually', they can enter the data in the two following screens:

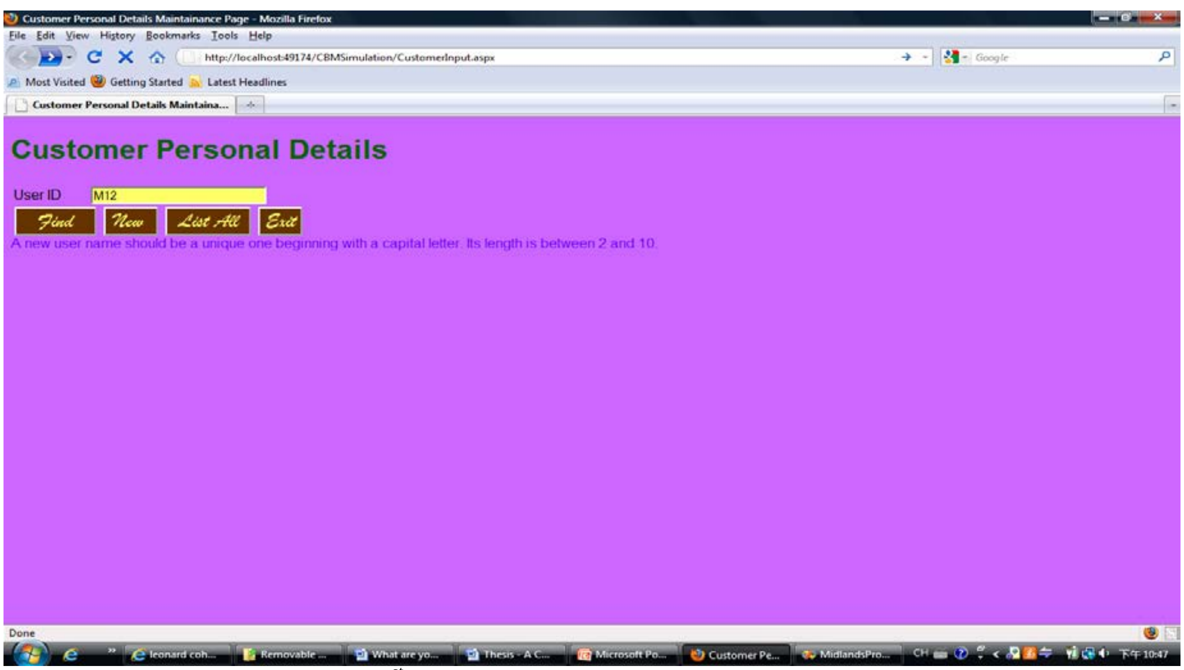


Figure A7.2 1st Page of Customer Personal Details Maintenance

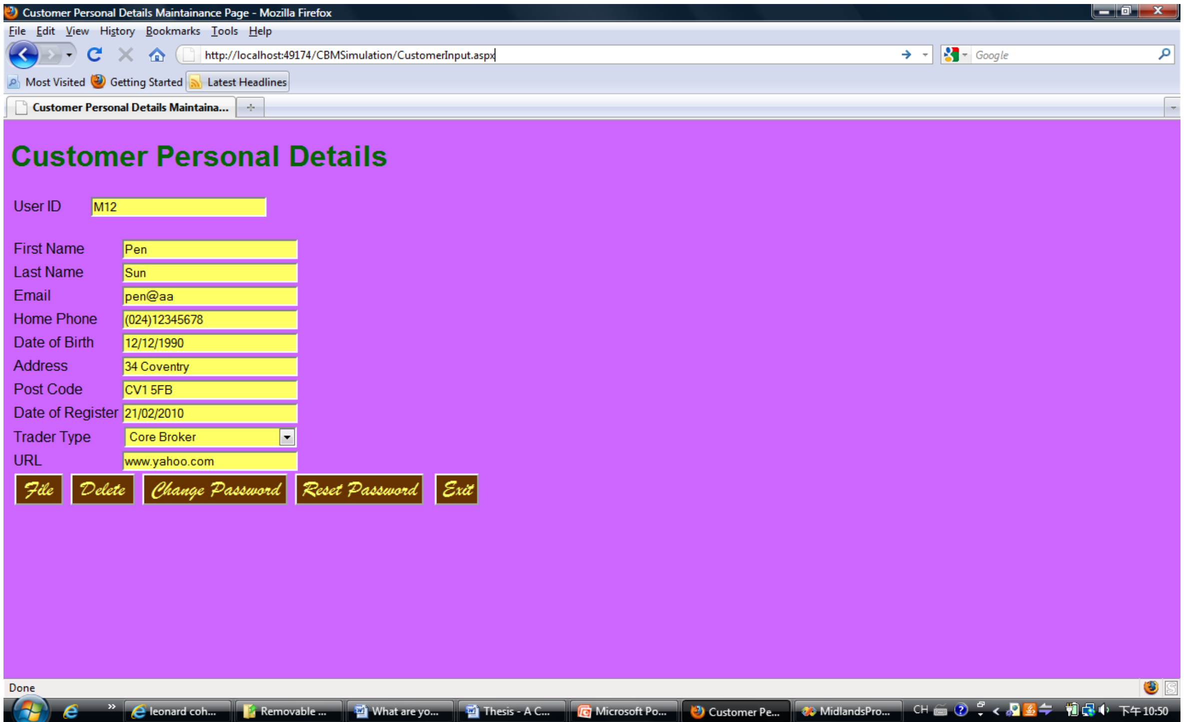


Figure A7.3 2nd Page of Customer Personal Details Maintenance

Table A7.1 Code for Using SQL in a C# Program

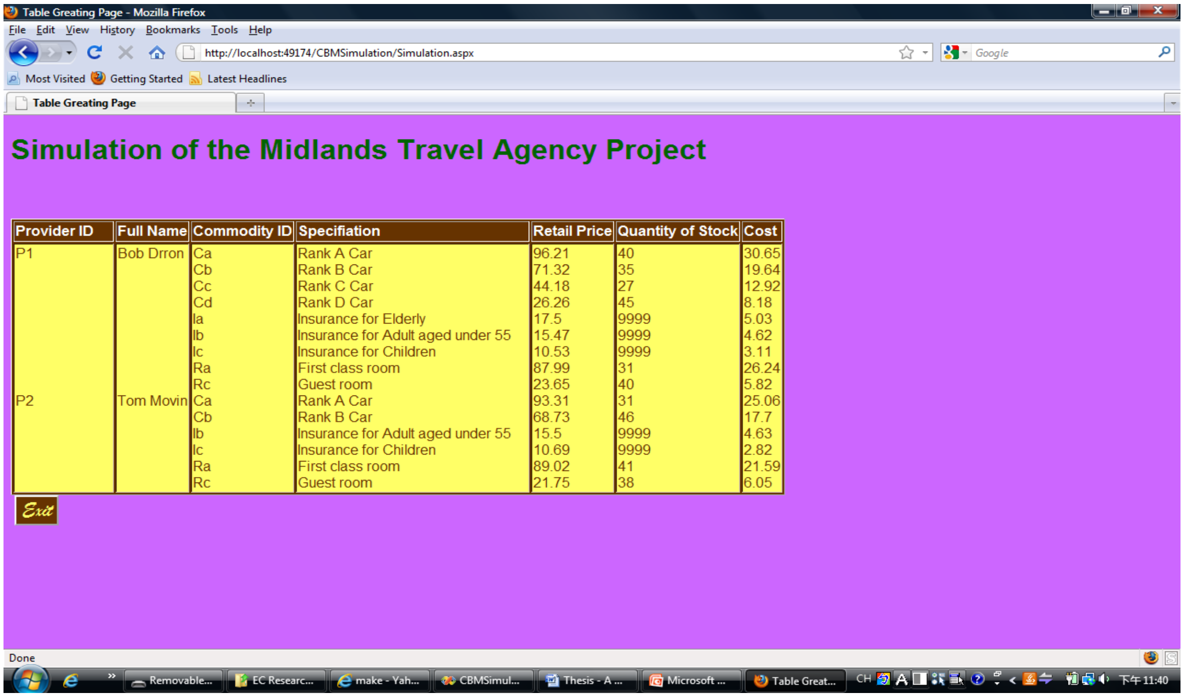
```
protected void TradersAppend_Click(object sender, EventArgs e)
{
  OleDbConnection myConn = new OleDbConnection("Provider=Microsoft.ACE.OLEDB.12.0;Data Source="
      + dSource + "; Persist Security Info=False;");
  LabelErr.Text = "";
  LabelMsg.Text = "";
  myConn.Open();
  string mySQL = "CREATE TABLE Customers (";
  mySQL += "UName VARCHAR(10) PRIMARY KEY, FName CHAR(20), LName CHAR(20), Email
    VARCHAR(30), ";
  mySQL += "Phone VARCHAR(15), DOB VARCHAR(10), Address VARCHAR(30), Postcode VARCHAR(10), ";
  mySQL += "Passwd VARCHAR(30), Mdate VARCHAR(30), Ttype INTEGER, URL VARCHAR(30))";
  OleDbCommand myCmd = new OleDbCommand(mySQL, myConn);
  Try
  {
    myCmd.ExecuteNonQuery();
    LabelMsg.Text = "Customers table is created complete. ";
  }
  catch { }
   mySQL = "DELETE FROM Customers";
  myCmd = new OleDbCommand(mySQL, myConn);
  myCmd.ExecuteNonQuery();
  mySQL = "INSERT INTO Customers (";
  mySQL += "UName, FName, LName, Email, Phone, DOB, Address, Postcode, Passwd, Mdate, Ttype, URL) ";
   mySQL += "VALUES ('M1', 'Bob', 'Delon', 'bob@1224', '(024)77778888', '04/06/1990', '1008 Coventry',
     'CV41 5FF', 'M1', '23/03/2010', 2, 'www.yahoo.com')";
   myCmd = new OleDbCommand(mySQL, myConn);
   myCmd.ExecuteNonQuery();
  LabelMsg.Text = "Customers table is appended with the data successfully.";
  myConn.Close();
}
```

The data can be generated automatically by pushing button 'Append Customers Automatically' and this can be done by executing a C# program. The sample codes in Table A7.1, are a typical example of a program which will perform this kind of task.

When button 'Append Provider's Offers Randomly' is pressed, this generator will create a random amount which will be what the providers offer for each product. The program to generate this is shown in Table A7.2.

Table A7.2 Codes for Generating Provider's Offers Randomly

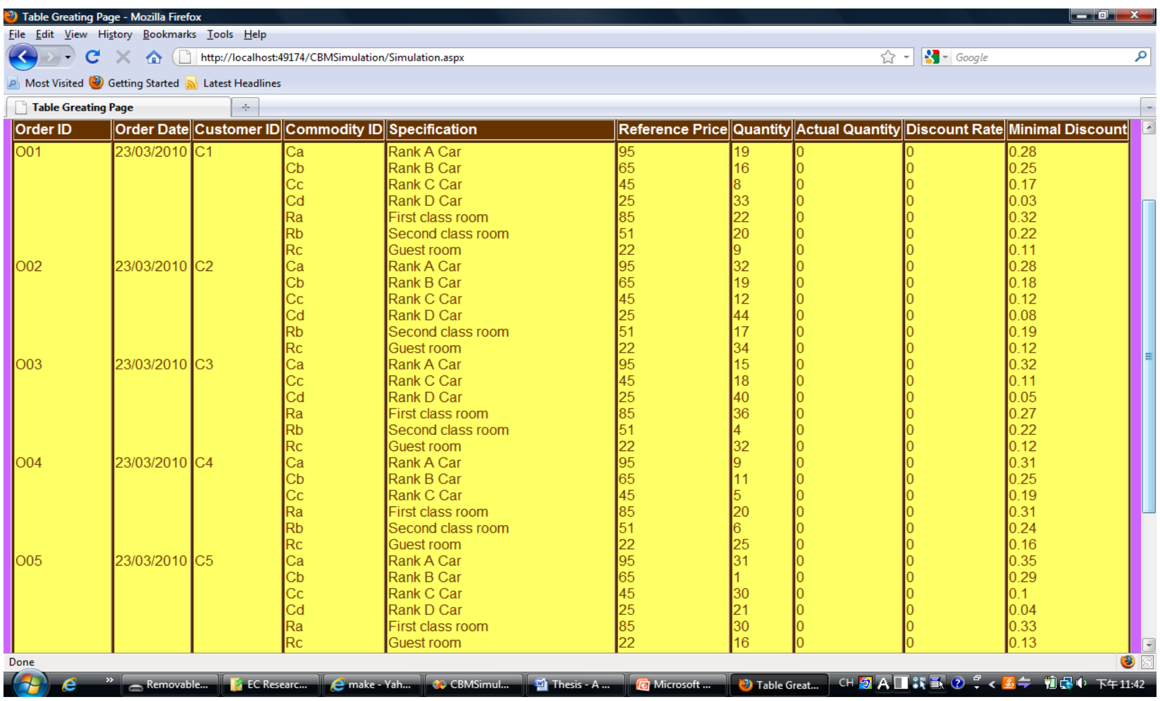
```
protected void ProvidingsRandomAppend_Click(object sender, EventArgs e)
  {
    OleDbConnection myConn = new OleDbConnection("Provider=Microsoft.ACE.OLEDB.12.0;Data Source=" +
       dSource + ";Persist Security Info=False;");
    myConn.Open();
    int providerNo = Convert.ToInt32(TextProviderNo.Text);
    string mySQL = "UPDATE Tradings SET ProviderNo=" + providerNo + " ";
    myCmd = new OleDbCommand(mySQL, myConn);
    myCmd.ExecuteNonQuery();
    Random ran = new Random();
    int loop = ran.Next(0, 50);
    while (loop > 0)  { double diff = ran.Next(0, 100); loop--; }
    for (int i = 0; i < providerNo; i++)
    {
      string pid = "P" + (i + 1).ToString();
      mySQL = "SELECT * FROM  Products";
      myCmd = new OleDbCommand(mySQL, myConn);
      OleDbDataReader myReader = myCmd.ExecuteReader();
      while (myReader.Read())
      {
        string CID = myReader.GetValue(0).ToString();
        double Price = Convert.ToDouble(myReader.GetValue(2));
        int t = Convert.ToInt32(Price * 100);
        double rprice = Price + (ran.Next(t / 15, t / 5) - t / 10) / 100.0;
        double cost = ran.Next(t/4, t/3)/100.0;
        mySQL = "SELECT MAX(Minimum) FROM Margins ";
        mySQL += "WHERE CID='" + myReader.GetValue(0).ToString() + "' ";
        myCmd = new OleDbCommand(mySQL, myConn);
        OleDbDataReader myReadera = myCmd.ExecuteReader();
        myReadera.Read();
        int high = Convert.ToInt32(myReadera.GetValue(0));
        int stock = ran.Next(high * 2 / 7, high);
        myReadera.Close();
        if (myReader.GetValue(0).ToString().Substring(0, 1) == "I")
          if(stock > high / 2) stock = 9999;   else  stock = 0;
        if (stock > high / 2)
        {
          mySQL = "INSERT INTO Providings  (UName, CID, Stock, Rprice, Cost) VALUES ('" + pid + "', '";
          mySQL += CID + "'," + stock + ", " + rprice + ", " + cost + ")";
          myCmd = new OleDbCommand(mySQL, myConn);
          myCmd.ExecuteNonQuery();
        }
      }
      myReader.Close();
    }
    LabelMsg.Text += "The Data is appented into Providings table complete. ";
    myConn.Close();
  }
```



Provider ID	Full Name	Commodity ID	Specification	Retail Price	Quantity of Stock	Cost
P1	Bob Drron	Ca	Rank A Car	96.21	40	30.65
		Cb	Rank B Car	71.32	35	19.64
		Cc	Rank C Car	44.18	27	12.92
		Cd	Rank D Car	26.26	45	8.18
		Ia	Insurance for Elderly	17.5	9999	5.03
		Ib	Insurance for Adult aged under 55	15.47	9999	4.62
		Ic	Insurance for Children	10.53	9999	3.11
		Ra	First class room	87.99	31	26.24
		Rc	Guest room	23.65	40	5.82
P2	Tom Movin	Ca	Rank A Car	93.31	31	25.06
		Cb	Rank B Car	68.73	46	17.7
		Ib	Insurance for Adult aged under 55	15.5	9999	4.63
		Ic	Insurance for Children	10.69	9999	2.82
		Ra	First class room	89.02	41	21.59
		Rc	Guest room	21.75	38	6.05

Figure A7.4 Offers from Two Providers

Assume the number of market-broker, provider and order are 3, 2 and 6 respectively. When 'List Provider's Offers' is executed, the offers from the two providers is shown in Fig. A7.4. The details of the six orders are displayed in Fig. A7.5 after the 'List Orders' button is pushed.



Order ID	Order Date	Customer ID	Commodity ID	Specification	Reference Price	Quantity	Actual Quantity	Discount Rate	Minimal Discount
O01	23/03/2010	C1	Ca	Rank A Car	95	19	0	0	0.28
			Cb	Rank B Car	65	16	0	0	0.25
			Cc	Rank C Car	45	8	0	0	0.17
			Cd	Rank D Car	25	33	0	0	0.03
			Ra	First class room	85	22	0	0	0.32
			Rb	Second class room	51	20	0	0	0.22
			Rc	Guest room	22	9	0	0	0.11
O02	23/03/2010	C2	Ca	Rank A Car	95	32	0	0	0.28
			Cb	Rank B Car	65	19	0	0	0.18
			Cc	Rank C Car	45	12	0	0	0.12
			Cd	Rank D Car	25	44	0	0	0.08
			Rb	Second class room	51	17	0	0	0.19
			Rc	Guest room	22	34	0	0	0.12
O03	23/03/2010	C3	Ca	Rank A Car	95	15	0	0	0.32
			Cc	Rank C Car	45	18	0	0	0.11
			Cd	Rank D Car	25	40	0	0	0.05
			Ra	First class room	85	36	0	0	0.27
			Rb	Second class room	51	4	0	0	0.22
			Rc	Guest room	22	32	0	0	0.12
O04	23/03/2010	C4	Ca	Rank A Car	95	9	0	0	0.31
			Cb	Rank B Car	65	11	0	0	0.25
			Cc	Rank C Car	45	5	0	0	0.19
			Ra	First class room	85	20	0	0	0.31
			Rb	Second class room	51	6	0	0	0.24
			Rc	Guest room	22	25	0	0	0.16
O05	23/03/2010	C5	Ca	Rank A Car	95	31	0	0	0.35
			Cb	Rank B Car	65	1	0	0	0.29
			Cc	Rank C Car	45	30	0	0	0.1
			Cd	Rank D Car	25	21	0	0	0.04
			Ra	First class room	85	30	0	0	0.33
			Rc	Guest room	22	16	0	0	0.13

Figure A7.5 Six Orders

Appendix 8 – Interfaces of the CS

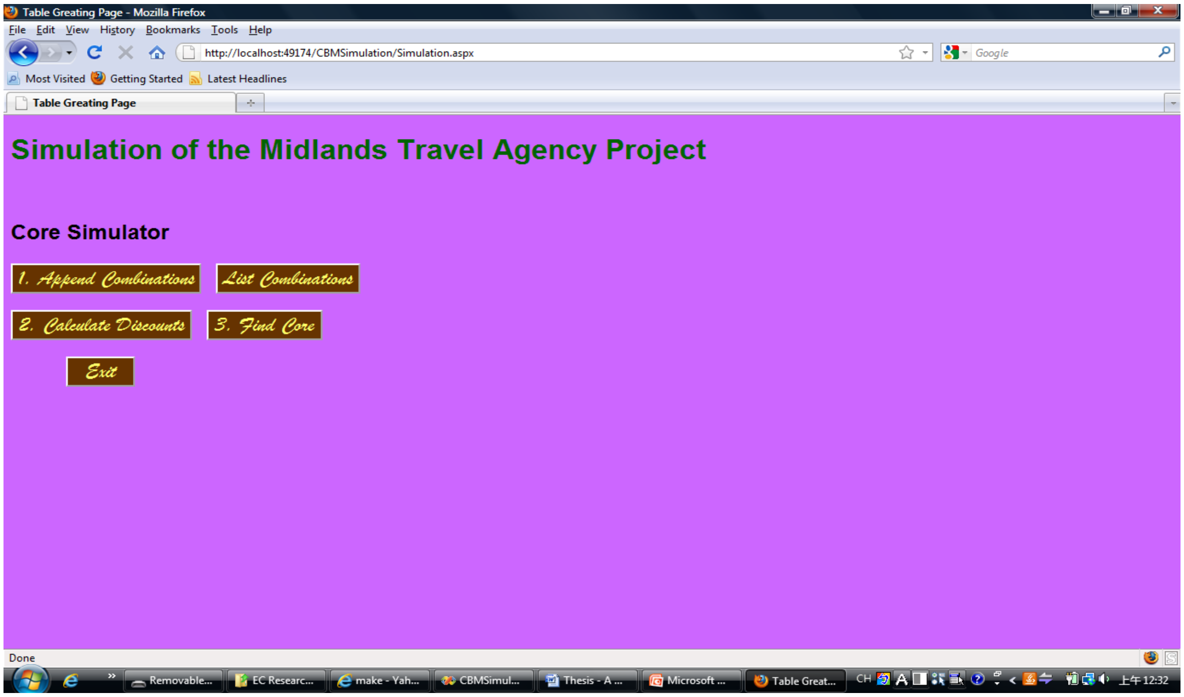


Figure A8.1 Main Menu of the CS

The first step to find the results of the core in the CS is to push button 'Combinations Append' and to store all the possible combinations of providers and customers in tables. If the number of the combination is large, in this stage, it can take long time to complete.

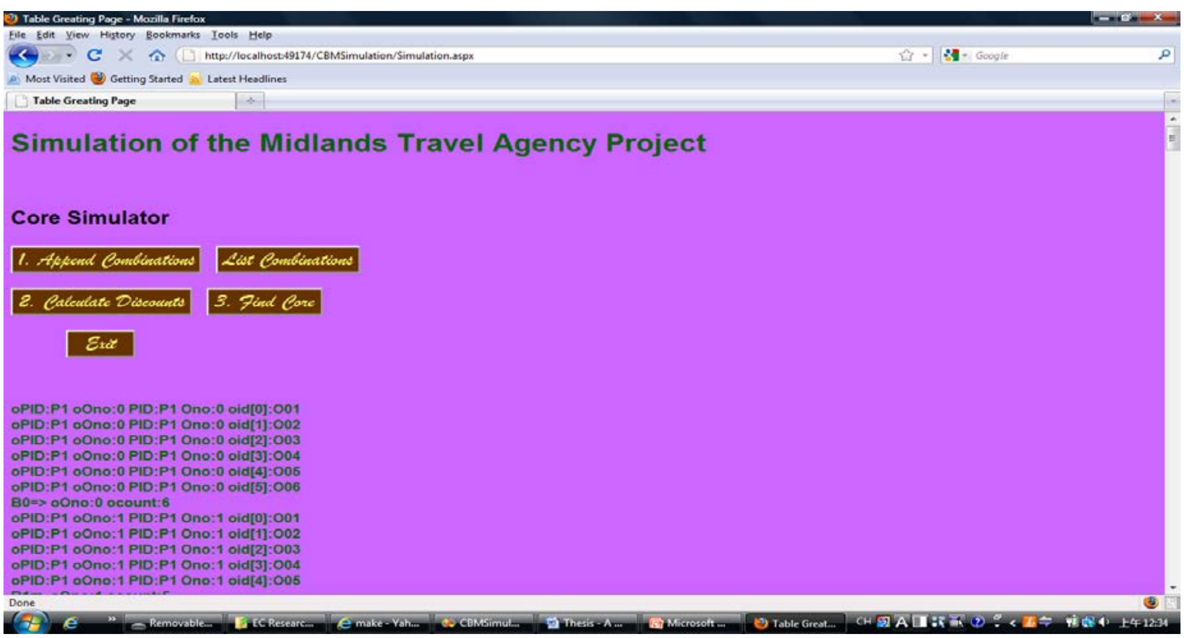
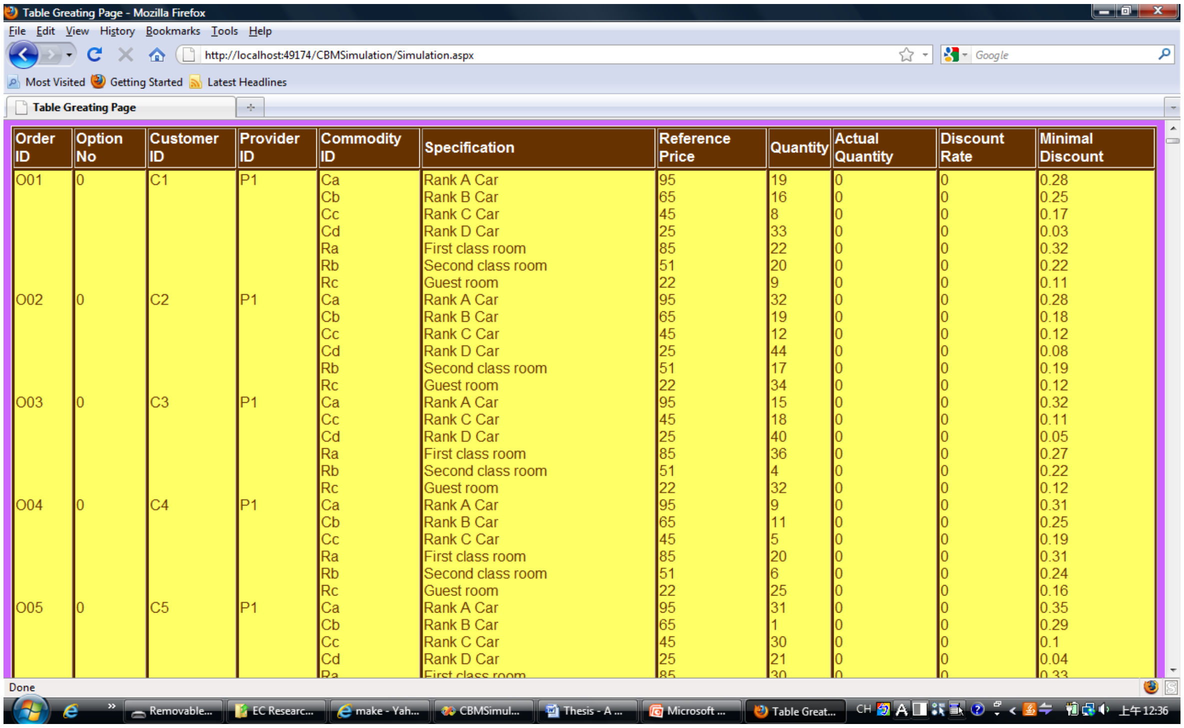


Figure A8.2 'Combination Append' Button

Fig. A8.3 shows all the possible combination by pushing ‘Combination List’ button.



Order ID	Option No	Customer ID	Provider ID	Commodity ID	Specification	Reference Price	Quantity	Actual Quantity	Discount Rate	Minimal Discount
O001	0	C1	P1	Ca	Rank A Car	95	19	0	0	0.28
				Cb	Rank B Car	65	16	0	0	0.25
				Cc	Rank C Car	45	8	0	0	0.17
				Cd	Rank D Car	25	33	0	0	0.03
				Ra	First class room	85	22	0	0	0.32
				Rb	Second class room	51	20	0	0	0.22
				Rc	Guest room	22	9	0	0	0.11
O002	0	C2	P1	Ca	Rank A Car	95	32	0	0	0.28
				Cb	Rank B Car	65	19	0	0	0.18
				Cc	Rank C Car	45	12	0	0	0.12
				Cd	Rank D Car	25	44	0	0	0.08
				Rb	Second class room	51	17	0	0	0.19
				Rc	Guest room	22	34	0	0	0.12
O003	0	C3	P1	Ca	Rank A Car	95	15	0	0	0.32
				Cc	Rank C Car	45	18	0	0	0.11
				Cd	Rank D Car	25	40	0	0	0.05
				Ra	First class room	85	36	0	0	0.27
				Rb	Second class room	51	4	0	0	0.22
				Rc	Guest room	22	32	0	0	0.12
O004	0	C4	P1	Ca	Rank A Car	95	9	0	0	0.31
				Cb	Rank B Car	65	11	0	0	0.25
				Cc	Rank C Car	45	5	0	0	0.19
				Ra	First class room	85	20	0	0	0.31
				Rb	Second class room	51	6	0	0	0.24
				Rc	Guest room	22	25	0	0	0.16
O005	0	C5	P1	Ca	Rank A Car	95	31	0	0	0.35
				Cb	Rank B Car	65	1	0	0	0.29
				Cc	Rank C Car	45	30	0	0	0.1
				Cd	Rank D Car	25	21	0	0	0.04
				Ra	First class room	85	30	0	0	0.33

Figure A8.3 Possible Combinations in the Core

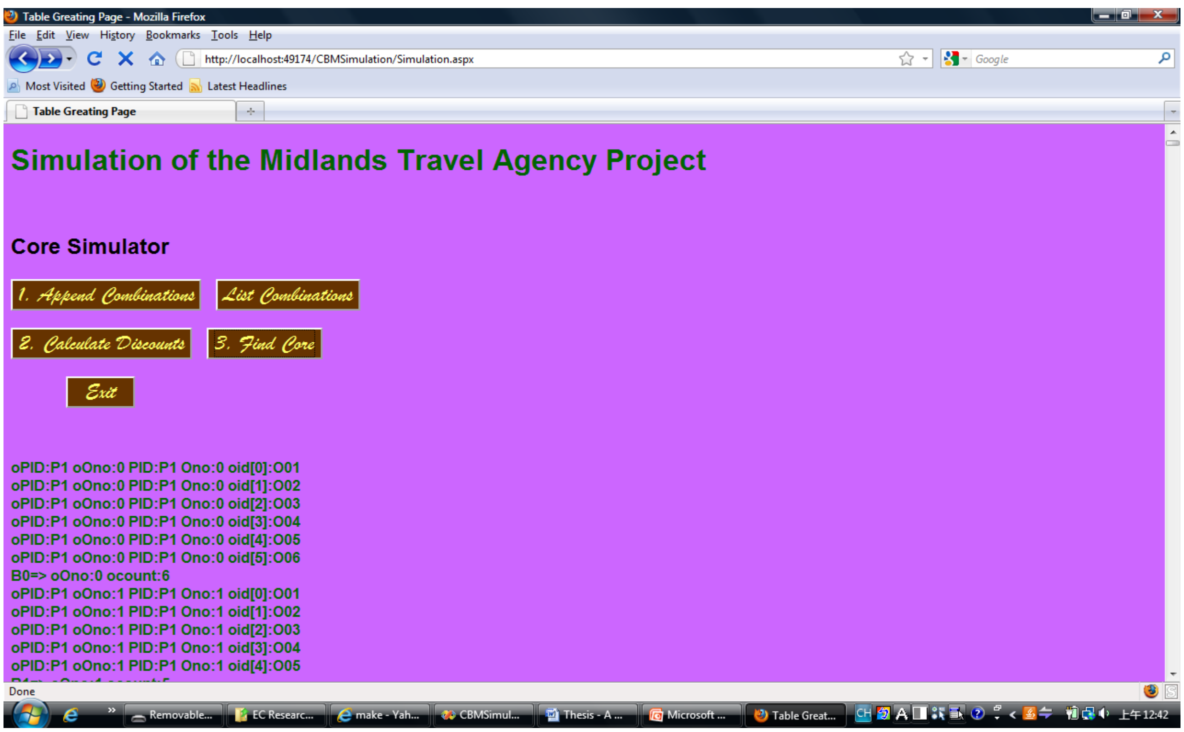
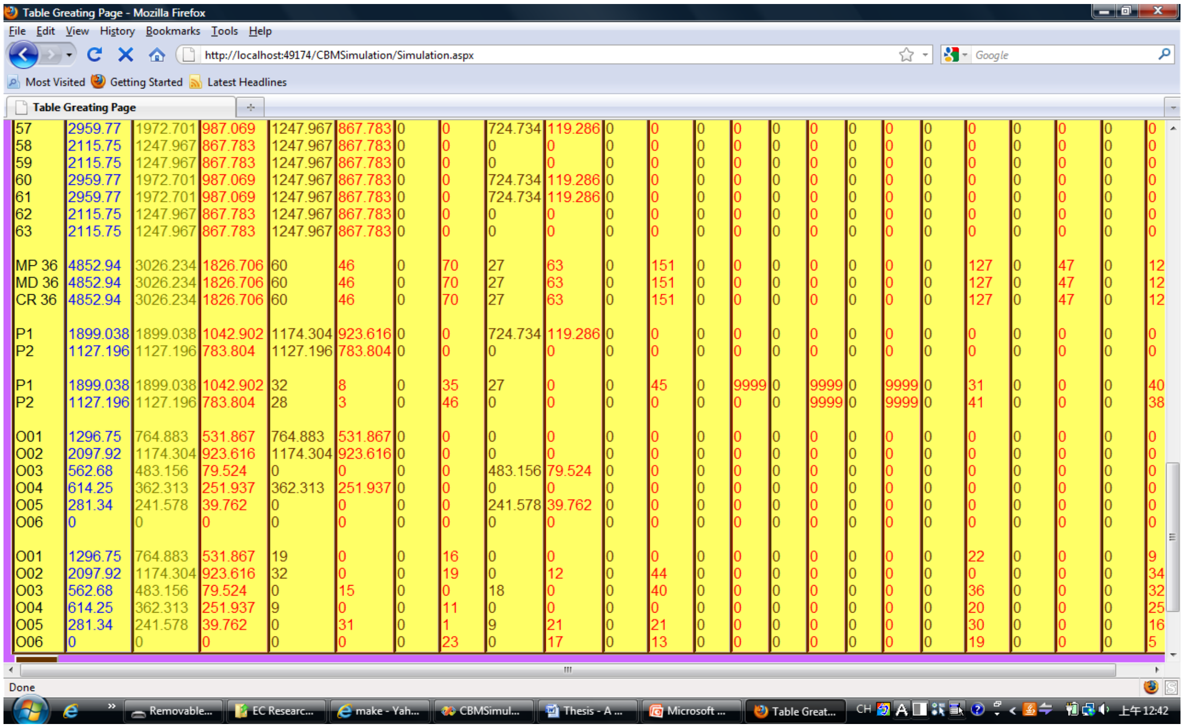


Figure A8.4 ‘Discount Calculate’ Button

The next step is to push ‘Discounts Calculate’ and calculates all the discounts for all the combinations.



57	2959.77	1972.701	987.069	1247.967	867.783	0	0	724.734	119.286	0	0	0	0	0	0	0	0	0	0	0	0	0	0
58	2115.75	1247.967	867.783	1247.967	867.783	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
59	2115.75	1247.967	867.783	1247.967	867.783	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
60	2959.77	1972.701	987.069	1247.967	867.783	0	0	724.734	119.286	0	0	0	0	0	0	0	0	0	0	0	0	0	0
61	2959.77	1972.701	987.069	1247.967	867.783	0	0	724.734	119.286	0	0	0	0	0	0	0	0	0	0	0	0	0	0
62	2115.75	1247.967	867.783	1247.967	867.783	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
63	2115.75	1247.967	867.783	1247.967	867.783	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
MP 36	4852.94	3026.234	1826.706	60	46	0	70	27	63	0	151	0	0	0	0	0	0	0	127	0	47	0	12
MD 36	4852.94	3026.234	1826.706	60	46	0	70	27	63	0	151	0	0	0	0	0	0	0	127	0	47	0	12
CR 36	4852.94	3026.234	1826.706	60	46	0	70	27	63	0	151	0	0	0	0	0	0	0	127	0	47	0	12
P1	1899.038	1899.038	1042.902	1174.304	923.616	0	0	724.734	119.286	0	0	0	0	0	0	0	0	0	0	0	0	0	0
P2	1127.196	1127.196	783.804	1127.196	783.804	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
P1	1899.038	1899.038	1042.902	32	8	0	35	27	0	0	45	0	9999	0	9999	0	9999	0	31	0	0	0	40
P2	1127.196	1127.196	783.804	28	3	0	46	0	0	0	0	0	0	0	9999	0	9999	0	41	0	0	0	38
O01	1296.75	764.883	531.867	764.883	531.867	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
O02	2097.92	1174.304	923.616	1174.304	923.616	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
O03	562.68	483.156	79.524	0	0	0	0	483.156	79.524	0	0	0	0	0	0	0	0	0	0	0	0	0	0
O04	614.25	362.313	251.937	362.313	251.937	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
O05	281.34	241.578	39.762	0	0	0	0	241.578	39.762	0	0	0	0	0	0	0	0	0	0	0	0	0	0
O06	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
O01	1296.75	764.883	531.867	19	0	0	16	0	0	0	0	0	0	0	0	0	0	0	22	0	0	0	9
O02	2097.92	1174.304	923.616	32	0	0	19	0	12	0	44	0	0	0	0	0	0	0	0	0	0	0	34
O03	562.68	483.156	79.524	0	15	0	0	18	0	0	40	0	0	0	0	0	0	0	36	0	0	0	32
O04	614.25	362.313	251.937	9	0	0	11	0	0	0	0	0	0	0	0	0	0	0	20	0	0	0	25
O05	281.34	241.578	39.762	0	31	0	1	9	21	0	21	0	0	0	0	0	0	0	30	0	0	0	16
O06	0	0	0	0	0	0	23	0	17	0	13	0	0	0	0	0	0	0	19	0	0	0	5

Figure A8.5 The Core

A core can be found by pressing ‘Find Core’. In Fig. A8.5, the results reveal that combination 36 is the core. Its profit for the providers is £3026.23 and its discount for the customers is £1826.71. The profits for P1 and P2 are £1899.04 and £1127.20 respectively. The discounts for O01, O02, O03, O04, O05 and O06 are £532.87, £923.62, £79.52, £251.94, £241.58 and 0 respectively.

The number of items sold is shown opposite where the pair ‘P1 and P2’ is listed for the second time in Fig A8.5. When the group ‘O01, O02, O03, O04, O05 and O06’ is mentioned for the second time in same figure, the number of product purchased by every order is shown opposite.

Appendix 9 – Interfaces of the CBMS

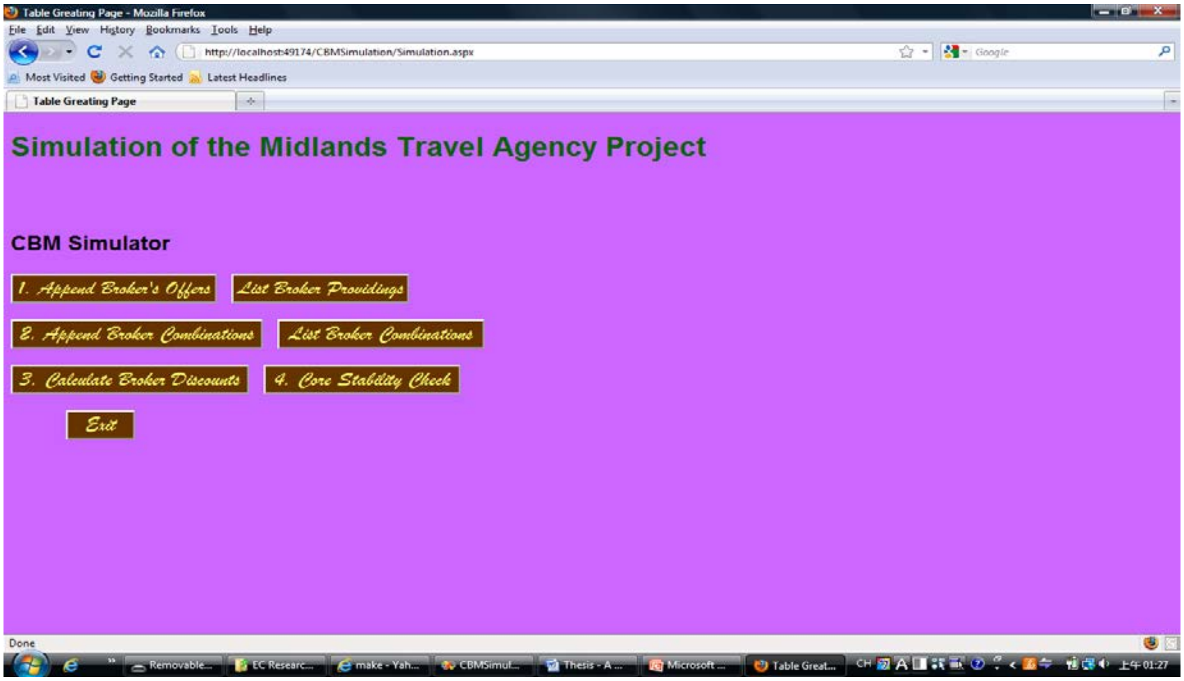


Figure A9.1 Main Menu of the CBMS

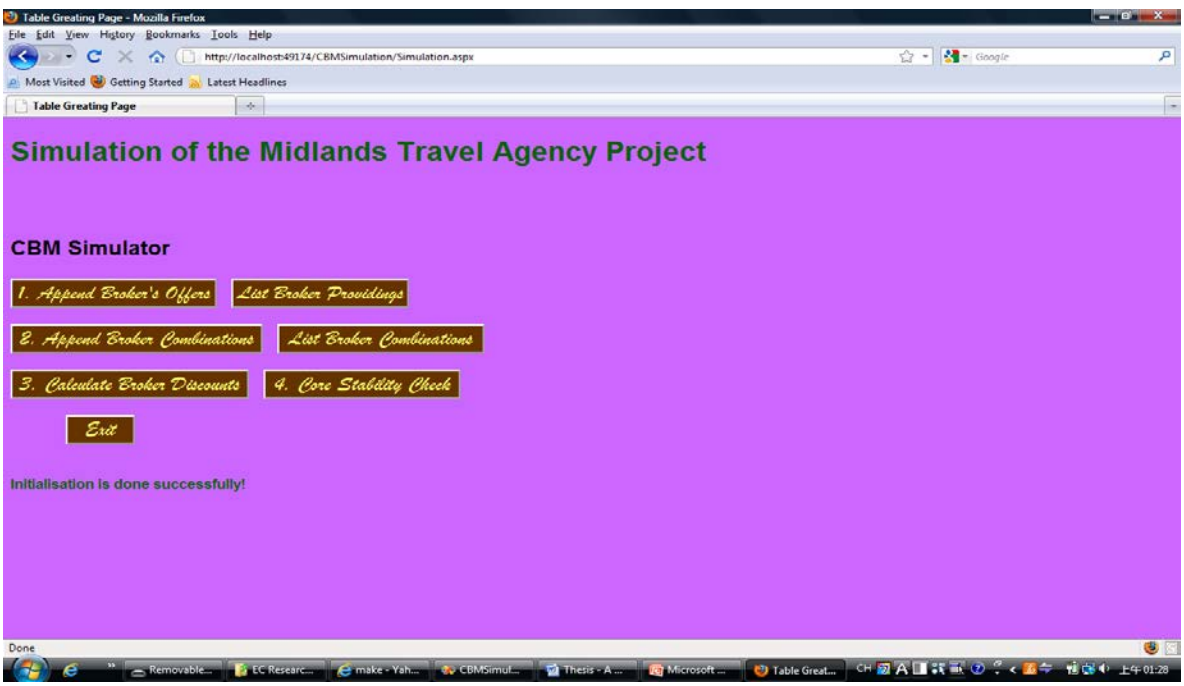


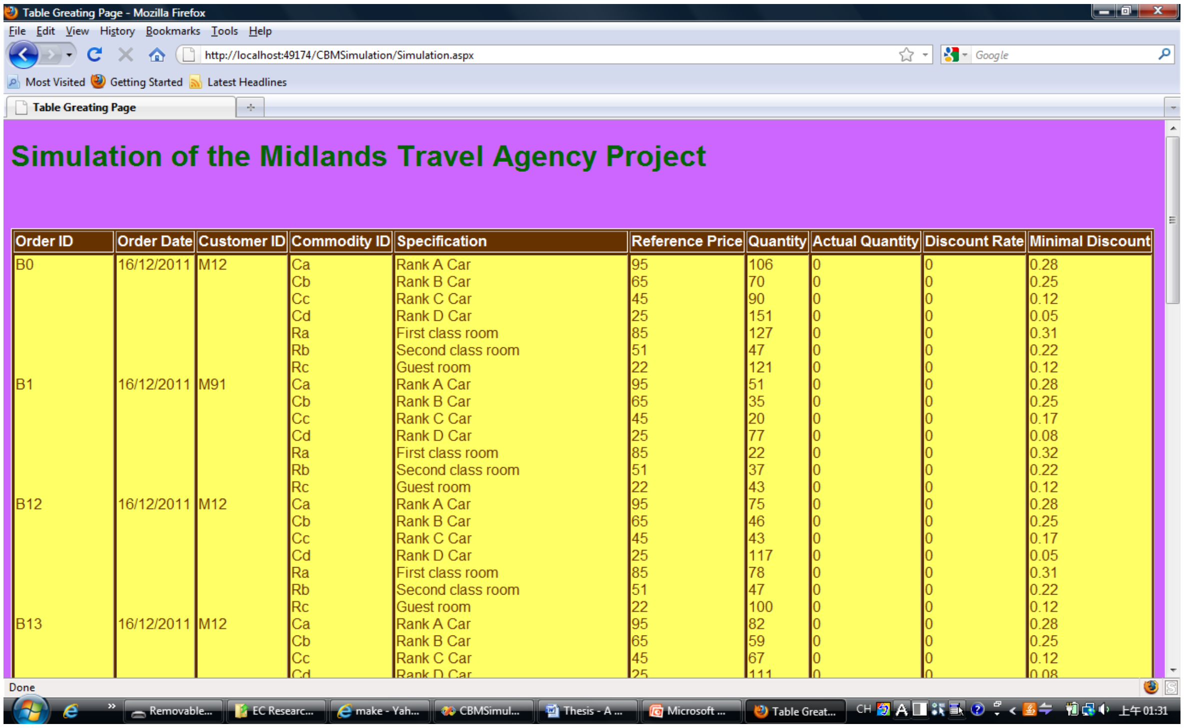
Figure A9.2 ‘Broker Providing Append’ Button

In order to perform joint-selling in this case, the products for sale have to be channelled through core-broker Pen and let him be the only provider to customers in the first stage of the CBMS. In Fig. A9.2, button 'Append Broker Offers' can accomplish this task for users. In Fig. A9.3, Pen has put all the providers' offers together. The retail price for each product is the average of the providers' retail prices and the cost is derived in the same way.

Figure A9.3 Core-broker Pen

Figure A9.4 'Core Combinations Append' Button

The second step is to push the ‘Append Broker Combinations’ Button in Fig. A9.4 and the resulting combinations are shown in Fig. A9.5. Because customers are performing group-buying here, many orders are combined so that the items can be purchased on a wholesale basis.



Order ID	Order Date	Customer ID	Commodity ID	Specification	Reference Price	Quantity	Actual Quantity	Discount Rate	Minimal Discount
B0	16/12/2011	M12	Ca	Rank A Car	95	106	0	0	0.28
			Cb	Rank B Car	65	70	0	0	0.25
			Cc	Rank C Car	45	90	0	0	0.12
			Cd	Rank D Car	25	151	0	0	0.05
			Ra	First class room	85	127	0	0	0.31
			Rb	Second class room	51	47	0	0	0.22
			Rc	Guest room	22	121	0	0	0.12
B1	16/12/2011	M91	Ca	Rank A Car	95	51	0	0	0.28
			Cb	Rank B Car	65	35	0	0	0.25
			Cc	Rank C Car	45	20	0	0	0.17
			Cd	Rank D Car	25	77	0	0	0.08
			Ra	First class room	85	22	0	0	0.32
			Rb	Second class room	51	37	0	0	0.22
			Rc	Guest room	22	43	0	0	0.12
B12	16/12/2011	M12	Ca	Rank A Car	95	75	0	0	0.28
			Cb	Rank B Car	65	46	0	0	0.25
			Cc	Rank C Car	45	43	0	0	0.17
			Cd	Rank D Car	25	117	0	0	0.05
			Ra	First class room	85	78	0	0	0.31
			Rb	Second class room	51	47	0	0	0.22
			Rc	Guest room	22	100	0	0	0.12
B13	16/12/2011	M12	Ca	Rank A Car	95	82	0	0	0.28
			Cb	Rank B Car	65	59	0	0	0.25
			Cc	Rank C Car	45	67	0	0	0.12
			Cd	Rank D Car	25	111	0	0	0.08

Figure A9.5 Possible Combinations in the CBM

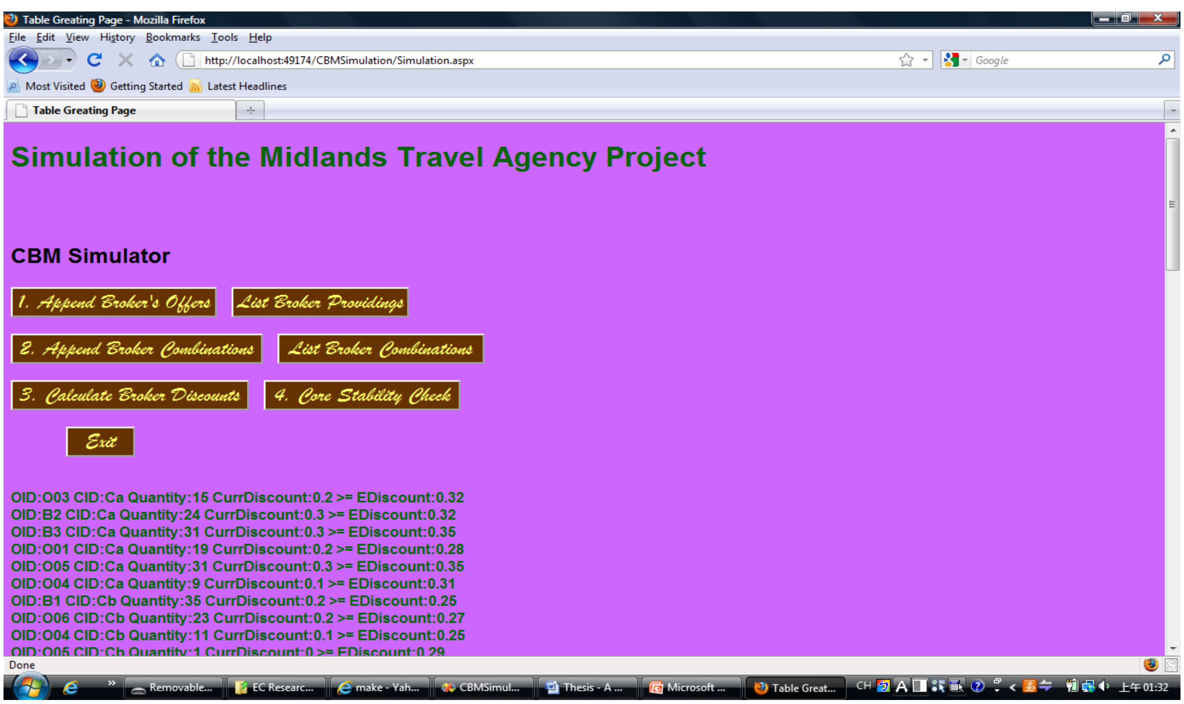
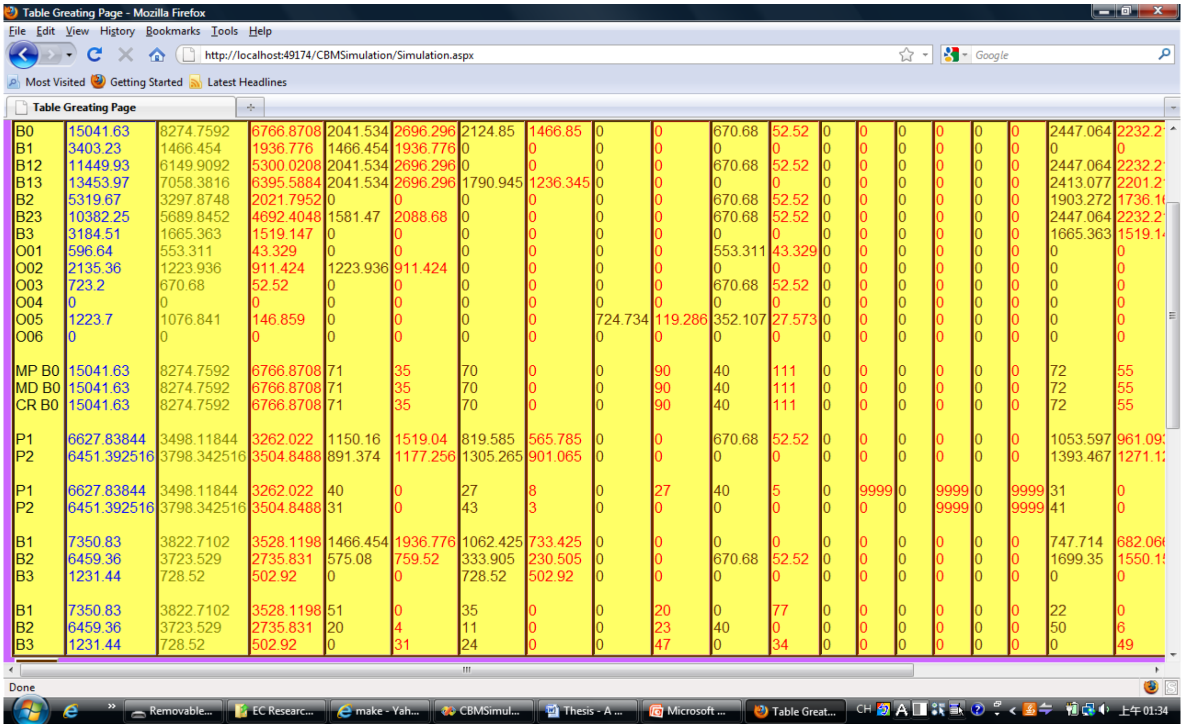


Figure A9.6 Calculate Discounts for the Possible Combinations

The third step is to push the 'Calculate Discounts' button and this will calculate the discounts for all the orders including the original and the combined ones.



B0	15041.63	8274.7592	6766.8708	2041.534	2696.296	2124.85	1466.85	0	0	670.68	52.52	0	0	0	0	0	0	2447.064	2232.2
B1	3403.23	1466.454	1936.776	1466.454	1936.776	0	0	0	0	0	0	0	0	0	0	0	0	0	0
B12	11449.93	6149.9092	5300.0208	2041.534	2696.296	0	0	0	0	670.68	52.52	0	0	0	0	0	0	2447.064	2232.2
B13	13453.97	7058.3816	6395.5884	2041.534	2696.296	1790.945	1236.345	0	0	0	0	0	0	0	0	0	0	2413.077	2201.2
B2	5319.67	3297.8748	2021.7952	0	0	0	0	0	0	670.68	52.52	0	0	0	0	0	0	1903.272	1736.1
B23	10382.25	5689.8452	4692.4048	1581.47	2088.68	0	0	0	0	670.68	52.52	0	0	0	0	0	0	2447.064	2232.2
B3	3184.51	1665.363	1519.147	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1665.363	1519.1
O01	596.64	553.311	43.329	0	0	0	0	0	0	553.311	43.329	0	0	0	0	0	0	0	0
O02	2135.36	1223.936	911.424	1223.936	911.424	0	0	0	0	0	0	0	0	0	0	0	0	0	0
O03	723.2	670.68	52.52	0	0	0	0	0	0	670.68	52.52	0	0	0	0	0	0	0	0
O04	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
O05	1223.7	1076.841	146.859	0	0	0	0	724.734	119.286	352.107	27.573	0	0	0	0	0	0	0	0
O06	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
MP B0	15041.63	8274.7592	6766.8708	71	35	70	0	0	90	40	111	0	0	0	0	0	0	72	55
MD B0	15041.63	8274.7592	6766.8708	71	35	70	0	0	90	40	111	0	0	0	0	0	0	72	55
CR B0	15041.63	8274.7592	6766.8708	71	35	70	0	0	90	40	111	0	0	0	0	0	0	72	55
P1	6627.83844	3498.11844	3262.022	1150.16	1519.04	819.585	565.785	0	0	670.68	52.52	0	0	0	0	0	0	1053.597	961.09
P2	6451.392516	3798.342516	3504.8488	891.374	1177.256	1305.265	901.065	0	0	0	0	0	0	0	0	0	0	1393.467	1271.1
P1	6627.83844	3498.11844	3262.022	40	0	27	8	0	27	40	5	0	9999	0	9999	0	9999	31	0
P2	6451.392516	3798.342516	3504.8488	31	0	43	3	0	0	0	0	0	0	0	9999	0	9999	41	0
B1	7350.83	3822.7102	3528.1198	1466.454	1936.776	1062.425	733.425	0	0	0	0	0	0	0	0	0	0	747.714	682.06
B2	6459.36	3723.529	2735.831	575.08	759.52	333.905	230.505	0	0	670.68	52.52	0	0	0	0	0	0	1699.35	1550.1
B3	1231.44	728.52	502.92	0	0	728.52	502.92	0	0	0	0	0	0	0	0	0	0	0	0
B1	7350.83	3822.7102	3528.1198	51	0	35	0	0	20	0	77	0	0	0	0	0	0	22	0
B2	6459.36	3723.529	2735.831	20	4	11	0	0	23	40	0	0	0	0	0	0	0	50	6
B3	1231.44	728.52	502.92	0	31	24	0	0	47	0	34	0	0	0	0	0	0	0	49

Figure A9.7 The Stable Set and Profit for Providers

The stable set can be found by executing 'Core Stability Check'. The CS and the CBMS are using the same data – the same providers' offers and the same customers' orders. The results of both simulations can therefore be compared. In Fig. A9.7, combined order 'B0' is the new stable set. Its profit for the providers is £8274.76 and its discount for the customers is £6766.87, which are much better than those that the core produces.

The total discounts for each market-broker's group depend on the products they purchase. In Fig. A9.7, opposite where the group 'B1, B2 and B3' is first mentioned, the discount for each product can be found, and when 'B1, B2 and B3' is repeated below that, the figure shows the number of items that the group gets.

There are only two providers. The number of items sold is shown opposite where the pair 'P1 and P2' is listed for the second time in Fig. A9.7. Opposite the first mention of the pair 'P1 and P2' in the same figure, the total benefits and the individual profits and discounts for each product are shown, after they have been fairly distributed by using Shapley value. Table A9.1 shows the codes used to calculate Shapley value.

Table A9.1 Codes for Calculating Shapley Value

```
public double[] ShapleyValue(int mcount, double[] contribution)
  {
    int Size = Convert.ToInt32(Math.Pow(2, mcount)); // Size = 2 ^ mcount
    int[] setsize = new int[Size];
    double[] coeff = new double[Size];
    double[] sum = new double[mcount];
    // generate setsize[], coeff[] and oid[,]
    setsize[0] = 0;
    coeff[0] = 0;
    setsize[Size - 1] = mcount;
    //coeff[i]=(setsize[i]-1)!*(mcount-setsize[i])!/mcount!
    coeff[Size - 1] = Factorial(setsize[Size - 1] - 1) * Factorial(mcount - setsize[Size - 1]) /
        Convert.ToDouble(Factorial(mcount));
    for (int i = 1; i < Size - 1; i++)
    {
      setsize[i] = 0;
      for (int j = 1; j <= mcount; j++)
      {
        int temp = i / (int)Math.Pow(2, j - 1);
        if (temp % 2 == 1)
          setsize[i]++;
      }
      coeff[i] = Factorial(setsize[i] - 1) * Factorial(mcount - setsize[i]) / Convert.ToDouble(Factorial(mcount));
    }
    // calcute Shapley Value
    for (int i = 0; i < mcount; i++)
    {
      sum[i] = 0;
      for (int j = 1; j < Size; j++)
      {
        double output = 0;
        int k = j / Convert.ToInt32(Math.Pow(2, i));
        if (k % 2 == 1)
          output = contribution[j] - contribution[j - Convert.ToInt32(Math.Pow(2, i))];
        //LabelMsg.Text += "i:" + i.ToString() + " j:" + j.ToString() + " output:" + output.ToString() + "<br/>";
        sum[i] += coeff[j] * output;
      }
    }
    return sum;
  }
```

Appendix 10 Published Papers Relating to the CBM

This section has been removed due to third party copyright. It consists of copies of the following papers. The unabridged version of the thesis can be viewed at the Lanchester Library, Coventry University.

Sun, P., *et al.* (2006) 'Core-based Agent for Service-Oriented Market.' In Lee, T. and Zhou, M. (ed.) *Proceedings of 2006 IEEE International Conference on Systems, Man, and Cybernetics (SMC'06).* Held 8-11 October at The Grand Hotel, Taipei, Taiwan. Piscataway, New Jersey: the IEEE Inc.: 2970-2975

Sun, P., *et al.* (2009) 'Extended Core for E-Markets.' In Isaias, P., White, B. and Nunes, M. B. (ed.) *Proceedings of IADIS International Conference WWW/Internet 2009* Held 19-22 November at Rome, Italy : IADIS Press: 437-444

Sun, P., *et al.* (2012 a) 'A Core Broking Model for E-Markets.' In *Proceedings of The 9th IEEE International Conference on e-Business Engineering* (*ICEBE 2012)* Held 9-11 September at Zhejiang University, Hangzhou, China: IEEE Press: 78-85 (19.7% acceptance rate)

Sun, P., Odetayo, M., Iqbal, R., & James A. (2012 b) 'Evaluations of A Core Broking Model from the Viewpoint of Online Group Trading.' In *Proceedings of The IEEE International Conference on Industrial Engineering and Engineering Management (IEEM 2012)* Held 10-13 December at Hong Kong Convention and Exhibition Centre, Hong Kong, IEEE Press: 1964-1968