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# Evaluation of intelligent agents in consumer-to-business e-Commerce

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ABSTRACT

Electronic commerce has changed traditional business trading behaviors, since consumers can easily consume through the Internet e-commerce platform. The Internet provides numerous products and services, but consumers find it is hard to choose their favorite ones. The consumer-to-business (C2B) is popular in recent years and it has become one of the best choices for customers forming a group to buy products. Thus, more and more consumers participate in online group buying. However, consumers anticipate to different prices when buying products and demand service. Thus, applying an intelligent agent into negotiation can effectively decrease efforts spent on collecting buyer information, transaction costs, and negotiation with sellers.

This study proposed a system that applies an intelligent agent into the C2B e-commerce process, and evaluates the system through an experiment. Additionally, a questionnaire is used to investigate the benefits of the proposed intelligent agent systems. Analytical results show that the proposed intelligent system can increase user satisfaction, reduce performance risk, and raise perceived fairness, but nothing help on perceived value. It implied that the system still needs efforts and time to promote in nowadays commerce. If people can understand its value from finding the information they need, it must grant the more perceived value. Additionally, this system is not only applicable to C2B, but it can extend to other e-commerce models, because the agent can help the negotiation between the sellers and buyers.

## 1. Introduction

According to Gartner [23], online consumers' expectations are continuing to increase in the last past years. These heightened consumer expectations have increased the complexity of online systems that businesses need to operate. In order to retain their consumers, online businesses need to redefine strategies to meet consumers' expectations [69]. Since the group-buying C2B model is a popular e-commerce model [8,86], identifying a group of consumer preferences is a key challenge in customizing e-commerce sites to fit individual user's needs [7,28,35]. Different uncertainties arise in relation to the efficacy of various aspects of the mechanisms which affect the willingness of consumers to participate [19]. In nowadays e-commerce, group-buying is a popular way in the C2B market [8,86]. Of course, customers can use a convenient search engine to find valuable comments, price, and even the risk. However, it still needs to filter the collecting information to make the decision in a fierce auction. Therefore, the agent is important to help the decision in such a situation.

Intelligent agents are computer programs that assist human decision-making [47,62]. An intelligent agent can enhance the effectiveness of users in searching, negotiation, and trading transactions [31]. Negotiation is an inseparable component of many ecommerce activities involving pricing, auctions, scheduling, and contracting. Negotiation is an area that can greatly benefit from automation [46]. In a price negotiation, a seller utilizes selling strategies to maximum his/her benefit [49]. By the application of agent technology and system specific combination, it will give full play to autonomy, flexibility, reactivity and initiative characteristics of agent technology, which can do well in the electronic commerce transaction negotiation process in a task [45]. However, if an agent system does not show its expected functionality, the system efficiency may be relatively low. Thus, this study presents an agent-based negotiation model for C2B commerce and uses a questionnaire to investigate the benefits of the proposed intelligent agent system. The contribution from this paper is threefold; first, an intelligent agent into the C2B e-commerce process is proposed. Secondly, a C2B e-commerce platform is built to collect experimental data and investigate the benefits. Last but not least, the proposed intelligent system can increase user satisfaction, reduce performance risk, and raise perceived fairness.

The rest of this paper is organized as follows. Section 2 reviews

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relevant literature. Section 3 shows the proposed model. Section 4 illustrates the example. Section 5 then details the research methodology and the proposed questionnaire. Next, Section 6 summarizes the survey results. Implications are discussed in Section 7. Conclusions are finally drawn in Section 8.

## 2. Literature review

### 2.1. C2B e-commerce

With the rapid development of e-commerce, online group buying has become a common and important sales channel for service providers [81]. Online group buying is considered to be a unique, innovative, and particularly interesting online consumer-to-business (C2B) business model because it enables buyers to obtain volume discounts and helps sellers to effectively sell a considerable number of items [38]. The increase in products offered and purchased through online group buying websites indicates the strong potential for e-commerce through online group buying. A compound annual growth rate of 35.1% between 2011 and 2015 is representing [48]. Online group buying is a global phenomenon due to its immense popularity and widely accepted contemporary shopping practice around the world [6,32,67]. The primary value proposition of online group buying to consumers is making a deal at a lower price by connecting and uniting individuals who share the same needs on certain products/services in a specific timeframe via the Internet to use their collective bargaining power to negotiate with the sellers and thus get volume discounts that were traditionally the privilege of bulk buyers [77]. Identifying consumer preferences is a key challenge in customizing electronic commerce sites to individual users [28]. Collective purchasing is sometimes referred to as a buyer coalition model, in which multiple buyers cooperate together to get a better price for a specific product or service [30]. Personalization of product information has become one of the most important factors impacting customers' product selection and satisfaction in today's competitive market [36].

Demand aggregation in group-buying benefits sellers by offering lower marketing costs and coordinated distribution channels, as well as buyers, who enjoy lower costs for product purchases [44]. Collective purchasing is not new to the traditional business. This type of purchasing is a well-known consumer behavior in traditional business; however, it is new to the electronic commerce market [13]. Yuan & Lin's approach [85] extended the concept of group buying to group selling and consequently enhances the market function. Doong et al. [19] proposed most observers of group-buying auction mechanisms agree that there are different uncertainties that arise related to the efficacy of various aspects of mechanisms which may affect the willingness of consumers to participate. The Internet provides a powerful tool for demand aggregation and hence is a natural platform for facilitating group-buying. It is thus not surprising that online group-buying has been perceived as one of the most innovative business models of e-commerce, and has been employed by many companies. Since group-buying is driven by the demand of buyers, improving the satisfaction of buyers is an essential part of the group-buying model [44].

In online group-buying auctions, in contrast to traditional auctions, cooperation results in higher welfare, leading to market expansion which benefits buyers and sellers, as well as the auction intermediary. Chen et al. [10] proposed a buyer collection purchasing model in 2008 for consumer-to-business electronic commerce which uses a laptop computer purchasing case as an example. Compared with other incentive mechanisms, a sequence-based incentive mechanism gives consumers a sense of less procedural fairness [38]. Chen et al. [12] obtained additional results for the case of continuous demand and found that there is a basis for sellers to improve revenues via effective group-buying auction price. The most recent technological innovations in group-buying market mechanisms seem to emphasize the unification of electronic and physical world operations, and providing consumers with the means to process auction information [22]. Yang et al. [82] defined the lens of website quality attributes on consumer participation, electronic word of mouth, and co-shopping, whereas Wang et al. [77] explained stickiness intention in online group buying using the commitment-trust theory. Shi and Liao [65] elucidated the magnitude of online group buying participation as a result of consumer beliefs of online consumer reviews. Moreover, Chang [9] accentuated the difference between fluency and disfluency conditions on online group buying conforming behavior. In sum, the aforementioned studies on online auctions and the design of effective transaction-making mechanisms have shown that negotiation between sellers and buyers is gradually becoming more important.

### 2.2. Intelligent agents

In a nutshell, an intelligent agent can be seen as a software and/or hardware component of a system capable of acting exactingly in order to accomplish tasks on behalf of its users [75]. Intelligent agent software is computer programs that act to assist human decision making behavior [31]. Software agents are flexible, autonomous, and dynamic computational entities [78]. Sycara et al. [72] precisely described intelligent software agents as programs acting on behalf of their human users to perform laborious information-gathering tasks.

Recently, there has been a wide range of research discussing intelligent agents, for example, Wen proposed a knowledge-based intelligent electronic commerce system for selling agricultural products [79]. Biswas recommended an agent-oriented model providing a new technique for the conceptualization of agent-based systems and concluded with a case study and insight about future challenges [4]. The Agent-oriented model presents a new conceptual model for developing software systems that are open, intelligent, and adaptive [68]. Another study used a multi-agent based simulation tool and simulation methodology to evaluate the efficiency and effectiveness of a collaborative system by analyzing both the global system of each of the strategies or mechanisms involved in the system [39]. Chen et al. [10] integrated mobile agent technology with multi-agent systems for distributed traffic detection and management systems. Renna and Argoneto [60] presented an innovative approach, based on a multi-agent system, and a concerning simulation test-bed conducted to demonstrate, in a quantitative way, the advantages of adopting the proposed approach. Chou et al. [15] presented the application of a Mobile-C library illustrated by the dynamic runtime control of a mobile robot's behavior using mobile agents.

As electronic commerce becomes popular, the role of automated negotiation systems is expected to increase [64]. Negotiation is an effective communication approach to solving transaction conflicts and making better deals between trading entities in the commerce world [76]. Usually, a research aims at designing automated multi-issue negotiation models and tractable negotiation strategies, often applying utility heuristic or learning methods in this respect [54]. Price negotiation is an important mechanism for determining the trading price between a seller and a buyer. In a price negotiation, a seller utilizes his/her selling strategy to get the best trading price (the highest price) [49]. Chen et al. [10] recommend an agent-based model for consumer-to-business electronic commerce which uses a laptop computer purchasing case as an example; their case is created to demonstrate the idea and show how the model works. Huang et al. [31] presented the agent-based negotiation process for B2C e-commerce; they use an example of notebooks to illustrate the purchasing process. Louta presented their results to evaluate a negotiation model and strategies [54]. Wang et al. [76] processed a computational method for agent-base e-commerce negotiations with adaptive negotiation behaviors. Palopoli et al. [57] presented distributed test bed architecture for e-Commerce recommender systems using a multi-tiered agent-based approach to generate effective recommendations without requiring such an onerous amount of computation per single client. An e-order fulfillment preprocessing system is proposed, which highlights the importance of using the genetic algorithm approach as the core means of tackling the common operational bottlenecks found in e-fulfillment centers, with an integration of a rule-based inference engine for further providing a more comprehensive solution to assist e-commerce order fulfillment operations [42]. Shojaiemehr et al. [66] developed an agent-based negotiation strategy that considers negotiation time, preferences of negotiators, and opponent's behavior respectively for generating proposals.

## 3. The C2B e-commerce model

This study presents a C2B e-commerce model and builds up a real system. We present an experimental model and examine the application of an agent in C2B. Then we build the system with a platform offered to users as part of the experimental model. This study also verifies the proposed system through a laboratory experiment.

There are some special mechanism dynamics that pertain to the operation of the online collective purchasing model that are worthwhile to point out. Chen et al. [10] propose a Buyer Collective Purchasing (BCP) model implemented in a multi-agent framework and divide the BCP model into six stages: (1) product description, (2) participant invitation, (3) buyer needs synthesis, (4) merchant brokering, (5) negotiation, and (6) purchase and delivery. Chen et al. [11] propose a model permits the group-buying auction mechanism to dominate the fixed-price mechanism from the seller's point of view under some circumstances. A sequence-based incentive mechanism gives consumers a sense of less procedural fairness [38]. However, the previous literature focused on using the fixed product or price to collect user preferences and never conducted the negotiation. This study thus proposes a more flexible collective purchasing behavior model, which comprises five stages: (1) Initiation, (2) Broadcast, (3) User Setting, (4) Search products, (5) Negotiation (Fig. 1).

Buyers can negotiate with sellers through the collective buyer negotiation agent and seller agent:

### 3.1. Initiation

The beginning of the collective purchasing process requires someone with the intention of making a purchase or using some services and wishing to invite others to join. Users thus must send a request to initiate buying behavior.

### 3.2. Broadcast

The system broadcasts the message to any Internet communities comprising individuals potentially interested in purchasing the proposed product. Users can join the group and participate in the action.

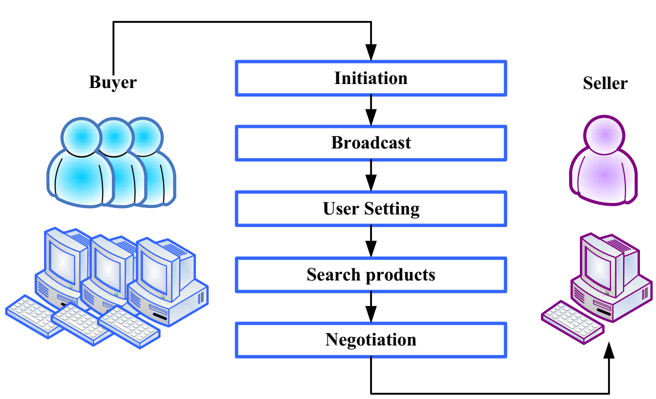


**Fig. 1.** The C2B E-Commerce Model.

### 3.3. User setting

The user setting provides a personal setting for the buyer agent for buying products. Users can set the membership function of all product attributes. This study calculates user demands based on fuzzy theory. Fuzzy theory mainly includes fuzzy set, fuzzy logic, fuzzy reasoning and fuzzy control [84]. We identify the user setting of the membership function and obtain means of the product attribute. The average value is introduced to help in the ordering of fuzzy numbers and is defined by means of an integrating process of a parametric function representing the position of every $\alpha$-cut in the real line [61]. This system initializes the heights of the Gaussians by the maxima values (peak values) and initializes the mean values of the Gaussians as the locations of these peaks [61]. Additionally, users can set up comparisons between product attributes to get the relative weights ($w_i$) of each attribute. This study adopts the Analytic Hierarchy Process (AHP) to calculate product weights for initializing the product's attributes. The Analytic Hierarchy Process (AHP) is a great tool for aiding people in making decisions. In the AHP, one can include and assess intangibles because of the relative comparisons that are made [18]. The absolutely essential perceptions of product attributes are divided into 1 to 9, from not very important to very important, to compare the values of attributes. In this way, a paired comparison matrix can be obtained. Continuing with the AHP analysis, the pair-wise comparison procedure is used to determine the priorities for each of the elements. The overall weights can thus be obtained.

### 3.4. Search products

The agent then can search and identify the appropriate product to meet the needs.

### 3.5. Negotiation

This proposed system evaluates product utility and then conducts negotiations. The model starts negotiations based on the search result, calculates product utility, and determines whether or not to accept the product. The negotiation processes are as follows: standardize attribute values, get margin utility, evaluate utility threshold, evaluate price ratio threshold, present new offer from buyers, evaluate price and price range, get responses from sellers, accept the response from sellers, and finish.

To standardize the attribute values of a product, this study has to normalize attributes ($V^i$) and product attributes from numbers 0 to 1. After calculating the normalizations of each attribute, the membership function region of each attribute is checked to reduce the marginal utility. This study not only negotiates with the requirements from users but considers the total utility of successful recent transactions as the threshold of filtering. Faratin et al. [20] presented the Negotiation Decision Function (NDF) using negotiation criterion. NDF allows agents to negotiate with multi-attributes such as price and quantity. In this study, we extend the NDF function and add the concept of a threshold value of utility to calculate satisfaction. If the total utility is below the threshold, then we delete the unnecessary information, so as to reduce the number of negotiations. This study adopted NDF (Negotiation Decision Function) but not the work of Payne et al. [59]. Of course, Payne et al. [59] provided the decision process in detail from the psychology aspect, but the negotiation is not the main idea in their work. The adaptive strategy selection is therefore not considered in this study. In this study, the agent help the purchasers the decision but lack of the scenario analysis to help participants the adaptive learning and feedback to his/her decision making. Restated, the agent can help the decision making from NDF, through accepting or declining the offer between seller and buyer, but the participants cannot form the adaptive strategies. However, it is fine in nowadays e-commerce, because the negotiation of utility and price are customers' main concern. The function is extended as follows:

$$U = \frac{\sum w_i \times V^i}{\sum w_i};\ 0 \leq U \leq 1;\ 0 \leq V^i \leq 1;\ 0 \leq w_i \leq 1;\ U \geq \overline{u_i}$$

U refers to the utility and $V^i$ to the utility of issue i. $W_i$ is the weight of issue i. $\bar{u}_i$ is the average total utility from successful recent transactions.

When a buyer agent receives offers from a seller agent, the buyer agent evaluates the threshold of product utility first. The buyer agent further evaluates the seller's price. If the buyer agent can accept the price, then negotiation is finished. Otherwise, the buyer agent offers a new price to seller agents. When the buyer agent declines sellers' offers, the buyer agent then uses the total utility to calculate the offer again and returns to sellers. This function is given as follows [78]:

$$\text{Offer}_{\text{new}} = \text{utility} \times 100{*}\text{u} + \text{Offer}_{\text{old}}$$

Where $\text{Offer}_{\text{new}}$ means new price, the utility is product utility, u is the unit increase value and $\text{Offer}_{\text{old}}$ is the last offer.

Sellers will further evaluate the new offer from the buyer agent. If the buyer agent declines the seller's offer, the seller agent will request a recalculation of offers and initiate the next negotiation [21].

$$\text{x}[\text{i}]_{\text{new}} = \text{x}[\text{i}]_{\text{old}} + (-1)^{\text{w}}\text{F}|\text{RV}_{\text{i}} - \text{x}[\text{i}]_{\text{old}}|$$

$x[i]_{\text{new}}$ is the new offer and $x[i]_{\text{old}}$ is the last offer. F is the factor falling between 0 and 1 and w is the factor controlling increase or decrease. RV means the max or min limit value, setting value or buyer offer. For the seller agent, the condition for stopping negotiation is when the buyer's price is located in the seller's acceptable range. If a buyer agent accepts the offer from a seller, then they both accept the price. Fig. 2 shows the proposed C2B e-Commerce process.

## 4. Example illustration

An example of the notebook purchasing process is illustrated. The five stages which presented above will be described below.

### *4.1. Initiation*

Users must send a request to initiate buying behavior.

### *4.2. Broadcast*

The system broadcasts the message to any Internet communities comprising individuals potentially interested in purchasing the proposed product. Users can join the group and participate in the action.

### *4.3. User setting*

Users can set the membership function of all products attribute (Price, Performance_CPU, Performance_HD, Performance_Memory). The membership function of the price set by the user is shown in Fig. 3. Each user will compare the price and the CPU, HD, and Memory. Continuing with the AHP analysis, the pair-wise comparison procedure is used to determine the priorities for each of the elements. The overall weights can be obtained (Fig. 4). Average the weights of the group (Fig. 4). Obtain the mean membership function and mean marginal utility value which includes the left value, middle value, and right value from this step to let the next step to use.

### *4.4. Search products*

The agent then can search for products from e-commerce platform and five candidates are found (×1, ×2, ×3, ×4, ×5).

### *4.5. Negotiation*

The normalization of price in product ×1 is 1; product ×2 is 0.53; product ×3 is 0.71; product ×4 is 0.35; product ×5 is 0. The marginal utility then can be multiplied by attribute weight. Finally, summarizing the average left value, middle value and right value, and the result is the total utility of the product. Therefore, ×1 = 0.51, ×2 = 0.69, ×3 = 0.74, ×4 = 0.65, and ×5 = 0.38. Since the threshold value is 0.4, product ×1's, ×2's, ×3's, and ×4's utility threshold are all greater than threshold value. In this example, the price ratio threshold (Buyer offer/Seller offer) is preset as 0.95. The ratios of these four products are all smaller than the threshold, so buyer will not accept the seller's offer. The buyer agent will continue to negotiate these four products. The buyer agent calculates new prices and presents to seller according to the utility function.

Seller agent checks whether the prices are larger than the lower limit of price range first. For this example, the seller cannot accept the buyers' offer and will reoffer the price to the next negotiation. Seller agent represents the offer according to the seller offer function

After several iterations, product ×1 is selected.

## 5. Research method

The purpose of this study is to assess the empirical effectiveness of the proposed intelligent agent system. Thus, this study uses an experiment and questionnaire survey to measure effectiveness. The question items of the survey are designed according to references. This study uses laboratory experimentation [43] and adopts Java as the programming language to build up the experiment platform. We use Eclipse as the development environment and MySQL as the database. The experimental scenario is illustrated as follows. Each participant is a user who wants to buy a desktop computer. The user sets up his/her requests through the proposed C2B e-commerce platform. The user sets up the price range and specifications, and the system broadcasts these settings to others using the same platform. The ones who are interested in the desktop computers join this activity automatically through the agents in this system. In the C2B e-Commerce platform, buyer agents represent the media for negotiation. Buyer agents can auto-negotiate with the seller agents. This study tried to find the differences between before and after use the agent-based C2B system. For the qualified participants, this study asked them the same question item sets before and after them uses the system. Before the experiment, the authors are asking the participants to answer the question items based on their purchase experiences. They are inquiring the same questions after they adopted the system. After that, this study can find the difference before and after the use of the system.

For the questionnaire survey, this study applies satisfaction, product risk, perceived fairness, and perceived value as the dimensions for understanding the effectiveness of the proposed system (Fig. 5). Kauffman provided some additional information related to online group buying auctions, consumer decision-making, the fairness construct and consumer satisfaction [24,38]. Offering online personalized recommendation services helps enhance customer satisfaction. Conventionally, a recommendation system is considered as a success if clients purchase the recommended products. However, the act of purchasing itself does not guarantee satisfaction and a truly successful recommendation system should be one that maximizes customers' after-use gratification [36,83]. Based on the above considerations, this study proposes the following hypothesis:

**H1.** *Users of the proposed C2B e-commerce platform have higher satisfaction than those who do not use the platform.*

Product risk is defined as the loss incurred when a brand or product does not perform as expected [26]. Product risk has been consistently found to be a significant inhibitor of online purchasing [50,52]. Six types of risk include: financial, product performance, social,

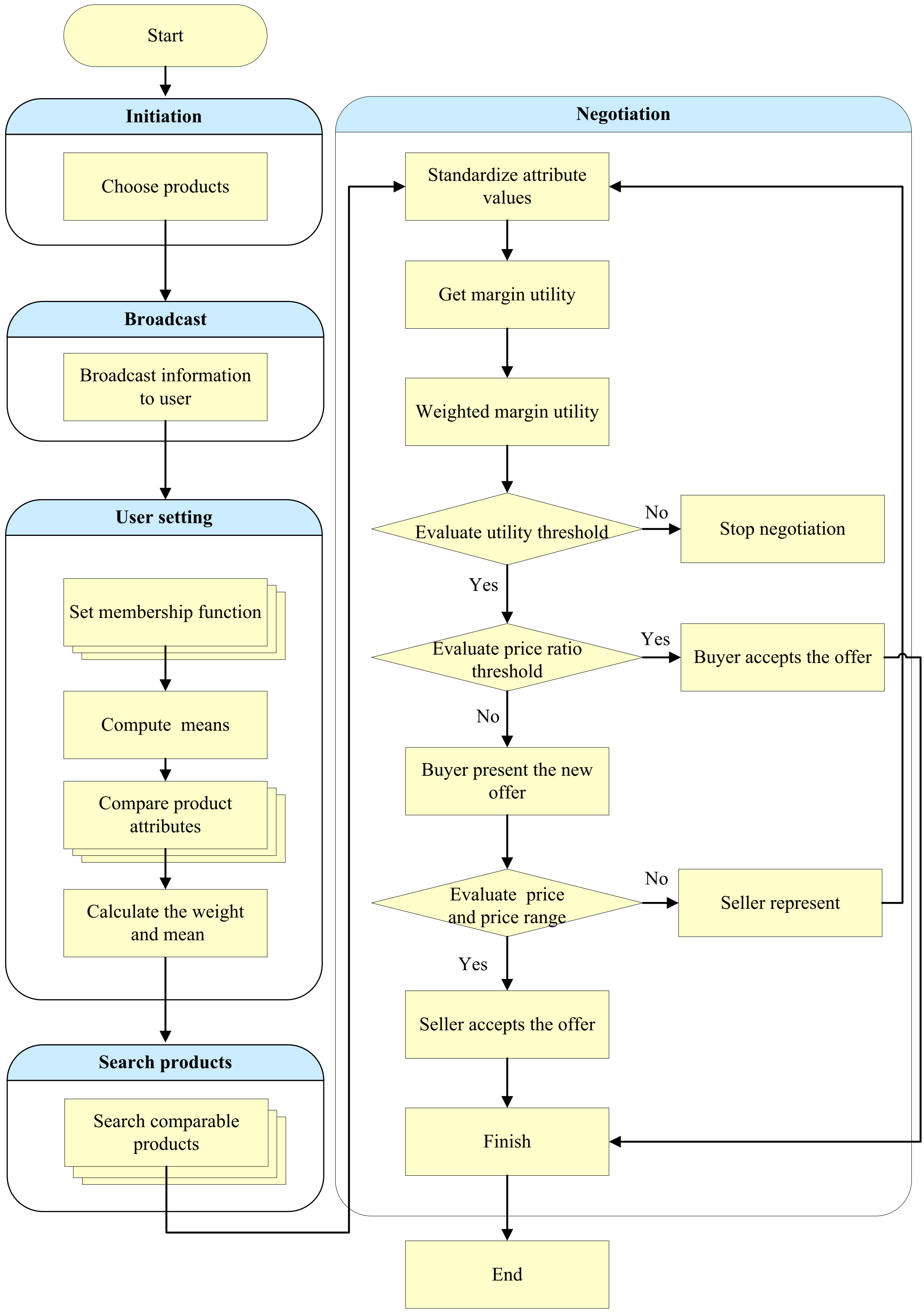


**Fig. 2.** C2B E-Commerce process.

psychological, physical, and time/convenience loss [52]. This study thus makes following hypothesis:

**H2.** *Users of the proposed C2B e-commerce platform have lower product risk than those who do not use it.*

A participant in an online group-buying auction considers distributive fairness based on three dimensions, including equity, equality, and needs [16]. Perceived fairness of pricing has been extensively studied in economic and marketing literature [16,55]. Different

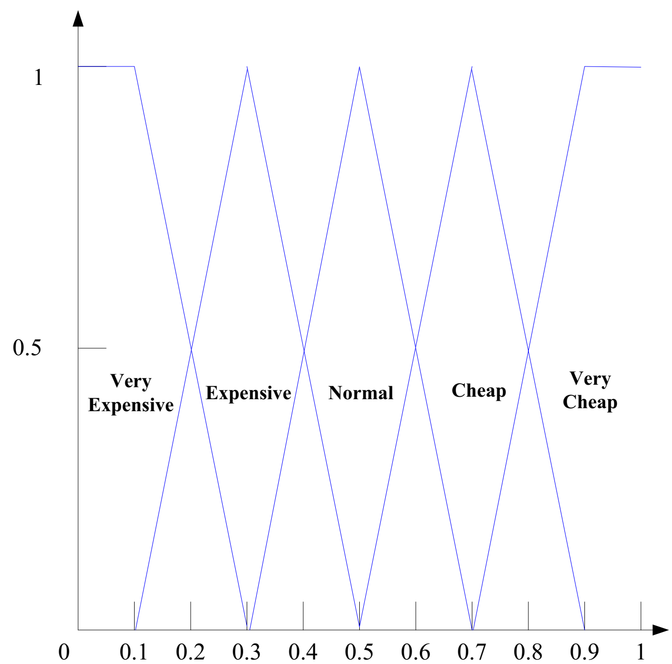


**Fig. 3.** Membership Function (Price).

incentive mechanisms for discounting final auction prices positively impact the procedural fairness and price fairness that consumers perceive [55]. According to the above findings, this study makes the following hypothesis:

**H3.** *Users of the proposed C2B e-commerce platform have higher perceived fairness than those who do not use it.*

Parasuraman et al. [58] defined perceived value as a consumer's overall assessment of the utility of a product, based on perceptions of what is received and what is given. It is the trade-off between a received benefit and a cost [29]. The importance of perceived value in e-commerce stems from the fact that it is easy to compare product features and prices online [2]. Previous studies have shown that perceived value is an important antecedent of overall satisfaction [1,14,29]. These items of perceived value have been identified as forms of emotional, functional and overall value which could be applied to measuring tourists' perceived values of destinations [29,41]. Ha & Jang [27] explored perceived values and satisfaction and verified that both utilitarian value and hedonic value positively affect the behavioral intentions of restaurant customers, both directly as well as via customer satisfaction.

**H4.** *Users of the proposed C2B e-commerce platform have higher perceived value than those who do not use it.*

Question items are designed based on the aforementioned hypotheses and listed in Table 1.

Although this study proposed the above question items to survey the participant respondents, factor validity is needed in order to verify the question items are well designed for each dimension before making comparisons of findings before and after this experiment [33].

Since it is difficult to reach out qualified participants having the concept of intelligent agents and familiar with the online shopping, the participants must be screened carefully. The sample size for this study is determined by a rule of thumb [40]. Roscoe [63] said that when using a rule of thumb, between 30 and 500 are appropriate sample sizes. Additionally, based on the practical guide proposed by Loeppky et al. [53], 10 times of dimension are enough for a computer experiment. This study was proposed to evaluate four dimensions to understand participant perception of using C2B system [3,5]. To prevent external interference, controlling experiment environment is needed. Therefore, this study must select the participants from a controllable group. The participants in this research are all graduate students from an information management department. They all have online shopping experience and understand the basic concepts of intelligent agents. Originally, this experiment has 54 candidates. Among them, 50 candidates meet the criteria having online purchasing experience and with the perception of C2B model which is sufficient for criteria of the sample size of a computer experiment.

## 6. Survey result

Data analyses were conducted by using the software SPSS 17.0. There are 50 participants (26 male participants and 24 female participants) aging from 23 to 27 in this experiment. The most common way to estimate the reliability of these types of scales is with coefficient α. With regard to minimum acceptable criterion, Nunnally [56] suggested that a construct has high reliability if α is greater than 0.7, and has low reliability and should be rejected if α is less than 0.35. The analytical results show that α is 0.844 in this study and, therefore, has high reliability.

Factor analysis is a statistical procedure that examines the correlations among variables to discover the validity of related variables [56]. This study uses factor analysis to assess construct validity. KMO (Kaiser-Meyer-Olkin Measure) and the Bartlett ball type test were used to determine that it is suitable for factor analysis. The KMO value is 0.757 and is higher than 0.7. Kaiser [37] stated that 0.7 is the minimum acceptable value for factor analysis. The p-value is 0.000 for the Bartlett ball test, so the questionnaire survey qualifies for factor analysis [37,51]. Table 2 shows the results of factor analysis through principal component analysis. Factor loading of each dimension is greater than 0.5 and the cumulative variance is higher than 40% represent, showing that the dimensions of question items are consistent [74]. Therefore, these questionnaire results are considered to be reliable.

Finally, the results of factor analysis show that four factors are found along with four dimensions: customer satisfaction, product risk, perceived fairness, and perceived value. Question item A2 is eliminated because the factor loadings are low ($<0.5$) [74] (Table 3). Table 4 shows the item statistics of the four factors.

To find customer perceptions of satisfaction, product risk, perceived fairness, and perceived value before and after the experiment, this study applies a paired-sample T-test to check the hypotheses (Table 5). Paired sample t-tests are used in 'before-after' studies, pairing samples, or in cases of control studies [80]. Table 5 shows that H1, H2, and H3 have significant differences, but H4 does not. The t-values are all negative. This represents that the proposed system effectively raises users' perceptions of satisfaction, product risk, and fairness. The analytical results show that the application of an agent into C2B e-commerce by the proposed system is useful and effective. H4 is insignificant in this study. Yet, Tsiotsou suggested that perceived product value is a quality dimension which is important and worthy of study [73]. More research should be carried out to study the role of perceived value in the future.

## 7. Implications

The experiment results show that the question items are well designed and represented, because they can form four factors from factor analysis which represent the dimensions of satisfaction, product risk, perceived fairness, and perceived values. The analytical results show that by applying an agent in an e-commerce system, users should obtain higher satisfaction ($p = 0.001$, which is smaller than 0.05), lower product risk ($p = 0.000$), and higher perceived fairness ($p = 0.013$). However, the perceived value has no significant difference between before and after the use of the system. A C2B e-commerce system can be enhanced by adopting intelligent agents in the experiment. Furthermore, this study shows the question items have high differences before and after the experiment as follows. The analytical results have shown that users are satisfied on using the C2B agent-based system,


**Fig. 4.** User setting value.

especially on the judgment of the product. For the developers, the accuracy of the information compared by the agents should be carefully handled. For the company who want to sell goods in such an overwhelmed era of information, how to provide precise information to help customer judgment is important. The real and detailed description of the good is needed.

Users agree with the low perceived product risk along with the adoption of the intelligent agent. Through the proposed question items, users perceived reduced risk, because users can get inside information through the intelligent agent. Customers want to get the expected goods [71]. For example, customer answers to question item B3 (*I am worried the purchased product is different what I imagined when using the online shopping system*) improve from 1.96 (before the experiment) to 3.80 (after the experiment). An intelligent agent can help the negotiation between sellers and buyers. Users trust that they can get the goods they need and are satisfied with the results when using an agent. Such an agent-based system can help customer the increasing faith on what goods they found. A company should care about the trend of the agent-

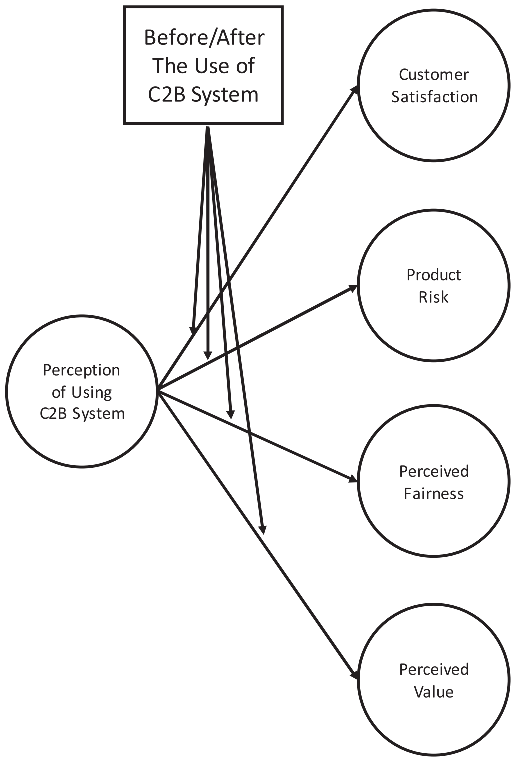


**Fig. 5.** Research Model.

**Table 1**
Question items.

| |
|---|
| **Customer satisfaction** |
| A1. This system provides personalized services in online shopping. |
| A2. This system provides convenient online shopping. |
| A3. This system can help me to do make better judgments when online shopping. |
| A4. I am very satisfied with the experience of shopping with the proposed system. |
| **Product risk** |
| B1. I am satisfied with the expected results of purchasing products using this online shopping system. |
| B2. I am satisfied with the demand for purchasing products using this online shopping system. |
| B3. I am worried the purchased product is different from what I imagined when using the online shopping system. |
| B4. I am afraid that this system cannot satisfy me on the understanding of the functions of the purchased products. |
| **Perceived fairness** |
| C1. I spend less but fair time than expected when I use this shopping system to find the products I want. |
| C2. The communication is appropriated show me fair information when I use this online shopping system. |
| C3. I can flexibly show my demand for products when using the online shopping system and the system can show me the fair results. |
| C4. When I search for the products I want, I can trust that the system has shown me all the potential products. |
| **Perceived value** |
| D1. I would like to use this online shopping system to purchase products. |
| D3. Through this online shopping system, I can get more favorable prices for products. |
| D3. Using the online shopping system raises my ambition to purchase again. |
| D4. I think the online shopping system offers appropriate values when it comes to the prices of products. |

based system to help customers touch their products because such a system may reduce customer perception on the purchase risk and increase their faith in buying goods. Additionally, the analytical result of perceived product risk also revealed one truth: customers are lack of faith in what they found on the Internet, especially in nowadays Internet business with overwhelmed frauds. The bad news is always spread over the Internet sooner than good news [17]. Therefore, the company must take care of providing correct information and preventing the spread of negative news.

Users agree with the findings of high perceived fairness along with the adoption of the intelligent agent. For example, the significant increase in customer answers to question item C1 (*I spend less time than I expected when using this shopping system to find the products I want*) (from 3.54 to 4.06) shows that customers felt the amount of time they spent is fair. The time cost implies how much time customers spend to finish their search and negotiate with sellers. Time is a sparse resource for customers because they want to spend less time finding goods but ignore other interesting products [25]. In such a short time window selecting goods, a company should develop its promotions referring to customer needs. Through intelligent agents, customers can get information about goods and finish the process of purchasing quickly. Question item C3 (*I can flexibly show my demand for products when using the online shopping system*) (from 3.72 to 4.06) shows that customers feel more flexibility when showing their demand for products than before when using the intelligent agent. Because of the information asymmetry, customers go insufficient information for buying goods from sellers before. However, through intelligent agents, customers can reveal their demands more flexible than before because they can collect sufficient information from the market using agents. Based on the analytical result, the flexibility in choosing products represents is what a company should provide to fit various customer needs. Restated, a company needed to take care of the market trend carefully with a timely matter. For the developers of C2B agent-based system, they can work out some business model to help the show of the company product based on their recommendation.

Users agree with the finding of high satisfaction along with the adoption of the intelligent agent. For example, customer answers to question item A3 (This system can help me to make better judgments when online shopping) increase from 3.44 (before the experiment) to 4.10 (after the experiment). Customers are always busy when making decisions about purchases. Users perceived good service quality along with less effort for decision making related to purchases [34,70]. They need to get sufficient information to make decisions precisely. Through this proposed intelligent agent, users can make decisions easier than before.

Additionally, in this study, the perceived value is with no significant difference between before and after the use of the system. It implied that an intelligent agent cannot enhance the value of the C2B commerce system. When the participants use the agent involved system, the so-called value might be not the customer's main concern. The user can perceive the help from the experimenting system, but the participants show no significant intention to use the system. It should be because of the limited time of the experiment. In such a short time of using the proposed system, participants cannot feel the definite intention or ambitious to use the system. Therefore, the analytical results show that the system is with the higher satisfaction, higher perceived fairness, and lower perceived risk, but the users have the neutral attitude to the perceived value and further the use of the system. It implied that the system needs more efforts to be promoted to the market.

## 8. Conclusion and future research

Along with the development of e-commerce, consumers use various ways to purchase products on the Internet. Intelligent agent software is a type of computer software that helps with decision making [31]. Negotiation is necessary for communication to solve transaction conflicts and make better deals between trading entities in the e-commerce world [76]. This study applies agents for negotiation in C2B e-commerce. We also conduct an experiment to evaluate the effectiveness with the proposed C2B e-commerce platform. In the experiment, participants join a group-buying activity of purchasing a desktop computer. Finally, customer satisfaction, performance risk, perceived fairness, and perceived value are assessed as the dimensions of the

**Table 2**
Total variance explained.

| Component | Initial eigenvalues | | | Extraction sums of squared loadings | | | Rotation sums of squared loadings | | |
|---|---|---|---|---|---|---|---|---|---|
| | Total | % of variance | Cumulative% | Total | % of variance | Cumulative% | Total | % of variance | Cumulative% |
| **1** | 5.489 | 34.309 | 34.309 | 5.489 | 34.309 | 34.309 | 3.131 | 19.569 | 19.569 |
| **2** | 2.162 | 13.515 | 47.824 | 2.162 | 13.515 | 47.824 | 2.836 | 17.726 | 37.294 |
| **3** | 1.152 | 7.199 | 55.024 | 1.152 | 7.199 | 55.024 | 2.254 | 14.090 | 51.384 |
| **4** | 1.073 | 6.709 | 61.733 | 1.073 | 6.709 | 61.733 | 1.656 | 10.348 | 61.733 |

Extraction Method: Principal Component Analysis.

**Table 3**
Factors analysis.

| | Component | | | |
|---|---|---|---|---|
| | 1 | 2 | 3 | 4 |
| **D2** | 0.798 | 0.057 | −0.006 | 0.047 |
| **D3** | 0.744 | 0.125 | 0.126 | 0.251 |
| **D1** | 0.680 | 0.132 | −0.065 | 0.203 |
| **D4** | 0.539 | 0.142 | −0.014 | 0.189 |
| **A2** | 0.438 | 0.271 | 0.121 | 0.301 |
| **A1** | 0.387 | 0.771 | 0.231 | 0.289 |
| **A4** | 0.301 | 0.709 | 0.171 | 0.321 |
| **A3** | 0.213 | 0.613 | 0.193 | 0.049 |
| **C4** | 0.176 | 0.311 | 0.678 | 0.038 |
| **C2** | 0.002 | 0.432 | 0.554 | 0.022 |
| **C3** | 0.041 | 0.231 | 0.510 | 0.121 |
| **C1** | 0.071 | 0.201 | 0.500 | 0.241 |
| **B3** | −0.74 | 0.046 | 0.008 | 0.948 |
| **B4** | 0.121 | 0.049 | 0.212 | 0.927 |
| **B2** | 0.277 | 0.043 | 0.301 | 0.779 |
| **B1** | 0.201 | 0.038 | 0.045 | 0.771 |

Extraction Method: Principal Component Analysis.
Rotation Method: Varimax with Kaiser Normalization.

**Table 4**
Item statistics.

| Component | | Before experiment | | After experiment | |
|---|---|---|---|---|---|
| | | Mean | Std. deviation | Mean | Std. deviation |
| Customer satisfaction | A1 | 3.68 | 0.741 | 3.96 | 0.570 |
| | A4 | 3.84 | 0.681 | 4.08 | 0.752 |
| | A3 | 3.44 | 0.733 | 4.10 | 0.839 |
| Product risk | B3 | 1.96 | 0.892 | 3.80 | 0.857 |
| | B4 | 2.16 | 0.792 | 3.86 | 0.904 |
| | B2 | 3.68 | 1.019 | 3.84 | 0.710 |
| | B1 | 3.34 | 1.154 | 3.74 | 0.751 |
| Perceived fairness | C4 | 3.86 | 0.670 | 4.02 | 0.685 |
| | C2 | 3.66 | 0.757 | 3.70 | 0.735 |
| | C3 | 3.72 | 0.745 | 4.06 | 0.767 |
| | C1 | 3.54 | 0.973 | 4.06 | 0.712 |
| Perceived value | D2 | 4.18 | 0.850 | 4.26 | 0.694 |
| | D3 | 3.94 | 0.550 | 4.06 | 0.620 |
| | D1 | 4.16 | 0.584 | 4.00 | 0.670 |
| | D4 | 3.54 | 0.734 | 3.94 | 0.767 |

questionnaire to survey participants before and after using the proposed system. The analytical results show that by applying agents in an e-commerce system, users obtain higher satisfaction, lower performance risk, and higher perceived fairness. Future research into the following three issues is warranted:

- To validate the model with larger sample size and different cases.
- To generalize the model and autonomously adapt to different industry domains.
- To allow a user to select different negotiation strategies friendly.

**Table 5**
Paired sample T test.

| Hypotheses | Group | Mean | Std. | *t*-value | *p* value |
|---|---|---|---|---|---|
| H1 | before experiment | 3.65 | 0.602 | −3.319 | 0.001** |
| | after experiment | 4.05 | 0.583 | | |
| H2 | before experiment | 2.79 | 0.625 | −8.741 | 0.000*** |
| | after experiment | 3.81 | 0.538 | | |
| H3 | before experiment | 3.67 | 0.533 | −2.538 | 0.013** |
| | after experiment | 3.96 | 0.511 | | |
| H4 | before experiment | 3.96 | 0.527 | −1.039 | 0.301 |
| | after experiment | 4.07 | 0.532 | | |

** is $p < 0.01$.
*** is $p < 0.001$.

## Conflict of interest

None.

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## Supplementary material

Supplementary material associated with this article can be found, in the online version, at doi:10.1016/j.csi.2019.03.002.

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