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An awareness-based meta-mechanism for e-commerce buyer coalitions

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Abstract Many of the existing theories in e-Commerce and Buyer Coalition assume that all persons involved adopt self-interested strategies by seeking their own gains using environmental/market information. In reality however, such information may not be complete. Also, each person's knowledge may differ from others. By adopting a collaborative perspective towards the buyer coalition process, this study introduces and validates an awareness-based mechanism for buyer coalitions that generates various outcomes corresponding to different levels of awareness of the collaborating roles within the process, where 'awareness' is defined in terms of the knowledge of the collaboration context of the coalition. The theoretical foundation of the study is an overlapping space of Game Theory (Hassan et al. Information Systems Frontiers 16(4):523–542, 2014), e-Commerce (Yang et al. Information Systems Frontiers 16(1):7–18, 2014), and Knowledge Management (Daneshgar & Wang Knowledge Based Systems 20(8):736–744, 2007). The research methodology is design science using simulation software for demonstration and proof of concept. Results indicate that higher levels of awareness of buyers do not necessarily increase total coalition discount but it enables individual buyers to make more opportunistic and calculated decisions to protect their personal interests.

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1 Introduction

In current study the concept *buyer coalition scheme* in e-Commerce, also referred to as *group* buying (Kauffman and Wang 2001), refers to the formation of buyers of a particular product who intend to benefit from additional discounts as a result of purchasing in larger bundles. More specifically, buyers form their coalition in order to negotiate with seller/s for purchasing identical items at a larger discount (Tsvetovat et al. 2001). Buyer coalitions are increasingly becoming important because buyers can improve their bargaining power and negotiate more advantageously with sellers in purchasing goods at lower prices. Buyer coalition helps to reduce the cost of communication between buyers and a seller. Buyers will benefit from purchasing the items in a large bundle of items through buyer coalitions if the price of the lot is less than the standard retail price. Additionally, the buyer coalitions may help to reduce the cost of stock of the items in situations where the items have not been produced yet. Sellers will also benefit from selling the items at larger bundles via buyer coalitions if the cost of the wholesale marketing (such as the advertising or bidding costs) is less than the cost of retail marketing (Tsvetovat et al. 2001).

One major scientific grounding of the research on buyers' coalition is the *n-person game theories* such the *core theory* and the *Shapley value buyer coalition schemes*. These theories are based on the assumption that all persons involved in the coalition adopt self-interested strategies by concentrating on their own (short/long-term) gains only. In the reality however, the underlying assumption of complete information cannot always be maintained, or such awareness would exist at

various levels. Almost all existing buyer coalition schemes allow buyers within the coalition to propose different reservation prices; the latter being the maximum price that a coalition buyer would be willing to pay for purchasing a single unit. Based on those buyer reservation prices the schemes design mechanisms that force buyers to move towards the final price that the latter are willing to pay. In fact, a review of the current literature conducted by the authors suggests that no buyer coalition scheme exists with a single mechanism that is suitable for all buyers within the scheme where each may have a different level of awareness about the coalition context. One mechanism may provide higher benefit to those with higher reservation price, e.g., the backward cost sharing (Li et al. 2004) while another mechanism may provide higher benefits to those buyers with the middle reservation prices, e.g., the proportional subsidy (Li et al. 2004).

Few exceptions however exist in the current literature. For example, two schemes provide comments on the importance of cooperation (Chen et al. 2002a, b, 2009). Another study provides a formal algorithm that explicitly incorporates awareness level of the buyers within the coalition however it does not provide mechanism that allows buyers having various levels of awareness (Laor et al. 2012). The current study continues the latter work by introducing a collaborative model in the form of a meta-awareness scheme that can be used by the existing buyer coalition schemes in order to generate various mechanisms based on the awareness of the buyers of various aspects of the collaboration context. The proposed model will then generate various scenarios based on the level of awareness of various collaborating roles. The study argues that buyer coalition scheme should focus on identifying awareness and knowledge sharing requirement of buyers as a basis for generating various scenarios, and to remove the need for developing unlimited number of mechanisms to cope with every possible situations. The proposed model stratifies buyers based on their knowledge of the collaborative context (in this study, the seller price), and then allows a buyer to bid on the basis of his/her own partial awareness of the collaboration context such as other roles' reservation prices, seller price, other people's interactions and intentions, and so on. The theoretical foundations of the study are rooted in the fields of Game Theory, e-Commerce, and Knowledge Management. It must be noted that the value that such contextual knowledge can generate would be highly dependent on the collaboration design of the process design. In closed cultures for example, some business processes may selectively desire various levels of awareness to be possessed for different roles within the process. The process support may then facilitate provisioning of these various levels of awareness for various roles (Daneshgar and Wang 2007), hence the notion of 'awareness levels' used in the current study. The literature on various existing buyer coalition algorithms is investigated and various schemes evaluated specifically in terms of addressing various levels of awareness of each buyer in relation to the seller's price. Furthermore, the existing literature on Knowledge Management was reviewed in order to identify an appropriate process model for the proposed buyer coalition framework with specific emphasis on awareness and knowledge-sharing requirements of its collaborating actors.

The study provides two benefits to the research and practice communities: (i) it provides an analytical tool for measuring the awareness levels of various stakeholders in the coalition, and as a result, inferences can be drawn about the intensity of knowledge-sharing in the coalition; and (ii) as a result of the above, various amounts of discounts can be calculated based on the levels of awareness of the stakeholders within the coalition. This in turn will assist in allocation of resources for maintaining awareness of the stakeholders within the coalition. The current study argues that without being able to define and measure the awareness levels of the roles involved, the coalition will not be able to allocate resources for the maintenance of the awareness and knowledge-sharing capabilities of the coalition members. This in turn suggests that the proposed model can be incorporated in any of the existing buyer coalition schemes as a complementary component that provides additional business intelligence to the existing schemes by identifying the awareness and knowledge sharing requirements of the members as opposed to the contributions that such awareness provisioning mechanism would have on the overall amount of coalition discounts. In addition, and as shown later on in the example scenario, higher levels of awareness do not necessarily mean additional overall discount for the coalition; the latter depend on other factors such as the governance restrictions and the overall business models.

2 Related work

The academic discipline *mechanism design* is a subfield of *microeconomics* and *game theory* and addresses the implementation issues within the coalition systems for multiple self-interested agents each having private information stored on their preferences. It defines a set of possible agent strategies and an outcome rule (Nisan and Ronen 2001; Shu-hsien et al. 2012). As an example, one mechanism guarantees the stability in surplus division within each coalition based on the core in the Game Theory (Yamamoto and Sycara 2001) whereas another mechanism includes both the stability in the core as well as incentive compatibility, the latter is a characteristic that enables individuals to identify best strategy for following the rules by computing all possible outcomes (Li et al. 2004). Two other studies (Chen et al. 2002a, b, 2010) provide best payoff strategies for buyers no matter what strategies the other buyers adopt. It is based on Nash equilibrium analysis of bidder strategies for a monopolist seller and a competitive seller. Three other mechanisms (Li and Sycara 2004; He and

Ioerger 2005; Cuihongi et al. 2010) guarantee stability in payoff division within each coalition with bundle of items in terms of the core in game theory where the price of goods in the first and the third studies is a function of the number of items sold in each transaction whereas the price in the second study is based on the total cost of all goods sold in one transaction.

While the above existing mechanisms mainly focus on various market characteristics, little has been done towards developing meta-mechanisms that guides the mechanism design itself by addressing the collaboration context of the buyer coalitions. Two recent studies provide a shift in mechanism design by explicitly addressing the collaboration dimension of buyer coalitions. The first study utilizes the theoretical frameworks of Social Networking and Game Theory and provides *algorithmic design* of a buyer coalition scheme with explicit focus given to the 'between-ness', 'centrality', and 'closeness' attributes of the coalition leader (Laor et al. 2012). The second study provides an early attempt in conceptualization of collaboration context by proposing a buyer coalition system called the Awareness-based Buyer Coalition (ABC) that allows various buyers to bid as a result of having various levels of awareness in relation to the other buyers' reservation price (Laor and Daneshgar 2013). The current study extends the latter work by developing an integrated meta-mechanism that addresses both supply and demand sides by addressing various levels of awareness of the buyers in terms of various reservation prices of buyers, as well as various seller prices. Details of the proposed model are described in the next section.

3 An awareness net model for buyer coalition

The following scenario is used to demonstrate the process of constructing an Awareness Net for the Buyer Coalition process. A brief description of the theoretical background of the Awareness Net Modeling Language (Daneshgar and Wang 2007) is provided in Appendix A.

3.1 Description of scenario

A coalition website is already accessible by potential buyers of camera. These buyers select a coalition leader to negotiate with a camera seller for purchasing a specific bundle of cameras at discounted price. The potential seller replies by providing a price list corresponding to various bundles. Two hypothetical selling price lists for various bundles and corresponding discount steps are shown in Tables 1 and 2. Table 1 consists of complete information about seller prices for various bundles (which, according to the Appendix 'A', would correspond to the level-3 awareness), and Table 2 provides partial information about selling prices and corresponds to the level 2 awareness. Awareness levels will be discussed throughout the next sections.

Table 1 Complete discount steps of seller's price schedule

Number of units sold in bundle	Unit Price ($)
1	100
2	90
3–4	85
>5	80

In the absence of no information-sharing, the intention to form a buyer coalition is formally posted on the coalition website by the coalition leader, and the announcement will remain active for a specified length of time. Each buyer will decide to either places a bid and becomes a member Buyer, or will remain outside the coalition process and possibly waits for an appropriate time to join. A Buyer will place a reservation price or a bid, which is the maximum price that s/he is willing to pay for a unit of the item. Different Buyers generally have different reservation prices and they post their bids ubiquitously. As an example, at 9:00 AM Buyer-A may post a reservation price of at most $92 whereas at 11:00 AM Buyer-B may post a reservation price of $90 or lower. The intensity of collaboration and information-sharing among Buyers (called the collective awareness levels of all Buyers) will depend on the information that each Buyer has of the history of the bids made by other buyers at any given time. To represent this concept, four levels of awareness are considered as shown in Figs. 2, 3, 4 and 5. The winners are decided on the basis of the following rule:

> '*Any number of Buyers (one or more) will be 'winner' of the coalition if and only if the utility of the coalition among them is more than zero; the latter concept is defined as the difference between the sum of Buyers' reservation prices in a coalition and the total coalition price. Furthermore, a coalition will actually be established if such utility is more than or equal to zero.*'

3.2 Formalization of the scenario

A formalization of the above rule and associated scenario follows:

Table 2 Partial/incomplete discount steps of seller's price schedule

Number of units sold in bundle	Unit Price ($)
1	100
2	90
>3	85

Given a set of Buyers $B=\{b_1, b_2, \ldots, b_k\}$ in a coalition, each Buyer $b_k \in B$ intends to buy an identical item G. A coalition C is a subset of Buyers $C \subseteq B$ where the Buyers are those who decide to join the coalition to purchase the item G with a discount the latter being the result of mass purchasing. For simplicity it is assumed that at any given time there is only one seller S who is willing to supply unlimited units of the item G. A seller's price list P is a descending function $P : k \rightarrow real\,number$; $P(k)$ is a unit price that the seller would expect from selling a bundle of size k of G. Upon arrival of a Buyer s/he can place only one bid to the coalition leader, CL. When the bid is made it cannot be changed or cancelled. The bid will be added to the history if and only if the new bidder is a winner. A winner bid is the one whose bid will maintain a positive value for the existing pool of *utility of the coalition, u(C).* The *u(C)* in turn can be defined as: $u(C) = \sum_{bk \in C} R_k - P(|C|) \times |C|$ where $P(|C|)$ is the coalition price of an item for the coalition C (Li et al. 2004). Only the winner bids are added to the history, H. The history consists of a set of reservation prices $H=\{R_1, R_2, \ldots, R_l\}$.

3.3 Representation of the scenario

The present study explicitly incorporates issues related to the information-sharing and awareness levels of Buyers at various levels based on various aspects of the collaborative buyer coalition process. To demonstrate such collaborative perspective for the above Buyer Coalition scenario the Awareness Net modeling language is employed. The strength of this language is that it facilitates identification of awareness and information-sharing requirements of various actors. In the current study such awareness is about various roles within the coalition (e.g., Buyers, sellers, coalition leader, and other Buyers), as well as the reservation prices of other Buyers' and the seller's prices. Based on the rules of the Awareness Net Modeling language the methodological steps for identification of information-sharing requirements of various Buyers are listed below and are further explained in the following sections:

Step 1: Constructing the Awareness Net

A summary of the theoretical background of the Awareness Net is provided in Appendix A. Figure 1 is a graphical representation of the buyer coalition as a collaborative business process. In Fig. 1 there are four roles (R1 to R4) along with their corresponding tasks (Task1 to Task6) and relevant role artifacts (Ra1 to Ra8) and task artifacts (Ta1 Ta2 Ta2.1 Ta2.2 and Ta3). In this process scenario, the coalition leader (R2) will negotiate with the seller (R3) in order to reach an agreement on the basis of their requirements which is reflected in the Ta2. Ta2.1 and Ta2.2 means the negotiation with knowing some discount steps of the price lists and the negotiation with knowing all discount steps of the price schedule.

The R2 will then advertise the coalition formation to all Buyers along with specified parameters such as item to be purchased. For simplicity only two roles are shown in Fig. 1; these are R1 and R4. The coalition will then be opened to the member roles R1 and R4 for a specified length of time. At this stage each role will either join the coalition or will leave the coalition process.

In the absence of any information-sharing among the Buyers themselves, after all member roles order the item, the coalition leader gathers the orders and purchases the items with a larger discount to the individual buyers. Definitions of the tasks, roles, role artifact, and task artifact of Fig. 1 are shown in Tables 3, 4, 5, and 6. These Tables will assist the reader to better understand the underlying meanings behind each concept in Figs. 1, 2, 3, 4 and 5.

Step 2: Identifying the Awareness Levels of Buyers

Four possible levels of awareness are considered for the Buyers: level-0, level-1, level-2 and level-3. These levels can be distinguished from one another on the basis of the number of objects that would be needed to put within the focus of the role in order to enable him/her to participate in various interactions, and equipped with appropriate level of 'focus'. Such 'desired' or 'designed' level is decided by the collaboration design, which in turn is affected by the organizational culture. For example, in highly hierarchical organizations very few people would need level-4 (high level of) awareness whereas in an open (R&D) culture, all roles would need highest levels of awareness. These levels can be demonstrated by various sub-graphs in Fig. 7 in Appendix 'A', where each sub-graph progressively representing a different set of objects that that would need to be put within the focus of the role in order to enable the role to have a particular level of awareness Also see Tables 7, 8, 9 and 10 for various sub-graphs corresponding to various awareness levels of one role only (for demonstration).. Graphical representations of these four awareness levels (or sub-graphs) for the R1 are shown in Figs. 2, 3, 4, and 5.

3.4 Analysis of the scenario

Treating the coalition business processes as collaborative process would create additional benefits to the roles involved in the process. This section demonstrates such benefits in more details. Tables 7, 8, 9 and 10 demonstrate four scenarios, each corresponding to a different level of awareness for the role R1. These Tables are for demonstration of various awareness levels only. To avoid repeating 16 other similar Tables for the demonstration of the awareness levels of all other roles, the other scenarios corresponding to the roles other than R1 are not shown here; they however follow the same logic. That is,

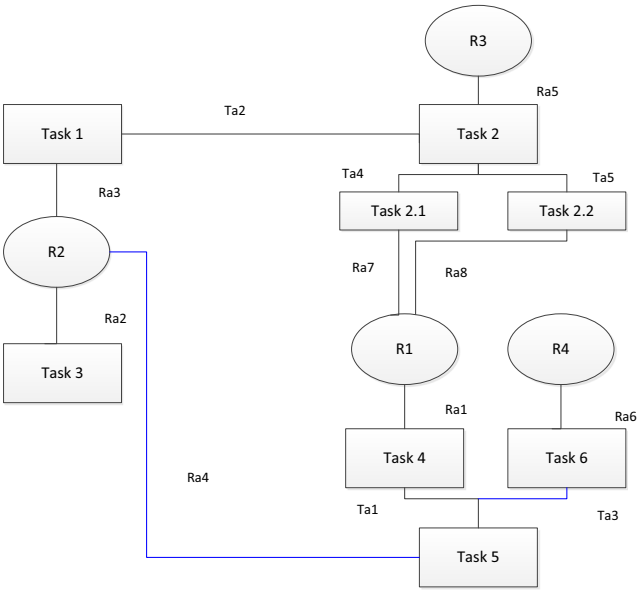

Fig. 1 An awareness net for the buyer coalition collaborative process

various awareness levels for each role can be demonstrated by various sub-graphs (or corresponding Tables) similar to the above four Tables . In the above four Tables, "Time" is the time when a potential Buyer arrives. Column "Buyers" denotes the bidder's identity. Column "Reservation Prices" shows the maximum price which the corresponding buyer would be willing to pay for a unit of an item. Column "History" records the bids of winners who had provided their bids before buyer (R1) ar. In these Tables, "Time" is the time when a potential Buyer arrives. Column "Buyers" denotes the bidder's identity. Column "Reservation Prices" shows the maximum price which the corresponding buyer would be willing to pay for a unit of an item. Column "History" records the bids of winners who had provided their bids before buyer (R1)

Table 3 Existing tasks in the awareness net of Fig. 1

Task number	Task description
Task1	Selecting sellers
Task2	The coalition leader conducts a negotiation session with a set of sellers
Task 2.1	The coalition leader conducts a negotiation session with a set of sellers with knowing some discount step of the price lists.
Task 2.2	The coalition leader conducts a negotiation session with a set of sellers with knowing all discounts steps of the price lists.
Task3	The coalition leader opens and advertises to potential coalition members
Task4	Participating of R1
Task5	Forming a coalition
Task6	Participating of R4

Table 4 The Roles of the awareness net of Fig. 1

Role number	Role description
R1	Buyers in a group
R2	Coalition Leader
R3	Sellers
R4	Other Buyers in the group

arrival. Column "RA of Seller" (if exists) denotes the *role artifact* that the Seller uses. Column "Current Winners" records the sequence number of the buyer who can remain a member of the coalition. Column "Coalition Price" indicates the coalition price of an item for a coalition which is the unit price of one item when the bundle are sold to the buyers in a coalition with discounts according to the descending function of the price list, column 'Utility of Coalition' represents the difference between the sum of buyers' reservation prices in the coalition and the total coalition price, and column 'Total Discount' denotes the difference between the total retail price and the total coalition price.

Scenario 1: All Buyers have Level-0 awareness:

In this scenario, a Buyer does not have any information about other Buyers in the coalition, nor about the Seller's price. S/he therefore places a Reservation Price (RP) without being aware of the information provided in Table 1 and Table 2. If the RP falls within the range of $0–$100 (from Tables 1 and 2) then the Buyer will remain a member of coalition. In Table 7, all Buyers place a bid and yet no coalition can be formed because the utility of the coalition is less than zero. So there are no winners within the coalition with these bids. The total discount of the coalition is also zero.

Table 5 Role artifact of the awareness net of Fig. 1

Role artifact	Role artifact description
Ra1	Personal K-based of R1
Ra2	List of Buyers
Ra3	Seller lists
Ra4	History
Ra5	Seller's price list
Ra6	Personal K-based of R4
Ra7	Person K-based of R1 with knowing some discount steps of the price lists
Ra8	Person K-based of R1 with knowing all discount steps of the price lists

Table 6 Task artifact of the awareness net of Fig. 1

Task artifact	Task artifact description
Ta1	Collaborative Platform of R1
Ta2	Condition of Coalition Leader & Seller parameters
Ta2.1	Condition of Coalition Leader & Seller parameters with knowing some discount steps of the price lists
Ta2.2	Condition of Coalition Leader & Seller parameters knowing all discount steps of the price lists
Ta3	Collaborative Platform of R4

Scenario 2: All Buyers have Level-1 awareness:

In this scenario, each Buyer knows about the other Buyers' reserve prices (RP) as well as the History, but still no Buyer knows the Seller's price. The first Buyer in a group of Buyers places an RP at random in the range of $0–$100 and the rest of the Buyers in the group each places an RP which is less than the minimum bid of other Buyers' RP that appear in the History. For example in Table 8, Buyer 'A' places a bid at $85 and Buyer 'B' places a bid at $84 which is less than $85 (the History). In this scenario, Buyers cannot form a coalition because the utility of the coalition is still less than zero.

Scenario 3: All Buyers have Level-2 awareness:

In this scenario, each Buyer knows about the other Buyers' RP, the History, and they also have partial information about the seller's price, as shown in Table 2. Nevertheless, no Buyer knows about the final discount step of the seller's price (that is shown in Table 1). The first Buyer in a group of buyers places an RP at random in the range of $80–$100 while each of other in the group places an RP which is the sum of the other Buyers' reservation prices that appear in the history minus the seller's price. For example in Table 9, Buyer A places a bid at $91 and Buyer 2 places a bid at ($90*2)−$91=$89. These two Buyers can now form a coalition because the utility of the coalition is more than or equal to zero. The coalition price is $90.

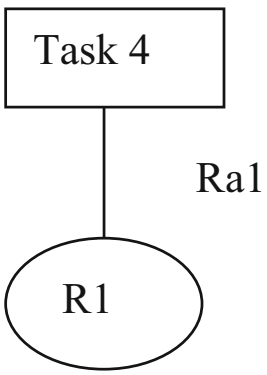

Fig. 2 Level-0 Awareness space for the R1

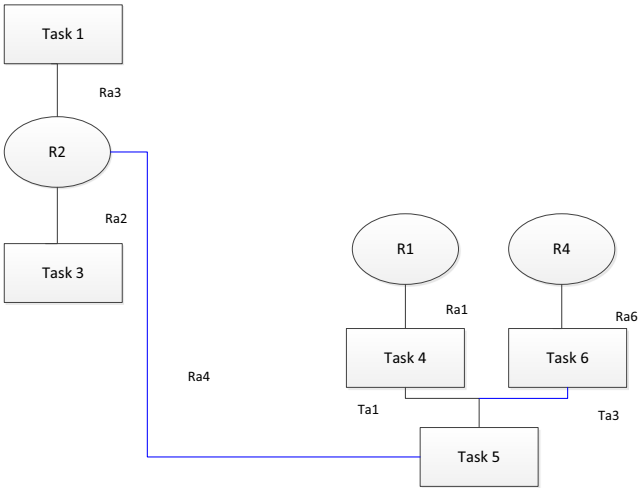

Fig. 3 Level-1 Awareness space for R1

Scenario 4: All Buyers have Level-3 awareness:

In this scenario, each Buyer knows other Buyers' RP and History, as well as the seller's prices. Additionally, each Buyer knows final discount step of the seller's price as shown in Table 1. The first Buyer in a group of Buyer places an RP at random in the range of $80–$100 while others in the group place RPs each is the sum of the other Buyers' reservation prices that appear in the History minus the total coalition. In Table 10, for example, Buyer A places a bid at $91 and buyer B places a bid at ($90*2)−$91=$89. They can form a coalition because the utility of the coalition is more than or equal to zero. The coalition price is $90. Notice that Buyer E in Table 9 proposes a reservation price at the coalition price ($85) which he recognizes under the scenario 3 while the same Buyer E in

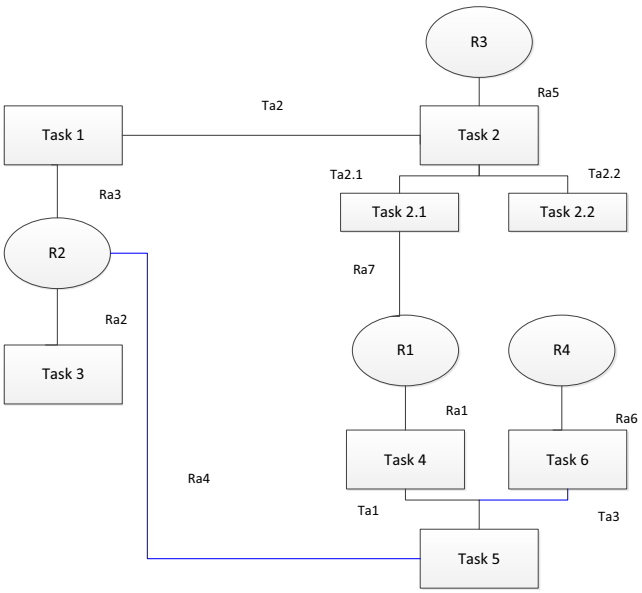

Fig. 4 Level-2 Awareness space for R1

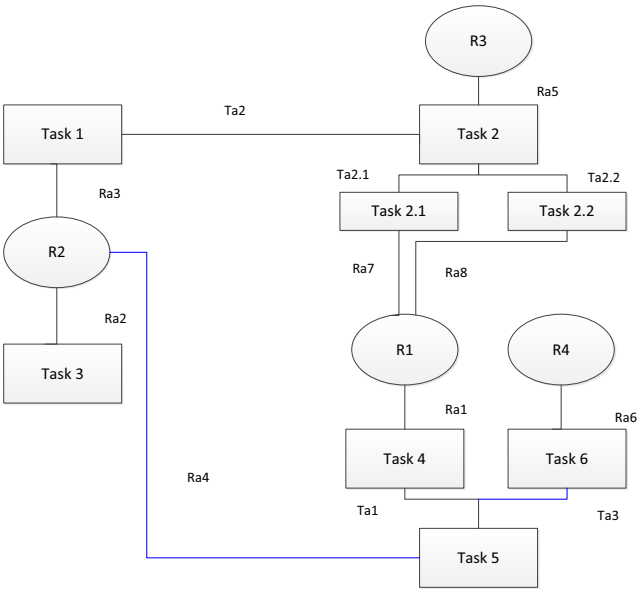

Fig. 5 Level-3 Awareness space for R1

Table 10 proposes a reservation price at the coalition price ($60) which he recognizes under the scenario 4. From the different level awareness, we observe that the scenario 4 will result in higher utility of coalition compared to the scenario 3. The higher utility of the coalition in scenario 4 can potentially be divided among the Buyers who propose high reservation price such as the buyer A, B, and D, and this will make them not to hesitate to join the coalition.

4 Research methodology

The traditional positivist/interpretivist researcher is primarily interested in theorising already existing information systems whereas the authors of the current study attempt to solve an unsolved problem and generate new types of information systems through development of new and innovative artefacts in order to solve the problem. As a result, thecurrent study adopts design science research methodology which is a

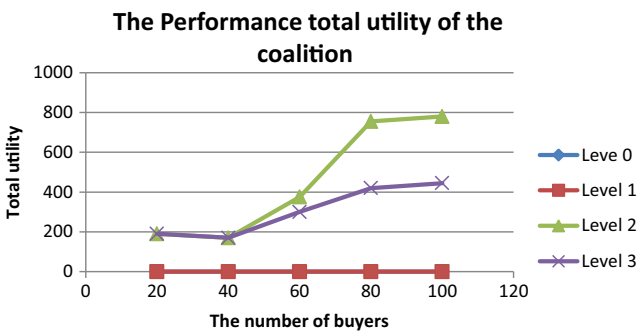

Fig. 6 Total utility under different awareness levels

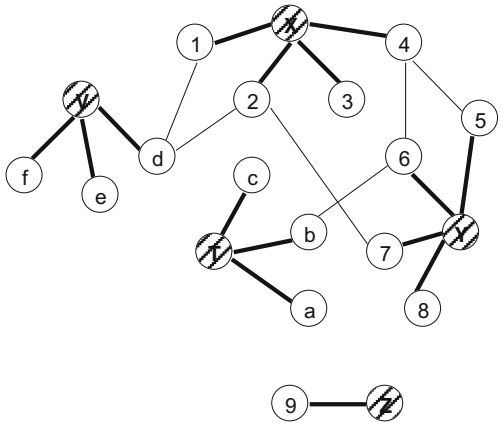

Fig. 7 An Awareness Net with four collaborating roles

prescription-driven methodology where prescriptions are presented as a solution concept. A solution concept in turn is a general prescription, which has to be translated (by experts in the field) to a specific problem domain (Van Aken 2004). The implication of adopting such research methodology for the current study is that the proof of concept will be demonstrated by building a design prototype of simplistic scenarios in order to demonstrate the effects that awareness and knowledge-sharing abilities of various roles will have on the overall outcomes. This section presents simulation results in order to evaluate the performance of the proposed Awareness-based Buyer Coalition system for buyers with similar or different awareness levels.

4.1 The experiment

The objective of this experiment is to demonstrate, through a simulated environment, results of 100 model replications with the aim of demonstrating the effectiveness of the proposed model in creating value in specific circumstances. The software technology used to develop the simulation program is the 'C' programming language.

Table 12 shows simulation parameters used for the experiment. The experiment is run for various sample sizes of 20, 40, 60, 80 and 100 cases. In each case the hypothetical Buyers with different levels of awareness participate in the coalition. The Seller's price list for this simulation is presented in Table 11. When all the Buyers possess Level-0 awareness, their reservation prices would normally be a random number in the range of $70–$100 where $70 is the lowest price for forming the coalition. When all Buyers possess Level-1 awareness, reservation prices of Buyers are randomly chosen from the range of $70 to the minimum reservation price that appears in the Buyers history. When all Buyers possess Level-2 and Level-3 awareness, their reservation price would be equal to the sum of the other Buyers' reservation prices that appear in the history, minus the total coalition. And finally, when the awareness levels of the Buyers differ (in our

Table 7 The utility/discount table for various buyers with level-0 awareness

Time	No.	Buyers	No of current buyers in a coalition	Reservation Prices ($)	History	Current Winners	Coalition Price	Utility of Coalition	Total Discount
9.00 AM	1	A	0	85	–	None	None	(85–100)=−15	0
9.30 AM	2	B	0	80	–	None	None	(85+80) −(90*2)=−15	0
10.00 AM	3	C	0	85	–	None	None	(85+80+85) − (85*3)=−5	0
10.30 AM	4	D	0	77	-	None	None	(85+80+85+77) − (85*4)=−12	0
11.00 AM	5	E	0	70	-	None	None	(85+80+85+77+70) − (80*5)=−7	0

scenario, these levels are 0, 1, 2, and 3) their reservation price for each Buyer will depend on his/her level of awareness. This scenario is shown in Fig. 6.

4.2 Simulation results

Figure 6 shows total discount for various number of Buyers when having Level-0, Level-1, Level-2, and Level 3 awareness. The graph in Fig. 6 is the result of the simulation program introduced in the previous section for the proof of concept. It can be seen that the higher the number of buyers will result in more total discounts and vice-versa.

Figure 6 shows various discounts corresponding to various levels of awareness. For example, the total discount when the level of awareness of all the Buyers is '3' for various sample sizes of 20, 40, 60, 80 and 100 would be 190, 170, 375, 755, and 780 respectively. The total discounts for other levels of awareness with various samples of Buyers are calculated similarly. As shown in Fig. 6, the total discount when all the Buyers have level-3 awareness is always higher than the total discounts when all the Buyers have awareness levels 0, 1, and 2. An interesting result is when the total discount for the level of awareness of all Buyers being 0, is higher than the total discount when the level of awareness of all Buyers is 1. The reason for this is that in the case of Level-0 the Buyers randomly provided their reservation prices whereas in the Level-1 case, Buyers are aware of the other Buyers' reservation prices. In other words, having level-1 awareness in relation to the other Buyers' reservation prices will selfishly result in the Buyer to provide a reservation price that is lower than the highest bid by other Buyers. Additionally, the total discount for the level of awareness of all Buyers laving awareness levels 2 and 3 is higher than the total discount when the level of awareness of all Buyers is 1. The reason for this is that in the case of Level-2 case the Buyers were aware of the other Buyers' reservation prices whereas in the Level-3 case Buyers were aware of both the other Buyers' reservation prices as well as the seller's price list. Finally, the total discount for the level of awareness of all Buyers at level 2 is higher than the total discount when the level of awareness of all Buyers is 3. The reason for this is that in the former case the Buyers were aware of both the other Buyers' reservation prices as well as the seller's price list with partial (or incomplete) discount step using Table 2, whereas in the latter case, they were aware of both the other Buyers' reservation prices as well as the complete seller's price list using Table 1 with all discount step. In one of the four examples in Fig. 6, levels 0, 1 and 2 were assigned randomly to the Buyers at various sample sizes, and

Table 8 Level-1 Awareness space for all buyers

Time	No.	Buyers	No of current buyers in a coalition	Reservation Prices ($)	Current Winners	History	Coalition Price	Utility of Coalition	Total Discount
9.00 AM	1	A	0	85	None		None	(85–100)=−11	0
9.30 AM	2	B	0	84	None	(85)	None	(85+84) −(90*2)=−9	0
10.00 AM	3	C	0	82	None	(85, 84)	None	(85+84+82) − (85*3)=−4	0
10.30 AM	4	D	0	72	None	(85 ,84,82)	None	(85+84+82+72) − (85*4)=−17	0
11.00 AM	5	E	0	70	None	(85, 84, 82, 72)	None	(85+84+82+72+70 − (80*5)=−7	0

Table 9 Level-2 Awareness space for all buyers

Time	No.	Buyers	No of current buyers in a coalition	Reservation Prices ($)	Current Winners	History	Coalition Price	Utility of Coalition	Total Discount
9.00 AM	1	A	0	91	None	–	None	(91–100)=−9	0
9.30 AM	2	B	0	89	A, B	(91)	90	(91+89) −(90*2)=0	(100*2)−(90*2)=20
10.00 AM	3	C	0	75	A, B, C	(91, 89)	85	(91+89+75) − (85*3)=0	(100*3) − (85*3)=45
10.30 AM	4	D	4	85	A, B, C, D	(91, 89, 75)	85	(91+89+75+85) − (85*4)=0	(100*4) − (85*4)=60
11.00 AM	5	E	3	85	A, B, C, D, E	(91, 89, 75, 85)	80	(91+89+75+85+85) − (80*5)=25	(100*5) − (80*5)=100

the results are shown in Fig. 6 which results in expected results, however due to space limitations further analysis of this example is not provided.

5 Conclusion and future work

This study extended previous works on the application of knowledge management to the e-Commerce domain by explicitly addressing the effects that various levels of Buyer awareness would have on the coalition's total utility. This study in particular extends previous works in (Daneshgar and Wang 2007; Laor and Daneshgar 2013) by applying the Awareness Modeling Language to the domain of Buyer Coalition Schemes. By adopting a design science research methodology the present research introduced a meta-mechanism for the current buyer coalition schemes which provides outcome scenarios of buyer coalitions, which in turn can potentially lead to enhanced overall performance of the coalition when the awareness levels of various Buyers are maintained at appropriate levels; the latter is assumed to lead to more knowledgeable bidding decisions by the Buyers. More specifically, while the importance of the "awareness about the collaboration context" had been raised by previous studies (e.g., Laor et al. 2012) the current study continues previous works by introducing and validating a novel awareness-based mechanism for buyer coalitions that generates various outcomes corresponding to different levels of awareness of the collaborating roles within the process. This has been achieved by (i) explicitly adopting a collaborative perspective towards the buyer coalition process, and (ii) developing a theoretical framework for the study which has been synthesized from the existing literatures in the areas of Game Theory, e-Commerce, and Knowledge Management.

Simulation results generally demonstrate that higher levels of awareness of Buyers do not necessarily increase the total coalition discount but it enables Buyers to make more opportunistic and more calculated decisions in order to protect their own personal interests as a result of having higher levels of awareness. This also confirms the fact that when each Buyer of the coalition has different level of awareness, those Buyers with higher levels of awareness will benefit most from their knowledge of the collaboration context of the coalition

Table 10 Level-3 Awareness space for the buyer

Time	No.	Buyers	No of current buyers in a coalition	Reservation Prices ($)	Current Winners	History	Coalition Price	Utility of Coalition	Total Discount
9.00 AM	1	A	0	91	None	-	None	(91–100)=−9	0
9.30 AM	2	B	0	89	A, B	(91)	90	(91+89) −(90*2)=0	(100*2)−(90*2)=20
10.00 AM	3	C	0	75	A, B, C	(91, 89)	85	(91+89+75)−(85*3)=0	(100*3) − (85*3)=45
10.30 AM	4	D	4	85	A, B, C, D	(91, 89, 75)	85	(91+89+75+85) − (85*4)=0	(100*4) − (85*4)=60
11.00 AM	5	E	3	60	A, B, C, D, E	(91, 89, 75, 85)	80	(91+89+75+85+60) − (80*5)=0	(100*5) − (80*5)=100

Table 11 Seller's price schedule

Number of units sold	Unit Price ($)
1	100
2-10	97
11-20	95
21-30	90
31-40	85
41-50	80
51-60	75
>=61	70

process. In practice, such conclusion would have implications on the membership fees of Buyers based on the level of awareness that the coalition website would be able to provide to each Buyer, although such conclusion is at its early stage and constitutes the authors' future work.

Another major conclusion of the study is that the current study provides foundation for considering Buyer cooperation rather than Buyer competition on the basis of total process gain. To promote the idea of collaboration instead of competition, the current study provides the following benefits:

Although not demonstrated in the present study due to space limitations, the proposed model is potentially capable of identifying awareness and knowledge-sharing requirements of various actors for varying levels of awareness. For example, for a role to have level-0 awareness s/he needs to know about his/her password only, whereas for possessing level 2 awareness s/he would need the password, the reservation price of all other Buyers, and for leve-3 awareness s/he would need password, plus reservation prices of other Buyers, plus the history of all bids and relevant details. While the current study briefly touched on this issue, a full investigation on this matter constitutes the authors' future study.

It has been claimed that organizational, group, and individual cultures affect collaboration (action) pattern of individual Buyers in collaborative processes. Again, the proposed model is capable of accommodating such requirements by providing an appropriate level of awareness that has been customized for each role within the process that satisfies various requirements of individual, organizational, and national cultures. In another situation a certain level of total discount may be given as a parameter, and corresponding levels of awareness for various buyers within the coalition is expected to be found. Demonstration of the above concept constitutes the authors' another future research.

One major limitation of the current study is its high level of abstraction and an absence of real-world case scenarios that can better demonstrate complexities of real world situations. In future studies, the authors plan to (i) use more realistic scenarios in order to demonstrate issues arising from the complexities of the real world, and (ii) by adopting a mixed quantitative and qualitative research methodologies combined with experimental design in future studies the authors intend to identify human and organizational factors that may affect the proposed technological solution that cannot necessarily be addressed by the rules of the Awareness Modeling Language alone. In relation to the former limitation, it must be noted that the current study has questioned the validity of the assumption in many current e-Commerce studies that buyers always follow a self-interested strategy and seek their own gains in all times by using environmental/market information. In reality, such information may not be complete. The study also raised the possibility of each person's knowledge within the coalition be different from others. On the basis of the above assertions the paper proposed the awareness mechanism that mimics the reality by assuming various levels of awareness for each role within the coalition, and also by providing a platform where various buyers can collaborate by sharing their own information in order to enhance the total utility of the coalition rather than seeking individual profit maximization goals under a less-than-perfect knowledge of market and business environments. There is however a major limitation to the current study which is also common to all other collaborative business processes; and that is the possibility that not all buyers may be willing to participate in such collaboration. While such action has been shown in the paper to be against the collective interests of the coalition as a whole, such individualistic-option is always open to each buyer to adopt. In situations like this the effectiveness of the proposed awareness mechanism will be undecided and at times, perhaps contradictory. Addressing this issue constitutes the authors' future study.

Table 12 Simulation Parameters

Entities	Parameter	Ranges
Seller	Number of sellers	1
Buyers	Number of buyers	20,40,60,80,100
Knowledge-sharing Capability of Buyers	Awareness levels of Buyers	0, 1, 2, 3

Appendix 'A'

Summary of the awareness net modeling language (adopted from Danbeshgar and Wang 2007)

Awareness net is a conceptual process map for collaborative business processes. Its aim is to identify awareness and knowledge sharing requirements of collaborating actors in collaborative processes. It is made of a set of collaborative semantic concepts namely, *roles, tasks, role artefacts,* and *task artefacts* and are explained below. An Awareness Net can be represented by a connected graph with at least two role vertices that perform at least one collaborative tasks and zero or more individual tasks. The nodes and links of the connected graph constitute various semantic concepts for the collaborative process. A hypothetical awareness net is shown in the top section of the Fig. 7, and includes four roles, V, X, Y and T. The graph shown on the bottom part of Fig. 1 however is not a representative of an awareness net because there is only one role within the process labeled as 'Z'.

The collaborative semantic concepts of the awareness net are described below:

Role = Role is a human actor that perform a set of *tasks* within the process. An actor may play several roles within the process, but a role is played by one actor at any given time. In Fig. 7, the four roles are shown by filled circles labelled 'V', 'X', 'Y', and 'T'.

Task = A sequence of actions or steps performed by a *role*. Some tasks are performed individually using a *role artefact*, and some are performed in collaboration with one or more other roles, in which case a *task artefact* is used/shared/exchanged by the collaborating roles. In Fig. 7, the three tasks corresponding to the role V are shown by plain circles labelled 'f', 'e' and 'd'.

Role Artefact = It is a knowledge asset/artefact that a *role* uses personally (non-collaboratively) in order to perform one of his/her individual tasks within the process. In Fig. 7, the role artefacts corresponding to the role 'V' are {V-f}, {V-e}, and {V, d}.

Task Artefact = It is an organisational/shared knowledge asset/artefact that two or more *roles* 'use/share/produce/act upon' in order to perform a collaborative task. In Fig. 7, the two task artefacts used by the roles X and V are {{1-d} and {2-d}.

Awareness levels

Under the Awareness Net modeling language, the human-bound psychological approach of awareness initiated by the interactionist researchers in the field of social psychology, has been extended to a process-bound context of business organizations where individuals perform collaborative tasks in order to achieve certain process goals. Five levels of (process) awareness have been identified by the original author of the Awareness Net and are listed below:

Level-0 awareness: is the role's awareness about his/her *role* within the collaborative process, the relevant *role artifacts, and* the *tasks* that s/he performs within the process. In Fig. 7 the level-0 awareness for the role 'T' consists of the following set of objects:

$$\text{Level}{-}0(\text{T}) = \{\text{T}, \{\text{T}, \text{c}\}, \text{c}, \{\text{T}, \text{b}, \ \text{b}, \{\text{T}, \text{a}\}, \ \text{a}\}$$

Level-1 awareness: is about the awareness of the context of the collaborating roles. It is the role's *level 0 awareness*, PLUS all the concepts/objects on the process map of Fig. 7 that correspond to the *tasks* that are performed by other collaborating *roles* within the process. The Level-1 awareness for the role 'V' is:

$$\text{Level}{-}1(\text{V}) = \{\text{Level}{-}0(\text{V}), \{\text{d}, 1\}, 1, \{1, \text{X}\}, \text{X}, \{\text{d}, 2\}, 2, \{2, \text{X}\}\}$$

Level-2 awareness: is about having awareness about all the process roles. It extends level 1 by including additional remaining *roles* within the process.

Level-3 awareness: extends level 2 by including all the remaining *task artifacts* that exist within the process.

Level-4 awareness: extends level 3 by including all remaining concepts within the process; that is, everybody else's *personal tasks*, as well as their related *role artifacts* that have not been known to the role at previous levels of awareness. A role's level-4 awareness corresponds to his/her full awareness about all the concepts that exist on the process map in Fig. 7.

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