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BIDDER BEHAVIORS IN REPEATED B2B PROCUREMENT AUCTIONS

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ABSTRACT
B2B auctions play a key role in a firm's procurement process. Even though it is known that repetition is a key characteristic of procurement auctions, traditional auctioneers typically have not put in place a suitable mechanism that supports repetitive auctions effectively. In this paper, we empirically investigate what has taken place in repeated procurement auctions based on real world data from a major outsourcing company of MRO (Maintenance, Repair and Operations) items in Korea. From this empirical study, we discovered the followings. First, we discovered that the repeated bidders contribute majority of all bids, and that the number of new entrants declined significantly as time passes. Second, repeated bidders become inactive and virtually leave the market, particularly if they fail to win in the auctions even though their bid prices were competitive. This implies that repeated bidders with lower winning rates have a higher possibility of becoming inactive. Third, the number of bidders along with the purchase amount and the bidder's previous winning rates are critical factors in determining both the winning bid price in the auction level and the bid price of each bidder. According to these research findings, we recognize that retaining a sufficient number of repeated bidders is crucial in the repeated procurement auction market. This motivates auctioneers to provide incentives to the repeated bidders to retain them in future auctions.

Categories and Subject Descriptors
H.1.2 [**Information Systems**]: User/Machine Systems – *Human factors*. J.4 [**Computer Applications**]: Social and Behavioral Sciences – *economics.*

General Terms
Theory, Verification.

Keywords
Repeated bidding, repeated bidder, procurement auctions, bid pricing behavior.

1. INTRODUCTION
Online auctions have been a major pricing mechanism in B2B procurement, and they have been used to procure billions of parts and services in the private and government sectors (Jap 2007).

Beall et. al. (2003) stated that the potential applicability of auctions by aggressive users could be as high as half of their annual procurement, and most likely about 10 – 15% on average.

The auction mechanism that is widely used in procurement process is the first-price sealed bid reverse auction, whose main objective is to reduce the cost of one time purchase. Studies conducted in the early stage of B2B auctions reported a high effect of cost reduction from auctions. For instance, Cohn (2000) reported 15% procurement cost savings, and Smart and Harrison (2003) reported the case of Airco Company achieving 30% reduction of its stationery procurement. These results far exceeded their expectation at that time. However, the concern of the present study lies in whether the effectiveness of auctions can be sustained as auctions repeat. Pinker et. al. (2003) pointed out that repetition is the key aspect of procurement auctions as they are often conducted yearly, quarterly or even daily.

In this research, we empirically investigate what has transpired in the real world of repeated procurement auctions in terms of bidders' behavior. Since the first-price sealed bid reverse auction mechanism was originally designed for spot sourcing without considering the nature of repeated procurement, we evaluate bidder's behaviors in a repeated procurement setting to justify the need for new auction mechanisms which are suitable for repeated auctions.

There have been very few empirical studies on repeated procurement auctions. Ishii (2009), Porter and Zona (1993) studied the issues of bidder collusion in repeated auctions of public work and highway construction respectively. Jofre-Bonet and Pesendorfer (2000) studied the capacity constraint effect on the bid price in the case of a highway construction auction. Zong and Wu (2006) and Goes et. al. (2010) proved that information learned from previous auction influence the bid prices of subsequent rounds. However, no empirical study has yet investigated the overall phenomena of repeated procurement auctions to improve the performance of frequently repeated B2B procurements.

In this study, we investigate several research questions that affect the auctioneer's procurement performance in a repeated auction setting regarding bidder behaviors.

First, what is the contribution of repeated bidders in repeated auctions?

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If a small number of repeated bidders cover most bids, then repeated bidders should be treated more carefully in order to maintain the effectiveness of auctions. This aspect of SRM (Supplier Relationship Management) is the same as the repeated buyers in CRM (Customer Relationship Management). In this regard, we need to verify whether the Pareto principle (i.e., the 80-20 rule) applies to repeated procurement auctions. Another issue that we need to examine carefully is the number of new entrant bidders in the market. According to Daly and Nath (2005), most industries have a limited number of incumbents and a limited number of potential entrants. Given a limited number of new entrants in repeated auctions, retaining repeated bidders is very crucial to the auctioneer in terms of keeping the bidding prices low.

Second, why do some repeated bidders become inactive?

Since retaining existing bidders is important, we need to ascertain how many bidders become inactive, which means they never submit bids after having participated in a certain number of auctions. We also need to know why they become inactive, so that we can propose a new mechanism of retaining existing bidders. To answer this question, we focus our attention on repeated bidders, because their contribution to the auction performance is critical in repeated procurement. The auctioneer needs to know how many repeated bidders have left the auction market and the reason why in order to improve the procurement performance.

Third, what are the major determinants of the winning bid price of the auction and the individual bidder's bid price?

We need to analyze how bidders decide their bid prices in repeated auctions. Each bidder's bid price will determine the final winning price of the auction. To reduce procurement cost, the auctioneer needs to identify the major factors that determine winning bid price of each auction. Although there are many factors that affect the bid price, we consider the factors that can be obtained by the auctioneer from historical data of auctions in this study. We particularly pay attention to the effect of the number of participating bidders on the winning bid price.

The impact of the number of bidders on auction performance has been addressed in many previous studies. Bulow and Klemperer (1996) noted that an increased number of bidders may raise price competition and cost savings for the auctioneer. Hence, keeping a sufficient number of bidders is critical to lower the bid price and eventually reducing the procurement cost for the auctioneer (Tenorio 1993). In this regard, we need to investigate bidders' bid pricing behavior. Since repeatedly participating bidders maintain the competition, they should be retained so that they will participate in future auctions.

To answer the above research questions, we conducted an empirical study with real auction data from the largest procurement outsourcing company in Korea. An outsourcing company can utilize a group purchasing mechanism to make auctions more attractive to bidders. The sourcing companies play the role of auctioneer to purchase on behalf of their clients. The major B2B sourcing companies in Korea - iMarketKorea, ServeOne, eN2B - work in this manner too. Based on the results of this empirical study, we propose requirements for a sustainable auction mechanism for repeated auctions in procurement in another paper (Park et al. 2008).

The rest of this paper is organized as follows. Section 2 empirically shows that most bids are submitted by a small number of repeated bidders in repeated auctions and the phenomenon of limited new entrants. Section 3 describes why repeated bidders become inactive. Section 4 develops a bid pricing model and illustrates the importance of retaining repeated bidders. Based on the results of the empirical study, a sustainable auction mechanism for repeated auctions is discussed in Section 5. Section 6 concludes with limitation of the study and directions for future study.

2. CONCENTRATION ON REPEATED BIDDERS AND LIMITED NEW ENTRANTS

2.1 Data Collection

To investigate the current phenomena in repeated auctions under the traditional auction mechanism which is first price, sealed bid reverse auction, we obtained auction data from the leading procurement outsourcing company in Korea, iMarketKorea (IMK). The auction service started in 2001 and we obtained a data set from 2001 to 2007 for the study. During the period, about 2,000 auctions were conducted every year. The trading volume is about 200 billion won (about US$160 million) per year, and a roughly 7% brokerage fee was charged. IMK deals with 293 item categories; 214 belong to MRO and the remainders are related to construction items. About 30% of the trading volume involved in MRO items. We use the MRO auction data and the data set covers the entire bidding history for each auction, including auction identification number, item and its category, purchase amount, bidders, bid prices, number of participating bidders, auction type and auction results. In procuring MRO items, IMK used the traditional auction mechanism, the first price, sealed bid auction, on their online auction site.

2.2 Concentration on Repeated Bidders

According to the well-known "Pareto principle", we assumed that about 20 percent of repeated bidders generate 80 percent of bids. This bidder behavior is analogous to customer behavior. As the cost of retaining existing customers is considerably lower than the cost of acquiring new customers (Hart, Heskett and Sasser 1990; Reichheld and Sasser 1990), we expect that the cost of retaining repeated bidders will be less than the increased procurement cost without them.

There are 214 MRO item categories in IMK data and each category has a different number of auctions. We defined the category with repeated auction, if the auction in the category had opened more than once per quarter.

Only 31 categories (14% of all MRO categories) had opened auctions repeatedly, but the number of auctions by these categories covers 70% of auctions and their number of bid covers 76% of bids. This means most client companies buy similar items from the MRO procurement outsourcing company.

In this study, we operationally define a bidder as a 'Repeated Bidder' if the bidder has participated auctions repeatedly for more than a year. According to IMK data, 17% of bidders are repeated bidders and they cover 71% of all bids as summarized in Table 1. Therefore, Pareto principle exists in both repeated auctions and repeated bidders. According to the Table 1, repeated bidders participated in 31.9 auctions on average, while non-repeated bidders participated in 2.7 auctions on average. In general, repeated bidders participated in auctions at a rate 11 times higher than non-repeated bidders. Hence, special care is necessary to ensure that repeated bidders continue their biddings in upcoming auctions.

Table 1. Repeated Bidders

	All bidders (a)	Repeated bidders (b)	Non repeated bidders (c)	Repeated bidders ratio (b/a)
Number of bidders	1042	181	861	17%
Number of bids	8135	5773	2362	71%

2.3 Limited New Entrants

Auctions perform well if there exist a sufficient number of bidders. To maintain a sufficient number of bidders, the role of potential entrants is critical. If there are a large number of potential entrants, the auctioneer may depend on new entrants to keep the price low. But this assumption is not realistic. According to Daly and Nath (2005), most industries have a limited number of incumbents and a limited number of potential entrants in procurement auctions. This hypothesis is validated by the IMK data, as Figure 1 shows, for the number of new entrants per year.

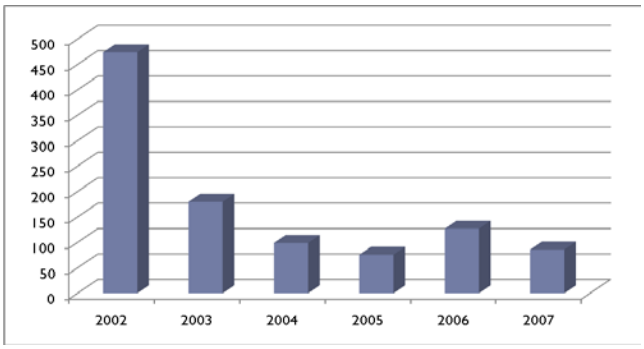

Figure 1. Number of new entrants per year

According to Figure 1, the number of new entrants drastically declined after the first year, and gradually declines as time passes although there is a slight ripple in a few new item categories. Thus we can conclude that there will be a limited number of new entrants after a few years of repeated auctions. In such a situation, retaining a sufficient number of existing bidders over time is critical for the auctioneer to keep procurement prices competitive.

3. WHY SOME REPEATED BIDDERS BECOME INACTIVE

With limited new entrants, the role of repeated bidders who contribute more than 70% of total bids is crucial to maintain the performance of auctions. Thus, the auctioneer has to retain repeated bidders over time. In this section, we study the participation behavior of repeated bidders over repeated auctions. A concern is that some repeated bidders stop participating after a certain number of attempts and never participate in auctions again. The auctioneer needs to know the reason why repeated bidders become inactive and leave the auctions. This phenomenon is analogous to CRM. For example, Peppers and Rogers (1993) pointed out that the majority of businesses were losing 25% of their original customers every year. Reicheld and Sasser (1990) proposed that businesses could gain 100% more profit by maintaining 5% of their old customers. SRM in a repeated auction context needs to pay similar attention to their bidders.

There can be many possible reasons for bidders to become inactive and leave the auction market temporarily or permanently. Sometimes bankruptcy or shortage of inventory may be the reasons, but these data cannot be traced from the auction data and such factors cannot be monitored and controlled by the auctioneer either. However, the auctioneer can monitor the behavior that is related with bidders' previous auction results. According to Riley and Samuelson (1981), repeated bidders become inactive when they have won the auctions less than they have expected or the expected winning probability is low. While Riley and Samuelson only provided conceptual findings in their research, our study attempts to empirically assess bidders' behavior on leaving the market.

In this regard, we classified repeated bidders in IMK into two categories: ***Active Bidders*** and ***Inactive Bidders***. We define that a bidder as Active Bidder if the bidder has participated in more than a year. If a bidder stops participating in auctions and never returns during the rest study period, the bidder becomes Inactive Bidder.

Using the IMK data, we compare the winning rate (number of wins / number of participations) between the active bidders and inactive bidders. Table 2 shows that the total number of repeated bidders is 181 and 30% of them (59 bidders) are inactive bidders. The average winning rate of active bidder is 0.30, while 0.21 for inactive bidder. The t-test indicates that, the winning rate of inactive bidders is significantly lower than that of active bidders. From this result, we can conclude that a low winning rate is one of the main reasons for repeated bidders to become inactive. This result confirms the Riley and Samuelson (1981) postulates. To maintain the performance of auctions in repeated procurements, the auctioneer needs to prevent the repeated bidders from being inactive. In particular, the repeated bidders who have submitted more competitive bid prices should be retained in order to enhance the auction performance.

Table 2. Comparison between Active and Inactive Bidders

	N	Average winning rate	*t* value	Degree of freedom	*p* value (Two tails)
Active bidders	122	0.30	-2.678	179	0.008
Inactive bidders	59	0.21			

4. WINNING PRICE OF AUCTION AND BIDDER'S BID PRICE MODEL

We study how the individual bidder determines the bid prices in repeated auctions, and how the winning prices of the auctions are determined. The bid price is modelled at bidder layer, while the winning price at auction layer.

For this study, we selected the item A4 sheets from the copy paper category. This item is particularly selected because it has standardized specifications and it is a frequently auctioned good. In other MRO categories, the products' specifications vary even though they belong to the same category. Different specifications cause large price variance. Thus, they cannot be used for price modelling. The study with the relative prices of all items will be conducted and analyzed in the next paper. The selected A4 data is used for the study of two models: Winning Bid Pricing Model and individual Bid Pricing Model.

The sample auction data consists of 102 auctions with 366 bids from 29 bidders. Their auction type is the traditional reverse auction with the first price sealed bid rule. Data from the 6 repeated bidders are used to study the bidder's pricing behaviour.

4.1 Bid Pricing Model

Many factors can influence the bid price of an auction, such as the bidder's cost function (Hao 2000), capacity and inventory level (Jofre-Bonet and Pesendorfer 2000), competitors' cost function (Hao 2000), previous auction results (Goes et al. 2010, Zhong and Wu 2006, Neugebauer and Selten 2006) as well as purchasing amount (Viswanathan and Wang 2003) and number of participating bidders of the current auction (Smart and Harrison 2003, Bulow and Klemperer 1996, and Tenorio 1993).

For each factor, the information holder is different and some information is not revealed to other auction participants strategically. In this study, our purpose is to model the bid pricing from the auctioneer layer as well as bidder layer. Figure 2 depicts the model of determining the winning bid price and individual bidder's bid price.

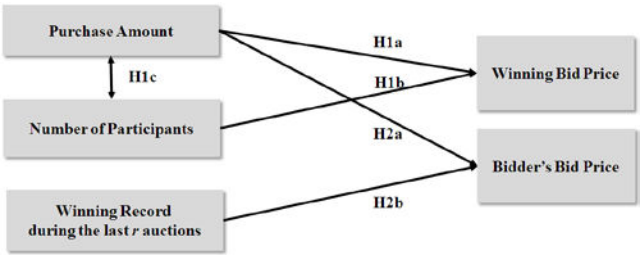

Figure 2. Analysis model of bid prices

For the dependent variable, we use the winning bid price of the auction or each bidder's bid price. In the A4 sheet case, the bid price implies the unit price.

4.1.1 Auction Layer

In the auction layer, we expect that the winning bid price will decrease as the purchase amount increases, due to the volume discount effect (Viswanathan and Wang 2003) as well as economy of scales. To reconfirm the traditional volume discount effect in the repeated auction context, we test the hypothesis (H1a) that the purchase amount has a negative impact on the winning bid price.

H1a: As the purchase amount increases, the winning bid price decreases in repeated auctions.

According to Bulow and Klemperer (1996), it is worthwhile for a seller to devote more resources to expanding the number of bidders than to identify the best mechanism to improve the performance of the auction. Many theoretical studies have noted that increasing the number of bidders will cause more serious competition among bidders and lead to a decrease of the bid price in reverse auctions (Smart and Harrison 2003, Tenorio 1993 and Hao 2000). This means the number of bidders significantly affects the auction performance, which means the winning bid price. Hence, we set hypothesis (H1b) to reconfirm the earlier theories.

H1b: As the number of bidders increase, the winning bid price decreases in repeated auctions.

Furthermore, we investigate the correlation among independent variables. In general, higher economic stakes motivate more suppliers to participate in the auctions (Jap 2007). Hence, it is hypothesized that purchase amount has a positive correlation with the number of participating bidders in the auction.

H1c: The purchase amount has a positive correlation on the number of bidders in repeated auctions.

4.1.2 Bidder Layer

Fundamentally, the individual bidder's bid price determines the auction's winning price which is the procurement cost for the buyer. Therefore, each bidder's bid pricing behaviour is modelled in the bidder layer.

Chen (2008) shows that the increased volume decreases the bid price of each bidder in a group buying auction. Bichler and Kalagnanam (2006) and Hohner et al. (2003) apply the volume discount effect on their auction mechanism design in a procurement auction to decrease each bidder's bid price. To identify the impact of purchase amount on each bidder's bid price decision, we test the hypothesis (H2a) that the purchase amount has a negative impact on the bidder's bid price.

H2a: As the purchase amount increases, the bid price decreases in repeated auctions.

In repeated auctions, bidders' experiences in previous auctions affect the current auction's bid price. Selten and Stoecker (1986) argued that learning direction theory holds in a repeated auction and this has been supported by many other studies (Neugebauer and Selten 2006, Selten et al. 2005). According to the theory, after a successful bid a subject tends to increase his bid, while after experiencing loss of an opportunity the subject tends to decrease his bid in a reverse auction. Goes et al.(2010) show that bid pricing behaviour is consistent with learning direction theory in sequential English auctions. However, in procurement auctions, the prediction is mixed. Fevrier (2003) shows numerically that the winner of the current auction should bid less aggressively than the loser in the subsequent auction in procurement. But Luton and McAfee (1986) suggest that the winner of the previous auction should bid aggressively in the next auction. In a repeated procurement auction, the supplier needs to win the auction continuously to secure sales (Pinker et al. 2007). Hence, we need to empirically explore the effect of the bidder's previous auction experience in repeated procurement auctions.

The most recent empirical study of the effect of previous auction results was conducted by Zhong and Wu (2006). They show that the information learned from the previous auction, such as the rank order of bid prices and lowest winning bid, has a significant impact on the suppliers' next bid. Studying only two consecutive auctions may not be enough to investigate bidders' pricing behaviour in the case of multiple repeated auctions.

To generalize the measure considering the previous winning rate, we adopt each bidder's winning rate for the last *r* auctions, which is denoted as Winning_Record(*r*), or WR(*r*) in short. In this study, we define ***r*** as the ***level of patience*** of each bidder in repeated auction. Since each individual bidder may have different level of patience, we seek the *r value* of each individual bidder. The *r value* can be derived by the correlation level between current bid price and the previous auctions' winging results.

According to the learning direction theory, some bidders may increase their bid prices, if they have a high winning rate in

previous auctions to gain a margin in the current auction. We name this kind of bidders ***Margin Seekers*** and they can be classified as traditional risk takers. Others may decrease their bid price to improve the chance of winning auctions continuously, so this kind of bidder are ***Win Seekers*** and they correspond to traditional risk averse bidders. The remaining bidders may be indifferent to their past winning record in deciding their current bid price, thus can be called as ***Neutral Bidders*****.** With the perspective of three bidder types, we study the effect of past winning record on the current bid price. We define that Winning_Record(*r*) has a different impact on the bid price depending upon the bidder type. We can identify the type of each individual bidder according to this perspective.

H2b: The bidder's previous auction experience has an impact on the bid price in the current auction.

H2b(i): The bidder is a margin seeker, if the bid price increases while the previous auctions' winning record(r) increases.

H2b(ii): The bidder is a win seeker, if the bid price decreases while the previous auctions' winning record(r) increases.

H2b(iii): The bidder is a neutral bidder, if the bid price is not correlated with the previous auctions' winning record(r)

4.2 Empirical Analysis Results

The sample auction data for the empirical study of bid pricing model consists of 102 auctions with 366 bids from 29 bidders. Descriptive statistics of key variables are summarized in Table 3.

Table 3. Descriptive statistics

	Min	Max	Average	Standard deviation
Winning bid price (unit: Won)	1,060	1,507	1,349.38	102.44
Bid price (unit: Won)	1,060	1,690	1,373.06	99.35
Number of bidders	2	8	3.59	1.67
Purchasing amount (unit: ream)	500	840,000	30,564.12	114,845.88

4.2.1 Analysis Results: Auction Layer

To test the hypothesis in the auction layer, 102 auction data are used for the test and the unit of purchase amount is set as one ream. For the hypothesis (H1) test, we use a multivariate regression model to determine the relationship among the independent variables and dependent variable as expressed in equation (1).

$$Winning\ Bid\ price = a0 + a1*Purchase\ Amount + a2*Number\ of\ Bidders \quad (1)$$

The results of the multivariate regression are summarized in Table 4.

Table 4. Multivariate regression results: Auction Layer

Dependent variables	Independent variables		
	Intercept	Amount	Number of bidders
Winning bid price	1,476.03**	-0.003**	-33.01**
Adjusted R^2	0.421		

* p<0.1 **p<0.05

According to the results in Table 4, H1a and H1b are supported. Both the increased amount and number of bidders significantly decrease the winning bid price. This implies that the new mechanism to maintain higher number of bidders will be critical to keep the procurement price low.

The hypothesis H1c tests the effect of purchase amount on number of participants. The result of correlation analysis indicates that the purchase amount has a significant positive correlation with the number of participants (correlation coefficient = 0.23, p<0.01). In a multivariate regression, the multicollinearity problem can occur when there is a correlation among independent variables. In this case, there is a correlation between the amount and number of bidders. To verify multicollinearity, we use the VIF (Variation Inflation Factor); all independent variables' VIF value is less than 10 which implies the model does not suffer from the multicollinearity problem.

4.2.2 Analysis Results: Bidder Layer

Among the 366 bidding data, only the 222 data (60%) from 6 repeated bidders are used for the test of the bidder layer because the research purpose is to analyse the bid price model of repeated bidders. To test hypotheses H2a and H2b in category level, we use a multivariate regression model as expressed in equation (2).

$$Bid\ price = b_0 + b_1*Purchase\ Amount + b_2*Winning\_Record(r) \quad (2)$$

Before we run the multivariate regression model, we first need to find the level of patience. Winning records of the last eighth auctions are considered as the candidate for the level of considering past auctions: Winning_Record(1), Winning_Record(2),…, Winning_Record(8). For instance, Winning_Record(2) means the bidder considers average winning rate of the last 2 auctions. To discover patience level *r*, we analyse the correlation of Winning_Record(*r*) with the current bid price as shown in Table 5.

Table 5. Correlation coefficient between current bid price and the average winning rate in the last *r* auctions

	WR(1)	*WR(2)*	*WR(3)*	*WR(4)*	*WR(5)*	*WR(6)*	*WR(7)*	*WR(8)*
Correlation Coefficient	-0.071	-0.135	-0.135	-0.122	-0.098	-0.098	-0.090	-0.039
p value	0.296	0.051	0.053	0.089	0.175	0.182	0.229	0.612

As shown in Table 5, the last auction's winning record, WR(1) is not significantly correlated with the bid price of current auction. WR(2) is correlated with bid price significantly and the correlation coefficient decreases and *p* value increases as *r* is increased. The results are consistent with the argument of Zhong (2007) that bidders have a short memory in learning in repeated auctions. Hence, we choose WR(2) to analyze the previous

auction results' effect on bid price. The correlation coefficient has a negative value and by fitting the bid price and WR(2), we found the bid price decrease as WR(2) increases along the auctions. Therefore, the average behaviour of repeated bidders at the A4 item level can be classified as a *Win Seeker*.

To verify multicollinearity, we also use the VIF (Variation Inflation Factor). All independent variables' VIF values are less than 10. The results of the multivariate regression are summarized in Table 6.

Table 6. Multivariate regression results: Item level

Dependent Variables	Independent Variables		
	Intercept	Amount	WR(2)
Bid Price	1399.12**	-0.00025**	-42.86**
Adjusted R^2	0.06		

* p<0.1 **p<0.05

According to the results in Table 6, H2a and H2b are supported. In H2a, an increased amount causes a significant decrease of the bid price. In H2b, the repeated bidders in A4 items are *Win Seekers* and they have a tendency toward risk aversion to secure sales in repeated procurement, contrary to the learning direction theory. But the behaviour of individual bidder may vary.

Each bidder may have different level of patience. Each bidder's level of patience is analyzed and the results are summarized in Table 7.

Table 7. Maximum correlation coefficients between the current bid price and past r winning rates

Bid price	WR(1)	WR(2)	WR(3)	WR(4)	WR(5)	WR(6)	WR(7)	WR(8)
Bidder A	0.353*	.249*	.283*	.325*	.367*	.329*	.303*	.387*
Bidder B	-0.163	-.229	-.278	-.266*	-.356*	-.163	-.156	-.075
Bidder C	-0.048	-.138	-.043	-.040	-.091	-.122	-.146	-.041
Bidder D	0.018	-.018	-.172	-.207	-.164	-.310	-.259	-.148
Bidder E	0.042	-.318*	-.248	-.240	-.191	-.136	-.102	-.061
Bidder F	0.156	-.308*	-.342*	-.301	-.216	-.347*	-.372*	-.438*

* p<0.1

According to case of bidder A, its current bid price is most significantly correlated with WR(8) positively. This implies he is a very patient bidder. However, a bidder A is not a Margin Seeker because the bid price increases as the winning rate increases, and vice versa. Bidders B, E, and F, on the other hand, have negative correlation and they are Win Seeker. Bidder C and D are risk neutral because there is no significant correlation. This confirms that each bidder have different bid pricing behaviour.

5. SUSTAINABLE AUCTION MECHANISM FOR REPEATED AUCTIONS

As noted earlier, 17% of bidders are repeated bidders who cover 71% of all bids. Furthermore there are a limited number of new entrants in the MRO market. Hence, retaining existing bidders is critical to maintain the auction market's competitiveness. However, 30% of repeated bidders become inactive under the traditional auction mechanism in repeated auctions. Repeated bidders who bid competitively but win less than they expected have a high possibility of becoming inactive. Keeping the number of bidders also significantly affects the bid price which will determine the procurement cost of the auctioneer. In repeated auction, the auction mechanism needs to provide incentives to maintain competitive bidders to join the auction repeatedly to increase the auction performance along the auctions.

Despite the prevalence of repeated procurement auctions in business practice, there have been few attempts at designing a sustainable auction mechanism for repeated procurements.

In order to have sustainability in repeated procurement, the underlying auction mechanism needs to help the auctioneer to maintain a number of competitive bidders for each auction over time. Keeping a sufficient number of bidders is critical to lower the bid price of each participating bidder and eventually to decrease the procurement cost for the auctioneer. For this purpose, an auction mechanism should motivate the bidders to join future auctions repeatedly. In particular, losing bidders with relatively competitive bid prices in previous auctions must be incentivized to compete in future auctions; otherwise they will drop out (Lee and Szymanski 2007). Through the provision of incentives, the auctioneer will reap the benefits of the price advantage by preventing competitive bidders from dropping out of the future auctions.

To increase and maintain the number of bidders in repeated auctions, Colombo (2003) suggests compensating losing bidders as much as the cost of their bid preparation. The rationale is that the compensation will entice firms who have only marginal chances of winning to enter the auction so that the auctioneer will be able to attract more marginal bidders and drive down the price. However, in the large scale B2B procurement exchanged, it is not straightforward to decide whom to compensate and how much to compensate. Supporting the bidders whose bid price are always uncompetitive would be wasteful. Moreover, compensation may generate fake bidders who may participate in auctions only to capture the subsidy. Good news with online B2B auctions is that the bid preparation cost in for online auctions has become very low. Thus this compensation scheme may not be considered.

Park et al. (2008) presented a preliminary study on the design of a new auction mechanism for repeated auctions. They proposed an incentive mechanism based on a bidder's previous bidding prices and winning results. The incentive mechanism provides greater winning opportunity to bidders who have bid at relatively competitive prices but have won comparatively less in the past auctions. The incentive score is systematically calculated based on the bidder's previous bid price and winning record. Consequently, the incentive mechanism will motivate competitive bidders to join more auctions and it will ultimately decrease the auctioneer's purchase cost. Hence, the proposed mechanism would increase the expectation of continuity between buyers and suppliers, which is one of the key factors for successful buyer-supplier relationships.

Few studies have attempted to develop a sustainable mechanism for repeated auctions. As the adoption of auctions in procurement increases, the comprehensive research for creation of sustainable auction mechanism for repeated procurement becomes more important to reap the benefits of repeated auctions.

6. CONCLUSIONS

Auctions play key roles in B2B procurement, especially with the growth of the Internet. In procurement auctions, repetition is a common nature. In this paper, we have empirically investigated what has transpired in repeated procurement auctions and have obtained valuable insights for the auctioneer to enhance the procurement performance of repeated auctions.

Through the empirical analysis with IMK data, we discovered the followings. First, we found that repeated bidders (17% of all bidders) submit 71% of all bids. As such, the Pareto principle is applied to repeated auctions. We also confirmed that there is a limited number of new entrants in the repeated procurement market. Hence, retaining repeated bidders is critical to keep the auction market competitive. Second, repeated bidders tend to become inactive when their winning chance is low. Thirty percent of repeated bidders become inactive due to a low winning rate. This eventually results in an increase of bid price and procurement cost. Finally, we analyzed bid pricing behavior. We found that purchasing amount and number of bidders significantly influence the winning bid price of the auction. Since the number of bidders influences the winning bid price most significantly, the auctioneer needs to maintain a sufficient number of bidders during repeated auctions to keep the procurement cost lower. In bidder layer, purchase amount and bidder's winning rates in the previous auctions influence the bid price in the repeated auction setting. The repeated bidders as a group may be regarded Win Seeker, however we confirmed that individual bidders have different risk behavior.

In the IMK case, 17% of bidders participated in auctions repeatedly and covered most of the bids. During the six years of repeated auctions, 30% of them left the auction and never returned. Moreover, there were few new entrants. Therefore, the auctioneer needs to design incentive mechanism in order to retain competitive repeated bidders as long as the cost of the incentive does not exceeds the price reduction effect. Few studies have attempted to give an incentive to bidders to motivate them to join more auctions, and thus more comprehensive research for this problem is needed.

There are limitations to this research. We need to confirm whether our findings can be extended to other items and other sourcing portals. In this study, the data are bounded by the available data in the auction market. In future study, the bidder's bid price model need to be extended to other MRO items and data analysis in other items is in progress. Even though using the real prices does not make sense because the product specifications evolve and vary, we can use the relative prices for the winning price model. This study is conducted as the next phase of study. Furthermore, the behavior model of individual bidder for all bidders of the entire items needs to be analyzed to identify the bidders risk behaviors in the real world.

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