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Introduction of Electronic Combinatorial Auction to a Food Manufacturer

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Abstract

Food manufactures often face difficult purchasing decisions when multiple business constraints and several bidding options affect them. The objective of the buying organization is to ensure corn sweeteners are purchased so as to minimize the total operational cost. To do so, the purchasing department compared the conventional method of a sealed-bid auction to, first, a reverse auction with single-item bids and, then, to a reverse auction with bundled bids. The senior author—as director of corporate purchasing—researched, proposed and executed the combinatorial auction to source corn sweeteners for a large, processed-meat manufacturer who uses large quantities of four corn sweeteners at its eight processing plants located across the United States. Two buying techniques were — electronic reverse auctions and combinatorial reverse electronic auctions. First, we present the difficulties of using a reverse combinatorial auction and describe the method used to obtain the least cost combination of bids that satisfies buyer's RFQ. Second, we show the progression of the bidding rounds and estimate the savings from this combinatorial auction as compared to what the company did with either a manual or a reverse single item auction. Finally, we address the diminishing marginal returns of repeated usage of CeRA, and describe how this food company advanced from the auction setting to a risk-management-based procurement process.

Keywords: transaction costs, optimization, eRA's, combinatorial

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Introduction

A firm can outperform its competitors by being able either to charge a higher price or to produce at less cost or both (Porter 1998). To be able to charge a higher price the firm must offer greater customer value. To achieve the latter, the firm must realize more efficiencies than its competitors. Such efficiencies may be realized internally or externally—through working with its supply chain partners. The latter is the subject here; specifically, cost savings through purchasing. Among the ways to reduce purchase cost is to incentivize suppliers: first by being asked to compete—head-to-head—and, second, to find cost savings through bundling bids.

The customer's choice of procurement method determines the intensity of bid competition and bidder's flexibility to bundle items in a customer's RFQ. When the customer offers bidders' flexibility to assemble from an RFQ their most favorable bundles, and suppliers compete to win the bid(s); flexibility gains to suppliers will, at least in part, be returned to the customer. However, allowing for such flexibility makes it difficult for the customer to identify the least-cost set of bids that satisfies, exactly, its RFQ. Simple, electronic reverse auctions (eRAs)—where the industrial customer requests single item or fixed-bundle bids are popular because of their ease of use. Such auctions encourage price competition among bidders, but preclude bid flexibility.

Although allowing bidders to make up and bid on their own bundles can produce significant cost savings, doing so complicates, greatly, the bid evaluation process, which increases bid-evaluation costs and lengthen auction response time, especially when done manually. The electronic, reverse combinatorial auction, implemented here, provides the bundling flexibility and calculates "winning bids" to give rapid response to bidders so as to promote bid competition.

The senior author—as director of corporate purchasing—researched, proposed and executed the combinatorial auction to source sweeteners for a large, processed-meat manufacturer who uses large quantities of four corn sweeteners at its eight processing plants located across the United States. Those corn sweeteners help to bind the meat together add flavor and promote the fermentation essential to the production of semi-dry cured and dry-cured sausages and processed meats, such as hot dogs, and bologna. Corn Sweeteners, made from the starch of maize (corn U.S.), are composed mainly of fructose, which is equal to glucose in caloric value, but sweeter and less expensive.

The combinatorial auction allowed each qualified supplier to structure, within the specifications of the RFQ, bundles of sweeteners and plant delivery locations to take advantage of that supplier's unique synergies in production and delivery. Corn sweeteners, for example, are the result of some joint production, of corn syrup, crystalline fructose, glucose—commonly referred to as dextrose—and two formulations of high fructose corn syrups—42 percent and 55 percent fructose. Some the manufacturers are corn millers while others are just distributors of dry product. Likewise, delivery transportation options may offer savings that could affect the bid price. For example, there may be savings in delivering different products, all at once to, a plant or of delivering, on a milk run, to a cluster of two or more plants. Allowing each bidder to choose how to form its bidding bundles makes it possible for the bidder to exploit its efficiencies from synergies in production and transportation.

Problem Setting

The study subject is a meat manufacturer who produces both fresh and processed meats. Some of its fresh meat production is used to make processed meats, such as cured, deli, and smoked meats. Beside fresh meat, a major direct input is the class of corn sweeteners—corn syrup, corn syrup solids, dextrose and liquid dextrose. The business operates eight processed meat plants, each using corn sweeteners. Depending on the products produced a plant may require four or fewer sweeteners.

Corn sweetener suppliers often submit multiple bids ranging from a bid to supply a single item to a bid to supply a bundle of items. The supplier's bids are based on price, and non-price performance facets, which suggest the supplier's bids, take into consideration its transportation, purchasing power, or product quality advantages. Normally, purchasing departments organize bids into predetermine lot sizes. The problem is that buyers often force suppliers into unnecessary constraints, and the suppliers' bids are not the best for minimizing costs or reducing the cycle time needed to evaluate bid. The original process of selecting the most competitive bid was complicated and inefficient; therefore, multi-attribute purchasing presented decision problems for the buyer.

Prior to this work, the company's purchasing office used manual auctions by corresponding with bidder through the US Mail. As an employee of the meat manufacturer, the senior author identified over 700 different direct inputs used by the processed meat division and searched for a means to improve purchasing by reducing combined purchase and transaction costs. The study led to the introduction of electronic reverse auctions (eRA) and combinatorial electronic reverse auctions (CeRA). At the heart of the concerns were the buyer's inability to properly evaluate bids with multiple attributes and eRA's would affect the non-price performance aspects of suppliers such as delivery and flexibility, which are often promoted by suppliers.

The objective of the meat manufacturer is to ensure corn sweeteners are purchased so as to minimize the total operational cost. To do so, the purchasing department compared the conventional method of a sealed-bid auction to, first, a reverse auction with single-item bids and, then, to a reverse auction with bundled bids. But first, we present the difficulties of using a reverse combinatorial auction and describe the method used to obtain the least cost combination of bids that satisfies buyer's RFQ. Second, we show the progression of the bidding rounds and estimate the savings from this combinatorial auction as compared to what the company did with either a manual or a reverse single item auction. Finally, we address the diminishing marginal returns of repeated usage of CeRA, and describe how this food company advanced from the auction setting to a risk-management-based procurement process.

Purchasing Inputs for Food Manufacturing

Purchases can be classified according to two broad categories: manufacturing (direct) inputs and operating (indirect) inputs. Direct inputs are raw materials, which make up the finished product or packaging materials that come in direct contact with the finished product. Direct inputs are purchased from industry-specific suppliers and distributors, and manufacturing cannot proceed without them. Indirect products do not come in direct contact with the finished goods, but are overhead inputs of maintenance, repair, and operation (MRO) goods and services.

Because purchases of indirect input usually small, but many, the associated transactions costs are a high proportion of total purchase cost relative the direct inputs. Thus, for indirect inputs, businesses have adopted two methods that reduce, dramatically, the transactions cost with indirect input procurement: P-Cards and eProcurement. P-cards are special commercial credit cards that control for the types of expenditure a card holder may make based vendor category and risk category and provides for electronic data transfer from the card company to the owner of the cards. eProcurement is based on a catalog and price list negotiated between the vendor and the procuring business. To purchase such inputs, an employee browses the online catalogs, adds item(s) to a shopping cart and submits a requisition, electronically, to purchasing. Completed requisitions are routed for review or approval via electronic workflow. Approved requisitions will generate a purchase order, which is transmitted to the vendor. All other approved eProcurement requisitions are routed to purchasing agents for review and processing into purchase orders.

For direct inputs purchasing may use spot transactions—likely using manual or electronic auction—or contracts with food brokers, ingredient distributors, or input manufacturers. In some cases, the food company may have some form of ownership through vertical integration, partnerships, or joint ventures to produce its proprietary direct inputs. Business-to-Business online bidding events help to communicate prices between the buyer and seller much faster. The negotiations are set in real-time dynamic auctions between a buyer and several suppliers, who compete against each other, online; lowering their bid amounts (Beall et al. 2003) until the lowest competitive market prices is reached. Price descends during a reverse auction as opposed to the traditional English auction, run by the seller and where the highest bid is the "winning bid" at close of the auction. The purchases of major inputs will be a few, large transactions. However, the many minor inputs may create relatively high transactions cost. That is because the individual purchases of such direct input are small and numerous as compared to high volume major inputs. For the minor inputs the cost of face-to face purchasing or manual bid taking are high relative to the cost of the input. Stated differently transaction costs make up a significant proportion of the total order cost. Just as with sourcing indirect inputs, reducing transactions cost is an important means to reducing the cost of minor direct costs. Internet auctions are one method to reduce transaction cost, yet promote price competition among suppliers.

Literature Review

The literature on eRAs is particularly rich in examining competition, price-based criterion, leadership, and specifiability. Kaufmann and Carter's 2004 case-study covers the circumstances under which electronic or face-to-face negotiations are appropriate. Foroughi, Kocakulah and Williams 2008; Hawkins, Randall, and Wittmann 2010; Huang et al. 2010 use models to describe the extent by which a firm's leadership and price-based selection criterion influences the decision of both suppliers and buyers to adopt eRA's. The beneficial and controversial aspects of eRAs in buyer-seller dealings emphasize the impact of opportunistic behavior on strategic supply relationships (Beall, Carter, Carter, Germer, Hendrick, Jap, Kaufmann, Maciejewski, Monczka and Petersen 2003). Pearcy, Giunipero and Wilson 2007; Caniëls and van Raaij 2009 focus on the factors that affect buyers' information processing and decision-making in e-RAs. Smeltzer and Carr 2003; Häubl and Popkowski, Leszczyc 2004; Ding, Eliashberg, Huber and Saini 2005 conclude product or service specifications must be clear and comprehensive to provide incentives for suppliers to participate in the auction. ERAs provide some measure of resolving the buyer's problem. Both anecdotal and empirical evidence have

shown that eRAs can lower purchase prices and reduce the amount of time it takes for feedback-evaluation-selection of a winning bid (Aberdeen Group 2005; Ariba.com 2012). Ariba, a software supplier, reported savings using reverse auctions in the 5% to 10% range. Companies that report successful use of reverse auctions include General Electric (Kwasnica and Thomas 2002), Mars (Hohner et al. 2003), Owens Corning (Moozakis 2001), and major retail chains such as Wal-Mart (Sheffi 2004). With a single-unit reverse auction the buyer requests from its approved suppliers a single-quote bid for either one item or on all items.

Purchasing using single-bid auctions, however, limits competition and reduces supplier flexibility. The single-bid auction is an all or none option: bid to supply all on the RFQ or make no bid at all. Requesting a single bid on a bundle of items or on a single item to be delivered to a number of locations could be too constraining because at least some potential bidders may not want, nor be able to fulfill all that is on the RFQ. Conversely, if each item is bid separately, a supplier may not be able to provide its best offer because its best offer might be contingent on getting the bid on some combination of items. Four in five Fortune 1000 companies have tried e-sourcing tools, but only one in five have gone beyond price-focused electronic RFQ and reverse auctions to tackle more complex categories (Ariba 2012). Here is where the combinatorial auction shines. It allows a bidder to choose which RFQ items and shipment locations to include in its bid (Sandholm et al. 2002). Note, that bundle may be not just for selected inputs, but also for selected delivery locations. So far, the combinatorial auction would appear to offer no serious complication; however, the complication enters when the buyer begins to evaluate the bids received to find the set of offers that satisfies the RFQ at least cost (Aberdeen Group 2005). That is because each potential supplier on each bid makes its own choice of what to offer and not offer, and purchasing must decipher what combination of bids satisfies the RFQ at least cost.

Combinatorial Auction Processing

To find the least-cost solution for such a combinatorial auction, one might use either linear or integer programming, depending upon the bidding rules. Use linear programming when a bid can be accepted in whole or fractionally. Use integer programming, when a bid can be accepted only in total or not at all. Since each bid is treated as a single activity, mathematically, each activity can take on only two values (0 and 1) with integer programming. For the least-cost solution, the combination of all bids with activity values of 1 will provide a set that satisfies the RFQ at least cost. With linear programming, the least cost solution may include activity values from and including zero to one. Model constraints are set to assure that all RFQ items are satisfied—item, location and time period, if specified. The model can be constrained, further. For example, the RFQ may require only one supplier per plant. Likewise, other bid limitations or specifications could be represented by model constraints, such as no supplier can supply more than 95 percent. Such constraints are known as provide a rich bidding language because it offers bidders choices on a range of options.

Online reverse auctions as a part of the electronic sourcing portfolio and more advanced electronic souring tool: combinatorial expressive bidding, which is a part called optimization technology or decision-support tools. The tool uses advanced mathematical algorithms to very quickly analyze unlimited business constraints and what-if scenarios (Sandholm 2002). The food industry buyer uses the tool to allow suppliers to creatively develop bids that make most efficient

use of their production capability. With the expressive bidding tool, suppliers could bid on multiple combinations of materials. Suppliers can come back with a number of expressive offers. The food industry buyer needed a tool less expressive reverse auction tool to present single item bids. Today, commercial software is available to handle the bid processing to find the least-cost solution.

The Corn Sweetener Procurement Setting

The relatively low cost of corn sweetener's made sweeteners processed from corn a viable alternative to beet or cane sugars. Several suppliers, in different locations and in different container sizes, manufacture dextrose and corn syrup. Generally, corn sweeteners are contracted for one year. The negotiations typically start in December and end sometime during the first quarter. Once the contract terms have been agreed upon the buyers order weekly or monthly demand requirements throughout the length of the contract without exceeding the contract volume limits. Food manufacturing's sourcing of heterogeneous and differentiated materials is initiated once the buyer distributes an RFQ. In an RFQ process, a buyer announces the technical specification, lists a number of negotiable attributes and invites potential suppliers to submit multidimensional bids on the negotiable attributes. Subsequently, the buyer evaluates the submitted bids ranks them according to her preference regarding the negotiable attributes and awards the contract to the supplier who has submitted the highest ranked bid. The rationale underlying these procurement processes is that the buyer seeks to designate the contract to the supplier who offers the best price/performance ratio. The suppliers follow the instructions and submit bids without knowledge of the amount of the bid by other participants.

The demand for corn sweeteners had steadily increased on average of 1.7% between 1990 and 2010 (USDA-ERS). In 2006, the purchasing department was faced with rising corn sweetener costs and the inability to sort through computationally complex bids from its suppliers in a timely manner. In each of the previous two years prior to 2005 prices for corn sweeteners had increased 2-3%. The meat processor purchased nearly 1.7 million cwt. of corn sweeteners valued at $2.4 million in 2005. Table 1 shows the estimated annual demand by plant and product specification.

Table 1. Quantity purchased by plant

Plant #	**Dextrose**	**Corn Syrup**	**Corn Syrup Solids**	**Liquid Dextrose**
	cwt.	**cwt.**	**cwt.**	**cwt.**
Plant 1	250		1,810	
Plant 2	5,570		220	30,000
Plant 3	1,950		500	25,000
Plant 4	6,000		660	40,000
Plant 5	1,890	43,000	1,512	
Plant 6	3,600		580	
Plant 7	600			
Plant 8	1,650		17	
Total	21,510	43,000	5,299	95,000

The Bidding Event

The buyer's procurement policy stipulates that only suppliers that demonstrate ability to maintain standards of product quality, provide evidence of its financial stability, and can regularly make goods and services available for shipment are approved as a supplier. Five corn sweetener manufacturers and four food ingredient distributors had been pre-approved to supply the buyer, and only those nine were permitted to bid. Previously, the food processor only accepted a single bid for each different quality specification or corn sweetener type. This is referred to as single bids and there were 20 different possible bids given the supplier's capabilities and the number of locations. In addition, the buyer accepted bids to supply multiple locations with different quality specifications. This is referred to as bundle bids. There were 19 different possible bids under the single-bid format. Under the bundled-bid format 100 different bid packages were possible, given the number of different combinations of sweetener types. Bidders will bid on four products originating from the corn wet milling process: dextrose, corn syrup solids, corn syrup, and liquid dextrose.

The buyer used a web -based portal through which buyers and suppliers could interact. The focus was to conduct a combinatorial auction to source four types of sweeteners to be delivered in specified amounts to each of the buyer's eight plants located in five states. Bidders will bid on four products or a combination of products. Corn syrup and liquid dextrose are liquids that must be stored in tanks, which creates food safety and traceability concern should the company use more than one supplier, as the product would be mixed in the tanks. Because the company does not want mixing of liquids from different suppliers in the same tank, each liquid supplied to a location must come from a single supplier. The firm preapproved nine suppliers—five are manufacturers of corn sweeteners and four are distributors. Two suppliers, a manufacturer and a distributor, handled all four sweeteners, three handled three of the sweeteners, and four handled only two of the sweeteners.

Buyer and Supplier Involvement in eRAs

Disruptive technologies like eRAs change the interactions between the buyers and sellers. The problems often center on pricing or agreed upon customer services that are part of contractual agreements (Lancioni, 2005). Perceptions of inequity play an important role as changes in business processes usually force buyers and sellers to reevaluate the existing relationship. Both parties have inputs into the transaction arrangement and both parties expect to reap certain benefits that would be equitably distributed. The digital era of purchasing has changed the interactions between buyers and suppliers (Sambamurthy and Zmud 2000). The ability to negotiate effectively and consummate deals that are both fair and equitable has long been an issue of contention in buyer–supplier relationships.

In 2005 and 2006, corn sweeteners were manufactured by five companies: ADM Company, Cargill Inc., Corn Products International Inc., Roquette America Inc., and Tate and Lyle Ingredients Americas, Inc. (Corn Refiners Association 2006). In addition, corn sweeteners are sold through a number of firms specializing in the distribution of food ingredients. Although some suppliers view eRAs as a strategy to get the cheapest price regardless of other non-price

performance factors, others viewed it as a mechanism to reap the benefits from their scaled operations, which are well suited for large customers. The processed meats and corn refiners industry have a history that begins with the corn sweeteners being used in the product formulation instead of higher costs substitute of beet or cane. Only the carbonated beverage manufacturers use more corn sweeteners than the meat processing industry. For the supplier, eRAs represent an opportunity for non-incumbents to participate in a neutral marketplace were able to freely and independently participate in the e-marketplace (Kaplan and Sawhney 2000). In order to be included in the research, the e-marketplace must have met the condition of neutrality.

The buyer paid a fee to use an eRA application developed by CombineNet, a third-party auction provider, to help develop the RFQ. CombineNet's core technology platform, REV™ Profit Accelerator, analyzed the bids for competitiveness and provided opportunities to analyze scenarios that included some less tangible factors in the decision making process. After receiving the buyer's "Letter Of Intent" to purchase corn sweeteners, the suppliers attended a webinar hosted by CombineNet to learn how to navigate the website during the auction and to review and accept the bidding terms. Training included how to access the website, how to submit bids, definition of terms and conditions of the event. The training also covered other topics, such as, the process of awarding the winning bid or how to communicate in the event they are unable to use the software. During the training sessions the supplier received information about the annual demand and pack sizes for each location by product. The bidders were advised their last bid must be honored by them and not withdrawn for consideration up to five calendar days after the auction ended. The five-day period provided the buyer an opportunity to download the last bids into REV™ and include other bids that were not submitted electronically. Bidders could respond to the eRFQ by mailing the bids through the U.S. Postal Service or express mail system. The buyer manually placed the bids and used the tool to analyze and compare to other bids.

The nine suppliers to submit sealed bids in 2005 were contacted by the buying organization to participate in the online bidding event. Each supplier had supplied or had been approved to supply the food processor in previous years. The list included five corn refiners and four food ingredient distributors.

Results

The single-bid auction and the bundled-bid (combinatorial) auction ran simultaneously. That is, bidders had an option to place a single or a bundled bid in the same web based portal. The bidders entered into a password protected website to view the requirements for all corn sweeteners by delivery location, packaging size, and to place bids. The bidders were allowed to submit bids for the total volume or on a portion of dextrose and corn syrup solids only. Bids for liquid dextrose and liquid corn syrup were accepted only for 100% of the volume at any delivery location for food safety reasons.

Corn sweeteners provide an opportunity for bidders to combine (bundle) bids. The auction was scheduled to last four uninterrupted hours. The software would only receive bids within the timeframe of the auction. Each bidding organization input their own single bid or bundled bid into the software, listing the price it was willing to sell by location, volume and specification as

single units or in bundles. Bidders were able to see their price for a single or bundle and if their own bid was a winning bid. In real time, the buyers were able to view each bid and the bidding throughout the entire event. Bidding continued throughout the time period. A bidder who did not have a winning bid at the time could, then submit a new bid if the bidder could afford a better bid. When time expired, bidders were locked out from submitting bids more bids.

Single Bid Outcome

In the single bid portion of the auction, two bidders met the requirement of supplying entire volume of corn sweeteners, see Table 1. A total of 98 out of a possible 180 bids were placed over four-hour period. In this auction, the buyer did not select any of the single bids, when determining the winning bid. Table 2 summarizes the bidding activity, which includes the number of bids, the percent of the demand requirements covered and the number of leading bids. We expected the bidders using single bid format to create more bids resulting in more lead changes. More bids were expected because of the real-time feedback features and the opportunity for non-incumbents to participate in a neutral marketplace to freely participate in the auction.

Table 2. Single unit bid summary by supplier

	Possible # of bids by location	**Actual # of bids by location and sweetener type**	**Percentage of total demand met by using the single-unit bid approach**	**Number of leading bids in the single bid option**
Suppler 1	20	4	20%	4
Suppler 2	20	11	100%	2
Suppler 3	20	20	55%	0
Suppler 4	20	9	45%	0
Suppler 5	20	5	25%	0
Suppler 6	20	14	70%	11
Suppler 7	20	15	75%	1
Suppler 8	20	20	100%	1
Suppler 9	20	1	24%	0
Total	180	99		19

However, the numbers of lead bid changes were less than expected considering the large number of bids. Also, the higher number of constraints in single bid format impinged on the bidder's ability to meet the buyer's total demand requirements. Thus, creating individual bids that did not meet the buyer's volume objective.

Bundled Bid Outcome

The bundled bid auction took place during the same time period as the single bid format. There was a 54% increase in the number of bids placed, but considerably fewer bids met the total demand requirement (See Table 3). Seemingly more bids were used to cover the buyer's demand, in a way that buyers did not force suppliers into unnecessary constraints. Bidders exercised their newfound freedom and flexibility to exercise different bidding options.

Table 3. Bundled bid summary by supplier

	# of bid combinations	Total # of bids placed	% of total demand met using the bundled bids approach	# of leading bids Using the bundled bids approach
Suppler 1	100	4	4%	1
Suppler 2	100	26	26%	16
Suppler 3	100	15	15%	0
Suppler 4	100	10	10%	1
Suppler 5	100	6	6%	0
Suppler 6	100	20	20%	1
Suppler 7	100	22	22%	2
Suppler 8	100	25	25%	1
Suppler 9	100	0	0%	0
Total	900	128		22

In the bundled bid portion of the auction, a total of 128 bids were placed out of 800 possible bids. The buyer selected bids from Suppliers 2, 6, 7, and 8 from the bundled bid option.

Comparison of Combinatorial Auction Option to the Market Price

Because of expanding demand for corn for ethanol production, less was directed to corn wet milling over the trial periods. As a result, corn sweetener prices increased and were not comparable across the two-year period. In order to quantify the savings from the combinatorial auction, we measured the total purchase cost against the same basket of sweeteners at reported national prices. In 2005, when the firm used the manual process, the firm paid 1% less that it would have paid compared to nationally quoted prices. In 2006 when reverse combinatorial auction was used, the firm paid 7.5% less than it would have paid for its entire basket of corn sweeteners using nationally quoted prices. Furthermore, the manual process took several weeks to run. Tables 4 and 5 show the outcome of the manual and reverse auction format.

Table 4. Savings using the conventional bid process

Sweetener	2005 RFQ quantities	National Average Price[1]	Projected cost	Actual price paid, manual bidding	Sweetener expenditures, using simple, manual auction
Dextrose	10,473	$23.10	$241,926	$23.00	$240,879
Liquid Dextrose	90,000	$17.75	$1,597,500	$17.50	$1,575,000
Corn Syrup	41,000	$14.25	$584,250	$14.15	$580,150
Corn Syrup Solid	1,100	$24.37	$26,804	$26.60	$29,260
Total	142,573		$2,450,480		$2,425,289
Conventional Savings					$25,191

Table 5. Savings with the reverse auction

Sweetener	2006 RFQ quantities	National Average price[1]	Projected cost[2]	Actual price paid, single bid auction	Sweetener expenditures, using simple, manual auction
Dextrose	21,510	$24.10	$518,391	$22.65	$ 487,202
Liquid Dextrose	95,000	$17.40	$1,653,000	$15.40	$1,463,000
Corn Syrup	43,000	$14.00	$602,000	$13.90	$597,700
Corn Syrup Solid	5,299	$23.90	$126,646	$25.60	$135,654
Total	164,809		$2,900,037		$2,683,556
Auction Savings					$216,481

Compared to national prices, 6 show a greater savings. Savings with the combinatorial auction resulted in a 13.6% benefit to the buying organization.

Table 6. Savings using combinatorial auction

Sweetener	2006 RFQ quantities cwt.	National average price[1]	Projected cost[2]	Actual price paid, combinatorial bidding	Sweetener expenditures, combinatorial auction
Dextrose	21,510	$24.10	$ 518,391	$21.33	$ 458,808
Liquid Dextrose	95,000	$17.40	$1,653,000	$13.80	$1,311,000
Corn Syrup	43,000	$14.00	$ 602,000	$13.50	$580,500
Corn Syrup Solid	5,299	$23.90	$ 126,646	$29.55	$156,579
Total	164,809		$2,900,037		$2,506,887
Auction Savings [1]					$393,150

Discussion

Combinatorial auctions tackle more complex spend categories by deploying sophisticated advanced sourcing and negotiations tools capable of "optimizing" lowest total cost and highest total value, not just the lowest price. These combinatorial auctions improve purchase order efficiency and automate back-end financial management (payables, receivables) systems. It serves as a transaction facilitator (Peterson et. al 2005). Transaction facilitators generally focus on reducing complex, paper-based transactions between buyers and sellers. When tailored to a specific industry/type of purchase, these tools can be invaluable in reducing transaction costs, dispute costs resulting from errors, and other operating costs.

The findings from the study in 2006 are not only consistent with the expected field research which suggest the use of this sourcing technique can create perceptions of opportunism among participating suppliers, but provides empirical evidence of multi-attribute purchasing that can be used to address the controversies that an eRA is solely a margin- squeezing tool myopically – and perhaps opportunistically – applied. Yet Sourcing professionals typically struggle to quantify value monetarily because of ignorance of the true cost structure for their own company as well as that of their suppliers (Emiliani 2004). This leads to heavy reliance on price comparisons (Anderson et al. 2000). Hence, absent sufficient competitive quotes as a basis of price comparison, assurance of attaining the best value is difficult. Sourcing professionals are also typically risk averse (Bloch and McEwen 2002; Nelson et al. 2001), preferring "an alternative whose outcome is known with certainty over one having an equal or more favorable expected value but whose outcomes are probabilistic (Puto et al. 1985, 90)." The weighted average cost for the entire basket of corn sweeteners purchased using the manual, reverse, and combinatorial auctions methods resulted in $17.35/cwt. $16.90/cwt. and $16.09/cwt., respectfully.

[1] Average Midwest corn sweetener prices. Milling and Baking News ingredient prices. March 3, 2004 to May 25, 2004; March 5, 2005 to May 30, 2005; March 14, 2006 to May 29, 2006, Sosland Publishing.

[2] Budgeted costs of corn sweeteners based on the forecasted volume and the most competitive price received from the auction.

Any shortcoming found by the buyer includes the go/no go decision process associated with using new technology. That is, either the eRA will be used or not. The decision to use an eRA for its appropriateness to the buyer-supplier relationship and the initial high administrative costs and ex ante transactions costs includes organizational decisions that involved senior leaders in the firm. The perception of eRAs producing higher transaction costs could dissipate after some experience is gained through program implementation. Adopting electronic trading schemes and other information technology systems, as applied to other auction settings, have shown that eRAs have the potential to lower – not raise – transaction costs in most markets.

The data in this study from 2005 and 2006 provide a before and after view of eRA's. In this empirical study, the buyer is at the crossroads of using the manual process, the burgeoning reverse auction tool, and combinatorial auction methods to reach its objective.

In 2008 and 2009, the manufacturer chose a different procurement strategy. The use of the combinatorial auction had highlighted the flexibility gains and the result of more competitive bidding. In 2008, the manufacturer, built on the sourcing gains of the previous two years and negotiated with its current suppliers risk-management-based contracts. Because of the increasing volatility of corn prices, the manufacturer negotiated a contract that allowed the food manufacturer to manage the input price risks and to pay a tolling or manufacturing agreement with the corn refiner. The food industry buyer used its own personnel to manage the corn price risk and paid the corn refiner to convert corn into the four corn sweeteners needed for its products. This demonstrates that changing conditions may call for changing sourcing strategies. Also, repeated use of CeRA may lead to discovery of ways that vendors might game the system or vendors who have not captured a winning bid, may choose not to continue to bid.

Conclusions

In this paper we evaluated eRA's and conventional method. The goals in a winning bid determination problem are to find the lowest cost scenario and to reduce the transaction cost of buying goods and services. The 2006 results from the single bid auction yielded a costs savings when compared against the national prices for corn sweeteners. In 2006, the bundled bid option yielded a 14% benefit compared to the national prices and a 4.9% advantage over the single bid option. The bidding flexibility provided in the bundled bid format allowed suppliers to bid based on their organizational capabilities. That is, it allowed suppliers to provide multiple single-unit bids and bundled bids. Furthermore, the new process allowed the buyer to evaluate both bidding formats in minutes, compared to weeks when the traditional methods were used.

After the 2006 auction, the food industry buyer adopted the combinatorial tool to help purchase corn sweeteners. The price per bushel of corn, however, increased and so did the costs for producing corn sweeteners. In 2007 the corn sweetener prices increased, but the prices paid using the combinatorial auction was less than the reported prices for corn sweeteners reported in industry publications. The combinatorial auction confirmed the food industry buyer's prices were very competitive.

The combinatorial auction format generated a significant costs savings by providing the seller more bidding flexibility. The costs savings from the event was similar to other firms using reverse auction strategies. In addition, the food manufacturer adopted a best practices procurement strategy, which reduced its time in determining the winning bid. Reverse auction speeds up the process of determining price in multi-attribute auctions. Typically, after the second or third time, the marginal benefits are less than the marginal costs of conducting the auction.

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