Procurement Mechanisms for Customized Products

Songlin Chen, Mitchell Tseng, Advanced Manufacturing Institute
The Hong Kong University of Science & Technology
Clear Water Bay, Hong Kong

Customization is essentially a pull system and customers’ demand for customized products is the ultimate force that drives a customization business. Research in product customization has been primarily focused on improving manufacturers’ efficiency in eliciting and fulfilling customers’ needs; less attention has been paid to customers’ procurement decisions. Although systems like product configurators and design toolkits have been developed to facilitate customers in product customization, they are more “sales” tools than “procurement” tools. This paper views customization from customers’ perspective and aims to understand the critical information, decisions, and incentives in procuring a customized product. Procurement of customized products is conceptualized as a contracting problem with an embedded co-design problem with information asymmetry. A decision framework for procuring customized products is constructed, different procurement scenarios are outlined and generic procurement mechanisms are surveyed and compared. This paper concludes by pointing out future research directions on procurement mechanism/system design towards improving customers’ efficiency of procuring customized products.

Introduction

Customization has been recognized as a frontier for manufacturers to gain competitive advantage in an increasingly diversified and dynamic marketplace [0]. Recent years have witnessed rapid increase in output of customized products, spanning from capital goods like airplanes, machine tools, elevators and escalators to consumer goods like computers, printers, sneakers, and watches etc. [0,0,0]. With the proliferation of customized products and spread of customization technologies, there emerges a new competitive landscape where multiple manufacturers compete on customization for customers’ patronage. For example, both Boeing and Airbus customize airplane interiors for airliners; Dell, HP, and Lenovo allow customers to configure their own computers; both Adidas and Nike offer custom made sneakers, etc. The increasing availability of customized products gives customers more choices that could potentially best fulfill their individual specific needs, which are often compromised in standard products designed for mass appeal. The escalating competition on customization among manufacturers further shifts bargaining power in customers’ favor. However, to tap into the potential value offered by product customization, customers are faced with a series of difficult decisions in procurement, e.g.
which manufacturer to buy from? What specification to commit upon (given the product is not available yet)? How much (premium) to pay for it? …

The difficulty to procure customized products originates from manufacturers as well as customers themselves. A major motivation for manufacturers to pursue customization is to differentiate from competition. Manufacturers often have distinct customization capabilities and their offerings are often heterogeneous and resistant to comparison. As a result, a customer looking for a customized product is essentially faced with multiple niche monopolists and the market price for a customized product is often obscure. From customers’ side, customers need to articulate their needs for a customized product. However, it’s often difficult for them to make informed tradeoffs and accurately articulate their requirements and preferences, particularly when the product to be customized is complex. Customer requirements are often found to be over-specified or under-specified, sometimes even infeasible, relative to manufacturers’ capabilities. Because of these difficulties, procurement of customized products could be a lengthy, costly, or even frustrating experience. In the context of industrial procurement, procuring custom made products like industrial equipments often involves painstaking preparations and back-and-forth negotiations [0]. The administrative cost of procuring customized products is often significantly higher than procuring standard products. Not surprisingly, customized products are avoided by purchasing professionals whenever possible. In the context of customized consumer goods, customers could get confused by the large number of options usually offered in customization [0]. Even worse, the value of choice implied in customization could get lost in the procurement process [0].

There’s a genuine need to look at customization from customers’ perspective and to improve their efficiency in procuring customized products. This is not only directly beneficial to customers but is also important to manufacturers that are pursuing customization as a long term strategy. Being essentially a pull system, customization as a business model can only succeed when customers are able to procure efficiently and consequently generate sufficient demand. As a first step towards developing a systematic approach for procuring customized products, this paper aims to understand the nature of customers’ procurement decisions for customized products. This paper is organized as the following: first, procurement mechanisms in general are reviewed; second, the special properties of customized products are discussed and a decision framework for procuring customized products is constructed; then, based on the framework, different procurement scenarios for customized products are outlined and general procurement mechanisms are discussed and compared. Finally, suggestions are given for further research.

Procurement Mechanisms in General

Procurement mechanisms, or the procedures and rules that buyers follow to select sellers and determine contract terms, have a direct impact on procurement performance. The advent of information technology brings new venues and means to conduct procurement and there is growing interest in procurement mechanism design from economics, computer science, management science and operations research [0]. Despite their diversity, procurement mechanisms can be classified into 3 general types based on the trading institution used, i.e. search-based, negotiation-based, and auction-based [0].

Search-Based Procurement

In search-based procurement, a customer searches for a product that best satisfies her needs from a predetermined solution space. For each product possibility, the customer is
faced with a take-it-or-leave-it decision without haggling on price, product attributes, or whatsoever. This is the mechanism we employ when buying from shopping malls, online product catalogs (e.g. amazon.com for books, autotrader.com for cars, etc.), or product configurators (e.g. dell.com for PCs, 121time.com for Swiss watches, etc.).

The advantage of search-based procurement is its transparency and simplicity. Information technology, search engines in particular, has made it easy for customers to locate relevant product information. The disadvantage of search-based procurement is its rigidity since the solution space needs to be determined ex ante by manufacturers. First, it’s difficult to describe a product, especially a complex one, in sufficient details without confusing customers. Second, it’s difficult to forecast customers’ willingness to pay and hence price right, particularly when both product variety and customer diversity are high. The rigidity of search-based procurement prevents effective communication and would result in demand-supply mismatch [0].

Negotiation-Based Procurement

In negotiation-based procurement, a customer engages in bi-lateral dialogue with a potential manufacturer upon product attributes, price, or anything that is pertinent to the transaction. Both parties make offers and/or counteroffers and collectively search for an agreement that is mutually acceptable. Negotiation is arguably the most widely used institution in industrial procurement, e.g. purchasing of materials, industrial equipments, office supplies etc [0]. Individual consumers who have bought souvenirs at tourist places probably also have had firsthand experience of negotiation-based procurement.

The advantage of negotiation-based procurement lies in its flexibility. With rich exchange of information, a buyer and a seller could dynamically explore all sorts of possibilities and potentially reach innovative win-win solutions [0]. In recent years, there’s been growing research on electronic negotiations to improve negotiation efficiency [0]. For example, negotiation support systems have been developed to support negotiators in decision making and agreement mediation [0]. Enterprise software vendors like SAP, Oracle, and i2 Technologies have incorporated various negotiation support functionalities in their procurement solutions [0]. However, there’re inefficiencies inherent in negotiations. Myerson and Satterthwaite prove “… the general impossibility of ex post efficiency of bargaining without outside subsidies” [0]. Raiffa et al point out the so-called negotiators’ dilemma: “… value creation is usually inextricably linked to value claiming in negotiation and the tactics used to create a larger pie may conflict with tactics designed to claim a large slice of the pie” [0]. The inefficiency of negotiations in practice is manifested by bluffs, threats, and traps, iterative processes, and unpredictable results. To some extend, it’s more an art than a science.

Auction-based Procurement

An auction is a market institution with an explicit set of rules determining resource allocation and prices on the basis of bids from the market participants [0]. Auctions used for sales are called forward auctions, in which bidders bid to buy products or services, e.g. selling art collectibles through Sotheby’s, and selling used books through EBay. Auctions used for procurement are called reverse auctions, in which bidders bid to supply products or services, e.g. government procurement of infrastructure construction service through public bidding. Forward auctions and reverse auctions are theoretically equivalent except a sign difference [0]. Depending on the number of biddable attributes, reverse auctions
can be categorized into single attribute (usually price) auctions and multi-attribute auctions.

The advantage of price-only reverse auction lies in its efficiency in price discovery. Companies like GE and Motorola [0] and market makers like Ariba have reported billions of dollars of cost savings through reverse auctions [0]. The downside of reverse auctions is the potential disruption of supplier relationship. Throat-cutting competition on price squeezes bid winner’s profit down to zero or even negative, a dilemma called “winners’ curse” [0]. Suppliers with differentiated solutions are particularly reluctant to participate in reverse auctions for fear of being commoditized. When participation is necessary, suppliers tend to capitalize on ambiguities in customer requirements by means of up-charges for customer-initiated changes [0]. As a result, price-only auctions are mainly used for procuring standard or commodity products where price is the king and there is little ambiguity on product specifications.

Multi-attribute auctions include other factors besides price into competitive bidding. The basic idea of multi-attribute auction is to convert multiple attributes into a score, or a virtual currency, as a measure of the overall utility of a bid [0]. With more factors considered, multi-attribute auctions give suppliers more flexibility to specify bids and give buyers more freedom in selecting bid winners. Compared to price-only auctions, multi-attribute auctions promise higher efficiency of allocation and better supplier incentives [0]. However, multiplicity of bidding attributes implies dramatic increase of complexity in bid preparation and evaluation [0].

Table 1 summarizes the properties of the 3 general procurement mechanisms:

<table>
<thead>
<tr>
<th>Procurement Mechanisms</th>
<th>Advantages</th>
<th>Disadvantages</th>
</tr>
</thead>
<tbody>
<tr>
<td>Search-based (fixed price)</td>
<td>Simple Low transaction cost</td>
<td>Fixed solution space No communication Inflexible</td>
</tr>
<tr>
<td>Negotiation-based</td>
<td>Flexible Rich communication</td>
<td>Inefficient Unpredictable High transaction cost</td>
</tr>
<tr>
<td>Price-only Auction-based</td>
<td>Competitive price Relatively simple</td>
<td>Supplier disincentive Little communication</td>
</tr>
<tr>
<td>Multi-attribute</td>
<td>High efficiency Better supplier incentive</td>
<td>High complexity</td>
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A Decision Framework for Procuring Customized Products

The mechanisms surveyed above apply to procurement in general. Customized products have special properties and entail special treatment in procurement. This section aims to construct a decision framework to capture the essential decisions, information, and incentives involved in procuring customized products.

Product Customization: Customers as Co-Designers

According to Oxford English Dictionary, to customize is “to make to order or to measure; to model or alter according to individual requirements”. Based on this definition, there are two essential elements about customized products. First, from a time perspective, the product is made after an order is placed, i.e. made to order. In other words, there’s a delay between committing on the product specification and receiving the final product; second, concerning product features, a customized product is made based on customer-specific
requirements. In other words, customers are integrated in the process of product creation by providing key design inputs. Customers’ involvement in product design has been recognized as a critical identifier of customization [0]. Hippel treats product customization as a form of innovation [0]. He argues that successful customization requires fusion of two sources of information: need information and solution information, which are usually distributed asymmetrically between customers (users in his words) and manufacturers respectively. Users have better need information because they have better understanding of local environment and intended use of the product; manufacturers have better solution information because of their expertise in product design, production, etc. However, both need information and solution information are often costly to acquire, transfer, and use in a new location, a problem called “information stickiness”. In case of product customization, Hippel advocates user-centered innovation and proposes user toolkits to transfer solution information to users so as to enable product customization by customers.

Berger and Piller emphasize the importance of customer interaction and propose to treat customers as co-designers in customization [0]. Piller et al. further capture the concept of customer interaction as “economies of customer integration” [0]. Similar to user toolkits, product configurators have been proposed to facilitate the customer-manufacturer co-design process [0,0]. With product configurators, product design can be simplified to a sequence of attribute selections, which can be performed by customers or salespeople. However, it’s worth noting that design toolkits and product configurators are developed from manufacturers’ perspective and they are designated to help manufacturers to better sell. This is evidenced by their lack of support, sometimes intentional prevention, for customers to compare offerings of different manufacturers. In other words, they are more sales tools than procurement tools.

Procuring Customized Products: Contracting + Co-Design

Procurement in general can be taken as contracting while customization involves co-design, so procurement of customized products can be conceptualized as a contracting problem with an embedded co-design problem. Although both contracting and co-design are decision making activities, they focus on different decisions, require different information, and they are driven by different incentives. This section aims to capture these elements with an integrative decision framework for procuring customized products.

Decisions

In procuring a customized product, the customer needs to select a manufacturer as the supplier and agrees upon a procurement contract, which usually includes (but not limited to) price, product specification, delivery schedule, warranty, service terms, etc. The contract items can be roughly grouped into commercial decisions (e.g. price, warranty, service) and engineering decisions (e.g. product specification, delivery schedule). Generally speaking, the commercial decisions correspond to the contracting aspect while the engineering decisions correspond to the co-design aspect. Without loss of generality, product specification (s) and price (p) are selected as the representative decisions of procuring customized products in this paper.

Product specification is basically the technical description of a product. It, however, has different implications to customers and manufacturers. To the customer, product specification describes, with legal authority, what product she is entitled to receive in terms of product features, functionalities, performance etc. To a manufacturer, product
specification is the legal commitment on what he needs to deliver if he wins the contract. The product specification will guide and bind a manufacturer’s operations including product design, production, delivery, etc.

Price is the monetary value a buyer pays in exchange for a seller’s product. There are generally two schemes of price contracting. One is fixed-price contract, in which the buyer offers the seller a pre-specified price for completing the project/product. The other is a cost-plus contract, in which the buyer does not specify the price but reimburses the contractor for costs plus a stipulated fee. Relatively speaking, fix-price contracts provide suppliers better incentives for cost reduction, while cost-plus contracts provide customers better “insurance” against the risk of design changes and contract renegotiations [0].

Information
As price and product specification are concerned, customers and manufacturers are asymmetrically endowed with different sources of information in both the commercial domain and the engineering domain. In the commercial domain, customers have better information on valuation or willingness to pay for a customized product. Manufacturers are better informed of the cost to provide a customized product. In the engineering domain, customers have better need information and manufacturers have better solution information [0]. Customization can be taken as a special form of design, which can be viewed as a series of what-to-how mappings from customer needs (CN) to functional requirements (FR) to design parameters (DP), and to process variables (PV) [0]. CN represents a customer’s real, but often hidden, needs for a product; FR is the articulated customer needs in terms of desired product functionality or features; DP represents a technical solution (e.g. product architecture, component selection) that satisfies FR; and PV describes how the designed product can be produced. Generally speaking, the customer’s need information is reflected in FR, while a manufacturer’s solution information is reflected in DP and PV. Collectively, FR, DP, and PV can be interpreted as product specification viewed from different perspectives [0]. Different sources of information and decisions are interrelated (Figure 1). With multiple competing manufacturers, different manufacturers have different solution information and cost structures. The customer may have certain information upon manufacturers’ solution information and cost structure individually or collectively, and each manufacturer may have certain information about the customer and his competitors. Different information structure leads to different behaviors in a competitive procurement environment, driven by different sets of incentives.
Incentives
So far, customers are used as a generic concept for buyers without distinguishing their actual identities. Customers could be government agencies, industrial firms, or individual consumers, and different types of customers have different objectives and priorities in procurement. For example, government agencies may care more about social welfare and fairness than economic benefits; industrial firms may focus their attention on cost reduction; while individual consumers may be experience-driven. This paper assumes customers’ overall objective in procurement is to maximize a general utility function:

\[
U(s, p) = V(s) - p - \sum_{i} Tc_i
\]

\(V(s)\) : the value of the product \(s\) to the customer;

\(Tc_i\) : the transaction cost of the product \(s\) to the customer dealing with manufacturer \(i\);

\(N\) : number of manufacturers.

A manufacturer is assumed to maximize profit:

\[
\pi(s, p) = p - C(s) - Tm
\]

\(C(s)\) : the cost for a manufacturer to deliver a customized product \(s\);

\(Tm\) : the transaction cost to the manufacturer.

The relationship between the customer and each manufacturer in product customization can be characterized as co-opetition [0]. The customer and each manufacturer are aligned in terms of value creation, i.e. maximizing the product’s value to the customer while minimizing its cost to the manufacturer. In the meanwhile, they are divided in terms of value claiming, particularly as price is concerned. From a domain perspective, the customer and each manufacturer are motivated to truthfully exchange need information and solution information in the engineering domain, but discouraged from sharing value information and cost information in the commercial domain. Instead, the competition for value claiming entices strategic withholding or even misrepresentation of value information and cost information. Distorted value information and cost information convey misleading signals about customer’s real needs and a manufacturer’s actual capabilities, and consequently prevent them from identifying efficient solutions. In
general, there’s an incentive conflict between design collaboration and contract competition, which poses a dilemma in procuring customized products.

A decision framework for procuring customized products

From an overall perspective, procurement of customized products can be characterized as a principal-agent problem, with the principal (customer) aims to hire an agent (manufacturer) to provide a customized product. The principal has individual-specific needs and private value information; each agent has distinct customization capabilities and private cost information. Given the asymmetry of information, the customer is faced with an adverse selection problem, which describes a contract situation with hidden information [0]. To overcome information asymmetry, the customer basically needs to conduct a screening process, in which the uninformed party (customer) attempts to screen the different pieces of information the informed party (manufacturer) has and then make selection decisions. Reversely, manufacturers conduct a signaling process, in which the informed party (manufacturers) attempts to signal to the other party (the customer) his local information through his offers [0]. Summarizing the essential decisions, information, and incentives, Figure 2 depicts a general decision framework for procuring customized products.

![Figure-2 A decision framework for procuring customized products](image)

**Procurement Scenarios and Mechanisms for Customized Products**

The construction of the decision framework basically follows a descriptive perspective and addresses questions including what properties are unique to customized products and what essential decisions, information, and incentives are involved in their procurement. This section takes a prescriptive perspective and aims to answer the question of how to best procure customized products. On the one hand, there are all sorts of customized products and different procurement contexts; on the other hand, there are all sorts of procurement mechanisms. The question becomes what procurement mechanism should be used under what conditions; and one step further, how to design more efficient mechanisms for procuring customized products. As previously discussed, customers’ objective in procuring customized products can be summarized as to identify a solution that offers highest value \((V)\) with lowest price \((p)\) and least hassle \((\sum T_{c_i})\) (Section 0). In the following sections, different procurement scenarios are outlined according to these dimensions and procurement mechanisms are discussed accordingly.
Maximizing value (V)
The value of a customized product depends on how well the product fulfills the customer’s specific needs. Manufacturers’ customization capabilities (solution space) will determine the potential of value maximization. It’s also critical to note that procurement contracting for customized products is based on customers’ articulated requirement information (i.e. FR) and product specification (i.e. DP and PV) instead of real customer needs and the final product. Hence the accuracy of customer need information and the customer’s ability in solution evaluation will also greatly affect the real value the customer can derive from a customized product.

Manufacturers’ customization capabilities
Although customized products are differentiated by definition, there could be certain similarity among manufacturers when viewed collectively. In some industries, manufacturers may use similar technologies and even share critical components or suppliers, for example, Dell, HP, and Lenovo on personal computers. In some other industries, manufacturers may use dramatically different technologies and hence have distinct customization capabilities, for example Boeing and Airbus on airplanes. When manufacturers are very similar, their customization capabilities and cost structures will be highly correlated and the incremental value of an additional manufacturer will be small. When manufacturers are highly differentiated, including an additional manufacturer may potentially bring in innovative solutions.

Accuracy of need information (FR)
Customers have varying degrees of accuracy in articulating their needs, subject to factors like product complexity, the customer’s technical knowledge, the dimension or nature of customization, and the media used for eliciting need information etc. Generally speaking, the simpler the product is and the more knowledge the customer has about the product, the more accurate the need information will be. As the dimension/nature of customization is concerned, there are 3 generic types, namely fit/size, functionality, and (aesthetic) design/taste, with increasing difficulty for customers to articulate their needs [0]. The media used for eliciting customers’ need information could be design sketches, engineering drawings, samples or prototypes etc. Generally speaking, the closer the medium is to the finished product, the less uncertainty is involved and the easier it is for customers to articulate their needs.

Inaccuracy in need information will expose the customer to the risk of committing on a product that is not what she really wants. Consequently, the customer may either need to initiate a design change and renegotiate the procurement contract or have to stick to what’s been committed and settle with compromise. Both options could be costly. So a general principle in procuring customized products is to get requirements as accurate as possible. One approach is to delay the commitment on product specification as late as possible. Another approach is to request prototypes. However, there’s a limit on how late spec commitment can be delayed and prototype making could be expensive. When customer need information is inaccurate and the cost of spec change or re-negotiation is significant, negotiation is the preferred mechanism due to its flexibility and rich communication. Furthermore, cost-plus contract is preferred to fixed-price contract, since it can better hedge against the risk of customer-initiated design changes [0].

Customers’ ability to evaluate solutions (DP, PV)
Customers may not be able to accurately evaluate a customized product, particularly when the product is complex and the customer is not an expert on the technical issues. In this case, the customer will be exposed to the risk of receiving an inferior product without knowing it. Although the manufacturer is contractually responsible for under-delivery, it’s the customer that bears the risk if she is unable to detect it. In economic terms, the customer suffers from the “moral hazard” effect, which describes a contract situation with hidden actions [0]. In many procurement contract situations, e.g. construction industry, it’s often very costly, if not infeasible, to enumerate all possible contingencies in the contract. Such incomplete contracts will also give manufacturers opportunities to deliver products that are not what the customer truly wants. When “moral hazard” is severe, negotiation-based relational contracts are preferred in procurement [0]; search-based mechanism is impractical; while reverse auctions should be avoided since competition will almost surely drive the contract to those manufacturers who are most willing to exercise hidden actions against the customer [0].

Minimizing price (p)

At a macro level, price indicates the relative abundance/scarcity of supply to demand; at a micro level, price reflects the relative bargaining power between buyers and sellers. Without sufficient bargaining power, customers are simple price-takers; with sufficient bargaining power, the customer is entitled to claim a large proportion of the surplus created [0]. A general approach for customers to minimize price is to maximally strengthen their bargaining power and effectively exercise that power.

Bargaining power is not static but varies with many factors. Generally speaking, a customer’s bargaining power increases with the size/importance of her business and the level of competition among manufacturers [0]. Correspondingly, one way for customers to increase bargaining power is through consolidation of procurement, which can be achieved by centralized procurement for big companies like Wal-Mart and GE or joining a purchasing consortium/group for small companies or even individual consumers [0]; another way to increase bargaining power is to develop alternative sources of supply and promote competition among manufacturers. Although manufacturers’ solutions are often differentiated due to the specificity of customized products, they are usually functionally similar and substitutable. One common method to include multiple differentiated manufacturers into competition is to give general instead of specific requirements [0]. However, it’s worth noting that general requirements imply ambiguity in requirement interpretation and may lead to the risk of wrong commitment or excessive iterations in determining product specification.

Effective exercising the bargaining power that the customer possesses is also important to achieve a competitive price. If the customer has sufficient bargaining power, conducting reverse auctions is the most direct and effective way to exercise that power. For example, many custom made industrial goods are procured through Request for Quotation (RFQ), in which multiple manufacturers submit solutions with price quotes and qualified manufacturers compete on price [0]. For government procurement of complex products like defense weapon systems, tendering and design competition are common practices [0]. In negotiation-based procurement, a customer’s bargaining power can be best exercised by developing the so-called Best Alternative to a Negotiated Agreement (BATNA), which gives the customer a reserve solution [0]. In search-based procurement, although
customers are faced with a take-it-or-leave-it decision, the customer can exercise her bargaining power by expanding the scope of search.

Minimizing transaction cost \( \sum_{i} T_{C_i} \)

It takes time and resources to identify potential suppliers, determine product specification, and negotiate prices etc., all of which contribute to the so-called transaction cost. Transaction cost will basically erode customer utility. Given the specificity of customized products and the associated uncertainties involved (Section 0), the transaction cost to procure a customized product could be so high that the customer may prefer to settle with a standard product that is readily accessible. Generally speaking, transaction cost increases with the number of manufacturers (N) and the efforts required to deal with each manufacturer. As a result, the presence of transaction cost limits the number of manufacturers and requires the customer to carefully select manufacturers. Transaction cost also depends on the procurement mechanism employed. Generally speaking, search-based procurement incurs the least efforts while negotiation is the most costly, and auction can be taken as a less costly approach to negotiation with multiple manufacturers (Table 1).

Tradeoffs

The discussion above is based on individual objectives in determining procurement mechanisms for customized products. There are tradeoffs between different objectives when it comes to a holistic approach on what procurement should be used under what conditions. For example, a large number of manufacturers are preferable for maximizing value as well as minimizing price but may drive up transaction cost. As procurement mechanisms are concerned, reverse auction is preferable for minimizing price and reducing transaction cost but may sacrifice value, particularly when spec ambiguity and moral hazard effect are present; negotiation is preferred in identifying innovative solutions and reduce the risk of wrong commitment hence increase the value of a customized product but it may not be able to achieve efficient price and may be costly to administrate; search-based procurement may economize on transaction cost, but may fail to identify the best solution and achieve competitive price. Because of these tradeoffs, it’s advisable for customers to first identify, assess, and quantify the impact of different procurement mechanisms on the objectives on value, price, and transaction cost respectively (the list could be extended if other decisions are included besides price and product specification). Based on the results, the customer should select the procurement mechanism that is feasible and offers the maximum utility.

Summary and Future Research

Product customization has become increasingly pervasive in today’s manufacturing industries. Research on product customization has been focused on the supply side, i.e. improving manufacturers’ customization efficiency in terms of product design, production, and distribution etc. Less attention has been paid to customers’ procurement decision for customized products, particularly in an environment with multiple competing manufacturers. This paper first reviews literature on procurement mechanisms in general and literature on product customization in particular. By synthesizing these two streams of literature, procurement of customized products is conceptualized as a contracting problem with an embedded co-design problem. A general decision framework is constructed to capture the essential information, decisions, and incentives involved in
procuring customized products. Based on the framework, different procurement scenarios for customized products are characterized and appropriate procurement mechanisms are discussed accordingly.

This paper takes a step in systematically studying customization as a procurement problem from customers’ perspective. The general decision framework proposed in this paper provides a conceptual foundation for further investigation. More specifically, future work is needed to quantitatively study the effect of transaction cost, inaccuracy in customer requirements and risk of design change, moral hazard effect, and manufacturer’ cost correlation etc. Research efforts are also needed in designing mechanisms specifically for procuring customized products. One particular challenge is how to design a procurement mechanism that effectively supports design collaboration in a competitive contracting environment. One interesting direction is to combine search, negotiation, and auction into a single procurement mechanism. In parallel to the research in procurement mechanism design, procurement systems need to be developed. One promising idea is to develop a procurement system that can effectively interact with multiple product configurators provided by different manufacturers. In general, the authors believe we are still lack of understanding of customers’ procurement decisions for customized products, and we are in great need of efficient mechanisms/systems for procuring customized products.

References