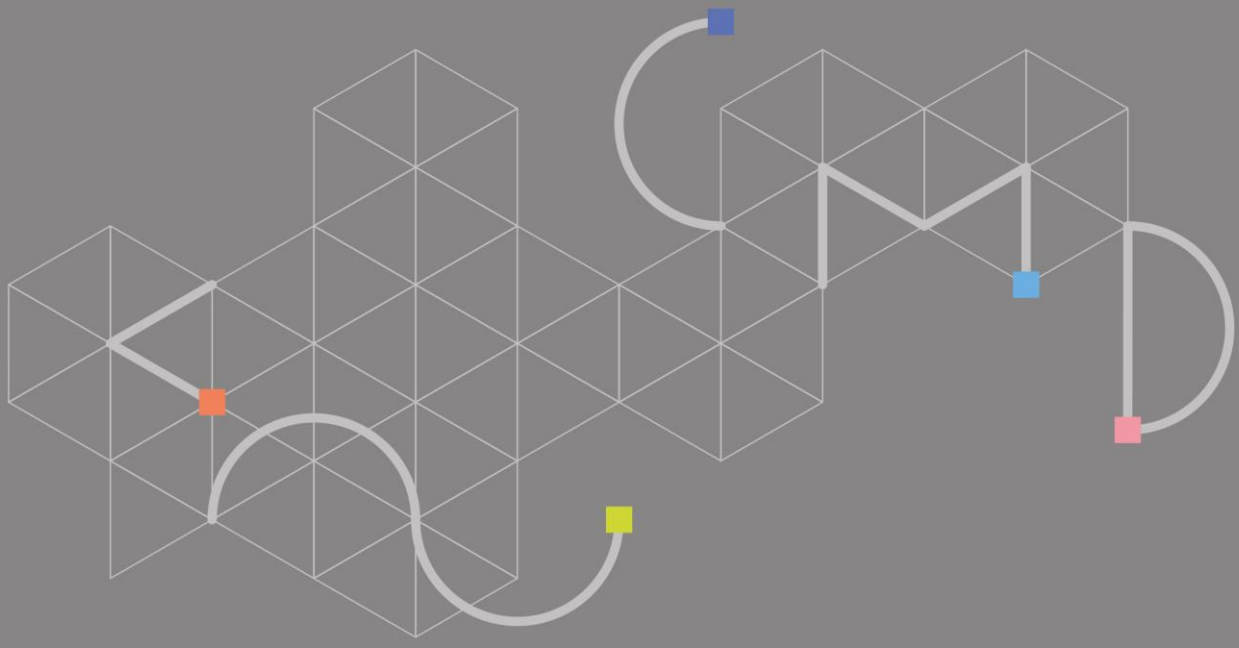
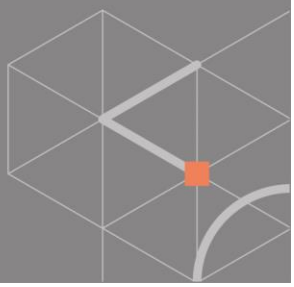
CENTRE FOR MARKET DESIGN

THE UNIVERSITY OF MELBOURNE



PROCUREMENT

DESIGNED, ELECTRONIC AUCTIONS FOR GOVERNMENT PROCUREMENT



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The Centre for market Design

The Centre for Market Design (CMD) is an innovative economic research centre hosted by the University of Melbourne. The CMD was created specifically to build capabilities in research, training and engagement needed to design and create efficient and effective public policy mechanisms. The CMD has established a distinguished publication profile in the fields of mechanism design, auction theory, industrial organisation, matching markets, experimental economics, and empirical economic analysis. We are also defined by our success in applying economic/market design ideas to create innovative mechanisms needed to achieve public policy objectives. The CMD has designed and implemented a range of public policy mechanisms including environmental markets, procurement auctions, auctions of access rights etc. in sectors of the economy including: extractive industries, the transport, human services, natural resources, the environment, government procurement, renewable resources, biosecurity and waste sectors. We have deep expertise in the application of empirical methods to evaluate competitiveness in the fuel and energy sectors, and to evaluate the effectiveness of demand management programs in the water and electricity sectors. Our research is extensively used by the ACCC and utilities. The CMD offers a unique engagement platform that enables interactions and mutually beneficial cooperation between government, industry, and academic economists. The CMD operates under the guidance of a Board consisting of high-level commonwealth and state government representatives, business leaders, internationally recognised academics and public policy experts. Further information about the CMD can be viewed on: https://fbe.unimelb.edu.au/cmd.

SUMMARY

The Victorian Government makes some of the goods and services needed to provide public services but purchases around $5 billion from non-government suppliers. When governments procure goods and services, they are faced with two important information problems: they must firstly discover which firm can supply the goods and services needed at low cost; and they must also ensure that the provider of goods and services does not skimp on inputs (leading to poor quality outcomes). These two problems occur widely in other domains of the economy because information is decentralised and the incentives of the government (the principal) differ from the incentives faced by private firms (the agent). Fortunately, there are ways to address, or partially address, these problems through the application of auction theory and incentive theory that can improve the efficiency and effectiveness of government procurement processes.

Auction theory provides an understanding of the problems of bargaining and negotiation under asymmetric information. One of the most important lessons from this area of economic theory is that bilateral bargaining between a well-informed supplier (firms and organisations they know their costs of production) and a poorly informed buyer (government does not have information about these costs) is that the uninformed party will come off second best in negotiated outcomes. In procurement, this translates to the government paying too much for the goods and services it needs to supply public services. Government's response to this should be to firstly avoid bilateral procurement processes by designing procurement auctions in which the price of goods and services is revealed through competition between suppliers. If well-designed, this strategy will dissipate excess profit margins that could be earned by service providers. Each procurement auction represents a unique economic design problem with different objectives (e.g., cost minimisation, efficiency); different constraints imposed by government (e.g., local content); different characteristics (e.g., single, multi-units) and a range of complexities (e.g., information, strategic and policy) that together influence the design of the procurement auction. The use of sealed-bid tenders for all procurement activities is not supported by auction theory. Procurement auctions need to be designed on a case-by-case basis. To accommodate these factors, governments will benefit from access to a wide range of auction formats including: sealed-bid, first price formats; a broad suite of open auction formats where there are common value information structures; through to highly specialised auction formats capable of dealing with package problems. Furthermore, when governments require procurement to reflect other government policy objectives, such as local content plans, preference for small firms, spatial, quality outcomes etc. these objectives will need to be achieved in the most cost-effective way. Under these circumstances, a systematic, designed approach to procurement will be needed.

The second important influence on procurement is the incentive structures embodied in the contract for goods or services required. The role of these incentives is to align the actions of the supplier with the objectives of government (the buyer). Alignment can be improved by delegating some risk to the provider of the good or service even though this may increase the price of risk bearing overall. In some procurement situations, these two problems, referred to as adverse selection and moral hazard) occur simultaneously creating additional design complexity.

Many of the auction formats that governments will want to use cannot be operationalized through paper-based systems. Open auction formats, for example, rely on information and messaging between participants in the auction, other auctions, such as combinatorial auctions used to procure packages of goods and services, need to be supported by algorithms that process information required to facilitate competitive bidding n the face of allocation complexities. These classes of auction will need to be hosted on web-based electronic platforms that are accessed through the internet. Besides improved flexibility, with respect to auction format, electronic auctions have other important benefits. These include:

- *improved flexibility and functionality* - electronic auctions provide the flexibility needed to host a wider variety of designed procurement auction formats;
- *improved participation* - increased participation facilitated through the internet will promote the achievement of government objectives with respect to procurement;
- *mitigation of corrupt behaviour* - electronic auctions provide a structural separation between government representatives and market participants; and
- *reduced red tape* - electronic auctions can be reused or modified at low cost for repeat or similar procurement activities and have been demonstrated to significantly reduce the procurement life cycle.

These advantages have been argued to have improved cost effectiveness in countries that have introduced web-based procurement auctions. Estimates of the cost savings from designed, auction-based procurement processes range from 10% savings for commodities to 20-30% cost savings for more complex services.

The following recommendations are made:

1. *Designed procurement* – An auction design and incentive design phase should be included in all procurement activities conducted by Victorian Government agencies. The objective of this step in the procurement process is to identify the specific auction format, rules and processes that achieve the objectives of Government with respect to procurement and to ensure that the goods and services supplied by third parties are consistent with government objectives with respect to quality and quantity. Bilateral negotiation processes should be avoided in favour of designed procurement auctions that specifically enhance the bargaining position of government relative to the market.

2. *Electronic auctions* – All procurement activities should be transitioned from paper-based, sealed-bid tenders to electronic procurement auctions. Electronic platforms allow for a wide range of procurement auction formats to be run compared with paper-based processes that essentially limit the auction format to sealed-bid tenders.

3. *Internet hosting of all procurement auctions* – All procurement auctions should be hosted on the internet. Advantages include: cost savings from improved design and increased participation; mitigation against collusion and corruption; and reduced internal red tape.

4. *Designed incentive structures for procurement contracts*- All procurement contracts should be designed to address the moral hazard problem as well as being legally robust.

5. *Staged transition* – A staged approach is proposed to implement the reforms to procurement. The first step will be to develop a general procurement auction platform that enables different auction formats to be operated. Once this platform has been developed, a library of procurement auctions can be accumulated. As with all new institutions, it is useful to start with simple problems first. The fuel procurement auction scheduled for 2015 will represent an ideal pilot for the designed, electronic procurement auction approach. The procurement auction required for fuel procurement is relatively simple (sealed-bid, first-price auction format) and an electronic auction platform has been developed by the CMD. This auction would be hosted on the internet. Following implementation and evaluation, this auction format would be archived with instructions to facilitate reuse when the fuel supply contract again matures or when the same auction format is needed to procure other goods or services. A library of procurement auctions would be developed over time by designing and creating procurement auctions that are fit-for-purpose to each new procurement activity. For example, fuel procurement would be followed (May 2015) by procurement of specialised expertise for medical panels (a Vickery Clarke Groves auction format), followed by travel services procurement later in 2015 (an auction of incentive contracts has been proposed), followed by electricity procurement (sealed bid format proposed) in November 2015.

1. INTRODUCTION

The public sector is a significant purchaser of goods and services. In the United States the federal government alone (excluding individual states) procured goods and services valued at over $378 bn. ($1,300 per person). In 2009, the European Union purchased over €420 billion (3.6 per cent of GDP) and the Australian Government procured $48.9 billion in the 2013-14 financial year - around $2,100 per person.

Government "makes" some of the goods and services needed to fulfil public policy obligations but also buys goods and services from the market. The make or buy decision hinges on transaction costs that apply to vertical integration of functions verses outsourcing of functions. The incidence of incomplete contracting problems that effectively raise the transaction costs associated with outsourcing effectively defines the boundary between the public service and the market. Governments typically "make" services where there are high transaction costs (e.g., producing the annual budget and policy advice) but routinely purchases a wide range of goods and services from the market such as: electricity, fuel, stationary, travel and accommodation services etc. Government typically engages with the market to purchase these goods and services through procurement processes in which there is one buyer (government) and multiple potential suppliers. More recently there has been interest in extending the role of the market in supplying a broader range of goods and services through the creation of new institutions tasked with harnessing competition and facilitating coordination needed to provide more complex goods and services such as freeways, prisons, foreign aid etc. These initiatives are variously referred to as public private partnerships (PPP), franchising and commissioning but they are all a form of procurement.

Procurement is typically framed as a principal agent problem in which the government (the principal) aims to achieve a defined objective but engages a third party, with specialised expertise, to complete the task. The third party is often (but not always) a private firm with incentives that are not aligned with those of government. Government publicises its requirements and invites firms, capable of completing the tasks identified, to register through expressions of interest. Each firm that registers have private information in that it knows its costs, skills, and expertise but this information is not known to government. None of the firms in contention has an incentive to truthfully reveal information about the real cost at which the good or service can be provided because to do so would eat into potential profit margins. Furthermore, once the task is assigned to a winning firm, it has an incentive to minimise inputs or skimp on quality to improve profits, but which adversely affects the government service provided.

The standard practice is for government to call for bids from pre-qualified firms through a sealed-bid tender process. Government then selects the lowest offer from the submitted tender and the winning firm is paid the price specified in the tender. Most procurement, including complex weapons systems, highways and government buildings are procured through a sealed-bid, pay as bid tender. In some cases, a tender process is used to create a short list from which the winner is selected through bilateral negotiation. This is referred to as a best and final offer process (BAFO).

Where agencies are looking to purchase goods and services that are generally available in the market place, they may seek to leverage government purchasing power by entering into fixed term contracts with preferred

suppliers selected through a competitive tender process. There will also be instances where government is the sole purchaser of a product or service, or one of only a small number of purchasers – for example, in the procurement of rolling stock for publicly sponsored train and tram services. In such cases, best value for money will most likely be achieved through a genuinely competitive procurement process. The concept of competitive tendering is embedded in the Victorian Government Purchasing Board (VGPB) Procurement Policies: *"Consistent with government procurement policy, the procurement process should optimise effective competitive tension to maximise value-for-money opportunities for government."* (VGPB 2009, p.49).

2. A DESIGNED PROCUREMENT PROCESS

There are two key problems that must be addressed if procurement is to meet the stated objectives of government. These are referred to as: a) the hidden information problem (adverse selection), and b) the hidden action (moral hazard) problem. Hidden information refers to the problem of discovering which firm can provide the services needed at lowest cost – this information is known by the firm but is hidden from government. Hidden action refers to the problem that the firm providing the goods and services has an incentive to minimise costs but information about the actions of suppliers is hidden from government. These information problems can occur sequentially in which case the hidden information problem needs to be resolved before the hidden action problem arises. In other ceases these hidden information and hidden action problems occur simultaneously (referred to as the mixed model) and need to be resolved in a coordinated way (see Laffont and Martimort 2002[1]). The following sections expand on how these information problems apply to procurement and way they might be addressed.

2.1 SELECTING THE "BEST" PROVIDER – THE HIDDEN INFORMATION PROBLEM

In the procurement context, adverse selection refers to the problem of identifying and selecting the firm (provider) that most closely matches the selection criteria that allows government (the purchaser) to meet its objectives. This usually, but not always, means choosing the firm that can perform the task at lowest cost, within set time constraints, to a given quality standard etc. Selecting the "best" supplier for the task is confounded by the problem that government does not have information about the relevant attributes and costs of private firms. Information (about costs, quality etc.) is confidential to private firms and is hidden from government. Holt[2] frames the procurement in a game theoretic context where the objective of the buyer (e.g., government) is to define the rules and processes that causes pre-qualified firms to truthfully reveal their costs of supplying the identified goods and services. This links procurement with the extensive body of auction theory in which economists seek to design auctions that reveal the information needed to

[1] Laffont, J. and Martimort, D (2002), The Theory of Incentives – The Principal-Agent Model, Princeton University Press.

[2] Charles A. Holt, Jr. Competitive bidding for contracts under alternative auction procedures. Journal of Political Economy, 88:433–445, 1980.

choose which firm is contracted to provide the goods and services required. Procurement is now seen as a major application of auction theory.

The key message from auction theory is that auction design is not a "one size fits all" process (Klemperer[3]). The type of auction needed for procurement is determined by considering the objectives of procurement (e.g., cost minimisation, economic efficiency, local content etc.); the characteristics of the goods and services being procured, the characteristics of the firms; and the nature and severity of complexities (e.g., information complexities, policy complexities, strategic complexities ….)[4]. At the simplest level, there are two broad families of auction (open and closed). Open auctions allow bidders to revise their bids according to the information revealed by other bidders. Closed auctions involve sealed-bid formats where each bidder makes an offer that cannot be revised. Both open and closed formats can be operated as either ascending price or descending price auctions (see Table 1). Auctions are further classified according to whether there are: single unit; multi-unit homogeneous; and multi-unit heterogeneous items and whether the value structures are independent or interdependent between items. Consideration of these and other complexities influence the choice of the auction format and the fine-scale rules of a procurement auction. Klemperer provides a more detailed discussion of the way auctions are designed and the factors that influence their design. Figure 1 illustrates the wide range of auction formats that have been used to allocate access to assets or procurement contracts. Further details are included in Attachment 1. One important observation from auction theory is that a first-price, sealed-bid auction (the standard tender) is the appropriate format only under a very specific set of conditions. Other auction formats, the fine-scale rules within the auction, qualification and settlement processes, reserve price strategies, activity rules etc., need to be designed according to the characteristics of the good or service in question, the complexities associated with procurement and the objectives of procurement. When auction theory has been applied to design procurement processes, a wide range of different procurement auctions and contract incentives have been developed to accommodate the diversity inherent in the different goods and services procured. Many organisations (including governments) use a second-price auction (often referred to as a reverse auction - like eBay) as the standard procurement auction format (UK, Brazil) with some private firms using very sophisticated combinatorial auctions to procure inputs to production (Mars, Home Depot). Other procurement auctions include: mechanisms to deal with bid preferences; bid schedules for different volumes of goods/services; novel incentive structures (e.g., encouraging optimal effort through auctions of incentive contrac[5]); incomplete contracts etc. Chandrashekar reviews the uptake of designed procurement auctions by Compaq Computer Corp., General Dynamics, Dutch Railway, General Electric, Sears Logistics, MARS, Home Depot etc.

[3] Klemperer, P., What really matters in Auction Design, Journal of Economic Perspectives—Volume 16, Number 1—Winter 2002—Pages 169–189

[4] See Plott for a comprehensive analysis of complexities that need to be taken into account in designing auctions.

[5] R. Preston McAfee and John McMillan. Bidding for contracts: A principal-agent analysis. RAND Journal of Economics, 17:326–338, 1986.

Table 1: Broad auction classification

Format	Open format	Closed format
Auction type	English auction (ascending price)	Sealed bid auction (first price)
	Dutch auction (descending price)	Sealed bid auction (second price)

2.2 WILL THE GOOD OR SERVICE BE PROVIDED? – THE HIDDEN ACTION PROBLEM

The second problem to be resolved in procurement arises because the actions of good/service providers is hidden from the buyer – also referred to as moral hazard. Do they use quality components, pay enough attention to the objectives of the purchaser, invest enough effort into the research required to provide advice? It arises because the motives of the agent diverge from those of government, and this becomes a problem because the government is not able to observe (or it is costly to observe) all of the actions of the private firm to ensure that the agent supplies what is promised. Under these circumstances, the agent is motivated to reduce costs, and this can lead to inferior service provision. Moral hazard is addressed by carefully designing the incentive structures that are embedded in service supply contract.

Economic theory relevant to incentive design (principal-agent theory) essentially highlights the trade-offs that are made in distributing risk between the principal and the agent. While government might be able to wear risk at lower cost compared with a small service delivery firm it will often be advantageous to share the burden of risk because of the incentive advantages of doing so. Although the service provider may need to raise its supply cost (bid) to reflect the additional cost of risk bearing, to overall cost of supplying services can be lowered if the devolution of some risk to the agent causes them to more closely align their actions with the objectives of the government. The contract is the mechanism used to define risk sharing arrangements between the government and the supplier. A contract that includes payments for inputs assigns all risk to the government (principal) and a contract that specifies payments for outcomes shifts all risk to the supplier (agent). Often a contract will specify a mix of input and outcome payments that reflects the “sweet spot” between the costs of risk bearing and the benefits from alignment of incentives. An incentive contact is a linear payment schedule where the buyer pays a fixed fee plus a proportion of the contracted cost. It can be implemented to reduce the risk of moral hazard and correcting the principle-agent problem that creates implications for the government due to poor behaviour from the supplier (See Weitzman). Table 2 identifies a range of contract types.

Figure 1: Taxonomy of auction formats

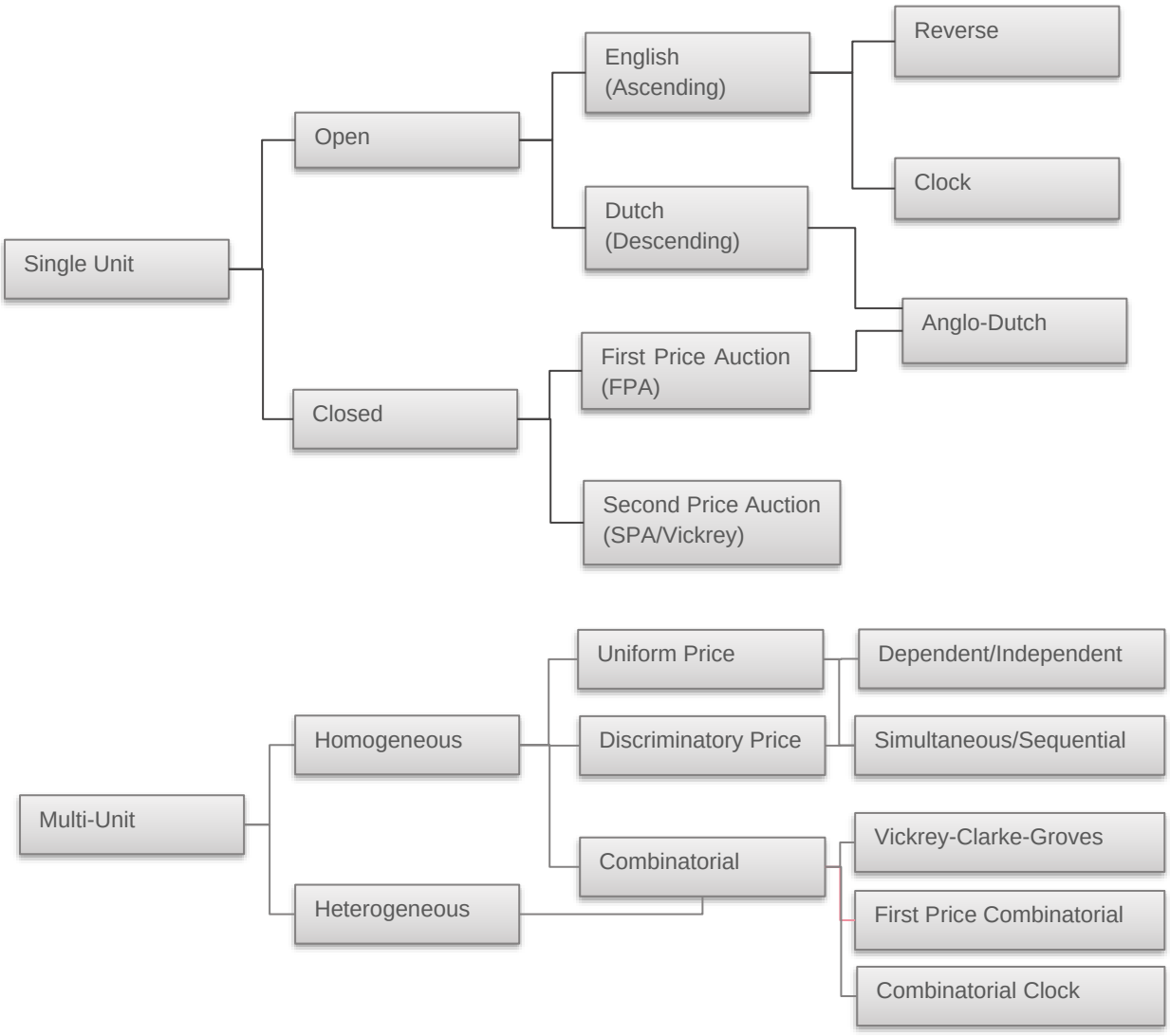

Table 2. Standard linear contractual structures

Type of Contract	Contract Specifications	Advantage	Disadvantage
Cost-Plus Contract (Cost-Plus Fixed Fee)	• Pay actual costs plus a fixed dollar fee (determined as a percentage of the cost estimate)	• Elicit information on bidder's productivity levels	• No direct alignment of incentives for cost reduction
Fixed Price Contract (Firm Fixed Price)	• Contractor agrees to fulfil the project for a fixed dollar price (regardless of cost overruns)	• Every dollar saved becomes firm's profits (creating an incentive to minimize cost to maximize profits)	• Buyer must compensate with a fee, decreasing average normal profits
Cost sharing contract	• Contracted amount is bid price plus (minus) cost overruns [production cost minus bid price]		

2.3 PROCUREMENT WITH MIXED ADVERSE SELECTION AND MORAL HAZARD PROBLEMS

In many procurement activities, the government starts by defining the incentive structure in the service contract. It then offers this contract to the market and uses a designed auction to determine which firm can provide the good or service at lowest cost. The winner of the auction then produces the good or service and is rewarded according to the incentive structures in the contract (the moral hazard problem). In some cases, however, adverse selection and moral hazard need to be resolved simultaneously. The best way to illustrate this is through an example. To procure travel services the government requires both a transaction services (i.e., booking airline tickets and accommodation) but may also want the travel agent to invest additional effort to search for and then purchase lower priced airline tickets and accommodation. This proposal creates the problem of how to induce the travel firm to invest the optimal level of effort needed to find and secure lower prices for the Government. Additional effort required to search for savings is costly for the firm. Each additional dollar invested in searching reduces the firm's profit so that it has an incentive not to search for better travel and accommodation deals. It is also difficult (and costly) for government to observe the effort invested by the agent as the basis of remuneration. In this case adverse selection and moral hazard need to

be resolved simultaneously. This is a well-recognised class of problem in economic design literature initially examined by Laffont and Tirole[6] (Tirole is this year's Noble Prize winner in economics) that can be addressed by *auctioning incentive contracts*. The *incentive contract* component is a way of rewarding the firm for investing extra effort to find cheaper airline tickets and accommodation for the government. To induce this extra effort, the government must share the rewards achieved by the travel firm when it secures discounts. If government does not reward the firm for this effort, the firm will just complete the transactions even if lower cost options were available. The ideal is to encourage the *optimal* effort (i.e., where the marginal benefits of additional effort are just rewarded by the additional returns) in discovering lower airline fares and accommodation rates. This class of procurement problem is observed in the public sector e.g., where government engages an agent to invest effort to: assist an unemployed person to find a job; provide legal advice for citizens on low invome etc.

3. STEPS TO DESIGN AND IMPLEMENT PROCUREMENT AUCTIONS

There are essentially seven steps in designing procurement auction. These are summarised below.

Table 3: Stages in a designed procurement process

Step	Description
1. Clarify and define the objectives	Whilst most procurement processes aim to minimise the cost of inputs purchased from the market, this is not universally the case. A range of other factors may be highlighted in the objectives of government procurement and incorporated into the procurement process. Governments may be interested in influencing market structure to preserve a competitive and diverse range of suppliers in the market. If possible, these objectives, and weightings for the different objectives should be stated before the procurement process is designed. The objectives of a procurement process could include: fairness, efficiency, cost minimisation, participation, strategic outcomes (i.e., diversity, sector composition).
2. Complexities	Identify the complexities that apply to the goods or services required. Complexities arise from: locational requirements for the goods or services to be provided, timing requirements, synergies between items needed, where there are economies of scale. These complexities can be designed into the procurement auction (to varying extents) so that the procurement process is able to achieve a better outcome than buying from the market. Different auction formats can be employed to accommodate these complexities.
3. Incentives	Apply incentive theory to design the incentive structure in the procurement contract.
4. Auction design	Apply auction design theory and experience to identify the auction format needed and the rules and processes that will reveal the information needed Consider the objectives,

[6] Laffont, J.J and Tirole, J (1987) "Auctioning incentive contracts", *The Journal of Political Economy* pp. 921-937

		complexities and incentive issues and design fit-for-purpose auction. The use of a tailored auction design should remove opportunities for bilateral negotiations between parties and induce competition.
5.	**Test-bed**	Build the auction and test its performance. This may include laboratory sessions.
6.	**Implementation and settlement**	A designed pre-qualification process is established, the auction is conducted, and contracts are awarded to bidder's dependent on awarding rules set in the auction design phase.
7.	**Feedback and evaluation**	Complete feedback and evaluation of goods and services supplied.

4. ELECTRONIC PROCUREMENT AUCTIONS

Many fit-for-purpose (designed) procurement auctions are difficult, in some cases, impossible to run as paper-based or open cry forms. Advances in information and communication technologies complement developments in auction theory by allowing a wide array of fit-for-purpose auctions to be hosted, expanding participation in auctions and reducing the cost of reusing auctions once they are developed. These developments have transformed procurement processes for individuals, private firms and government. Sites such as Alibaba, eBay and gumtree are examples of electronic, designed procurement auctions that allow a wide range of goods and services to be procured by individuals and private firms through the internet. Where private firms purchase large volumes of goods and services as part of a production process, it may be advantageous to develop specialised procurement processes that accommodate the specific attributes of the good or service in question and the complexities that impeded transactions and to reuse these procurement auctions at low cost. The Mars Corporation and Home Depot[7] are examples of private firms that have developed sophisticated electronic procurement auctions that allow these companies to rerun efficient procurement auctions using electronically hosted auctions. These developments in the private sector also apply to government procurement where specific goods and services are procured repeatedly and where there are advantages to using fit-for-purpose procurement auctions that require electronic hosting. ComprasNET developed by the government of Brazil is an example of an electronic procurement auction system. It employs a relatively simple auction format for a wide range of goods and services but is reusable at low cost. The World Bank[8] has an international program to assist developing countries migrate to electronic platforms and the OECD actively uses designed procurement auctions.

[7] Chandrashekar, T.S. Narahari, Y., Rosa, C., Kulkarni, D., Tew, J., Dayama, P. "Auction-based mechanisms for electronic procurement", *IEEE Trans. Autom. Sci. Eng.*, vol. 4, no. 3, pp.297 -321, 2007

4.1 BENEFITS FROM DESIGNED ELECTRONIC PROCUREMENT AUCTIONS

The benefits from a more systematic design and execution of procurement processes arise from four sources:

- Improved procurement auction design - harnessing competition, exploiting synergies etc.
- Improved incentive structures in the service contracts - improved quality of services provided.
- Internet bidding - increased participation, reduced scope for corruption.
- Electronic hosting of auctions - reduced reuse costs, more complex auction formats able to be used.

As a general observation, the potential for cost savings from designed electronic procurement auctions tends to be lower where the buyer is procuring from an already competitive market (e.g., commodities) and where collusion or other market power problems are minimal. Benefits will be higher where there are: thin markets, market inefficiencies such as collusion; transaction complexities; and where there is corruption in procurement processes. Table 4 provides a summary if the claimed gains from procurement reforms made by various government agencies.

The cost savings from e-auctions observed in the UK are higher than anticipated given that many of the case studies noted involve procurement of commodities such as computers, stationery, pharmaceuticals, communication equipment etc. As noted earlier, we would not expect a procurement process to out-perform an efficient market as is the assumption for most commodities. For these case studies, the gains are likely to stem from greater participation through internet bidding and the use of a competitive auction compared with the standard sealed-bid tender often with a negotiation phase. Nevertheless, the costs savings stated are higher than expected. The gains identified by Brazil (20-30%) through ComprasNET are also at the high end of the range of expected gains given that ComprasNET appears to be mostly used to procure standard goods and services with a standard auction format. The cost reductions achieved are largely derived from the impact of an electronic platform on collusive behaviour (see Santanna[9]). Electronic auction platforms structurally separate the government officer from individual suppliers by embedding auction format, winning rules and price discovery in computer code that affording a higher level of commitment by government, independence and transparency than can be achieved through bilateral negotiation processes. Other examples illustrate the gains from auction design alone. For example, an evaluation of the environmental procurement auctions conducted by Victoria[10] estimate the gains from improved auction design at 30%.

[9] Santanna, R. (200#) Electronic Procurement Allow for Inspection By Society, Global Forum on Governance:

Modernising Government: strategies & tools for change, Rio de Janeiro - Brazil

[10] Stoneham, G (2007), Creating markets for environmental goods and services, Land and Water Australia.

reduction in environmental procurement costs that are purely derived from auction design. from procurement auctions that reveal relevant information. An additional advantage form electronic procurement auctions arises because of savings in internal administration and approval processes. In Brazil, for example, the procurement cycle has reduced from 117 days to 20 days because electronic auctions can be reused quickly and at low cost.

5. IMPLEMENTATION STRATEGY

Government procurement practices can be improved by incorporating three capabilities in their procurement processes:

- *economic design* - the use of designed, fit-for-purpose, procurement auctions and designed incentive contracts;
- *electronic auctions* - creating electronic auctions that enable the use of a broader range of auction formats and features not available in paper-based or open cry auctions; and
- *internet bidding* - internet bidding increases participation and can mitigate the possibility of corruption.

Governments procure a wide range of goods and services from commodities to highly specific human services for a wide range of clients at different locations. This suggests that a wide range of auction formats will be needed in response to the characteristics of different goods and services and the information, spatial, strategic, policy and timing complexities relevant to government. Figure 2 illustrates the sort of procurement auctions that government might want to use for different circumstances. For example, sealed-bid auctions might be needed to procure commodities or where collusion is anticipated by bidders; clock auctions might be used where goods have a common value information structure i.e. a roadway where there is demand forecasting risk); multi-unit auctions might be used in situations where bidders wish to offer lower prices to reflect economies of scale with larger orders; multiple clock auctions might be used where several interrelated goods/services will be needed an there are synergies between goods/services; similarly combinatorial auctions would be considered where packages of goods/services are needed; and auctions of incentive contracts might be used where suppliers can invest additional effort that benefits the procurer (e.g. complex legal services). Although there is an investment required to design, build and test each of these auction formats, once created, they can be reused at almost zero marginal cost. The procurement auction capability illustrated in Figure 2 is best developed by building a library of fit-for-purpose procurement auctions needed for each good or service procured by government. Because the features of each auction reflect the specific characteristics of each good or service required, a strategy to sequentially develop the library as existing procurement contracts mature and need renewing will be preferable to building a singly auction platform for all goods and services.

The A staged approach, summarised in Table 5, is proposed to implement the procurement platform. The first stage involves designing and building the web-based platform needed to host electronic auctions. Fortunately, internet hosting of auctions is now commonplace (e.g. eBay, Tradeslot, Intelimarket, Power Auctions etc.) and very little bespoke design and development is needed to create the platform. The internet platform must be scalable, reliable and accessible. The Centre for Market Design will coordinate and fund

the creation of this platform. Once the internet platform has been developed, a library of procurement auctions should be developed sequentially. As existing procurement arrangements mature, fit-for-purpose auctions can be designed and created (stage 2). Once implemented and evaluated (Stage 3) each auction would be archived with instructions developed to facilitate reuse when the supply contract matures (Stage 4) or adaptation to a new procurement activity.

Figure 2: Schematic representation of a procurement platform

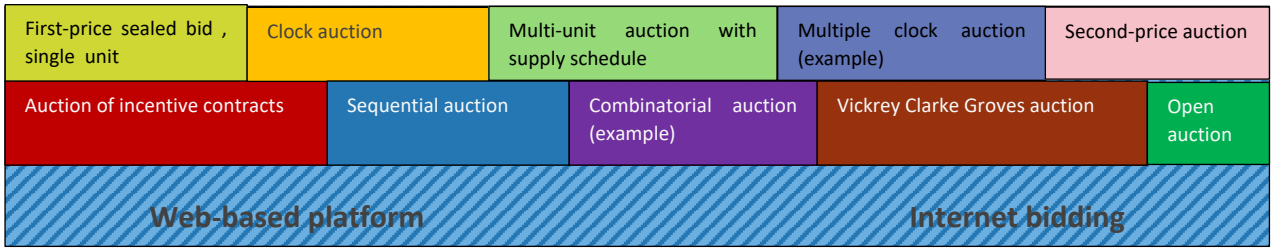

Table 5. Stages in implementation

Stage	Activity	Description and strategy	Resources	Time
Stage 1	Develop internet auction platform	Design the platform to be used to host and save a library of auction formats needed to procure goods and services required by government	CMD to fund and coordinate	Jan 2015
Stage 2	Design and create fit-for-purpose procurement auction formats as new procurements arise	The library of procurement auctions will be developed sequentially as existing procurement contracts mature. The following procurement arrangements are anticipated: • Medical Panels • Fuel (May 2015) • Travel services • Electricity	CMD to design auctions	March 2015 May 2015 ? Nov. 2015
Stage 3	Implement and evaluate each procurement auction	Develop software for the fuel procurement auction	CMD and Caltech	Jan 2015
Stage 4	Archive auction formats	Save and catalogue each new auction format and develop an instruction manual to guide reuse of the auction	CMD& Strategic Sourcing	As procurement auctions are completed

Table 4: Summary of international experience with procurement reform

Jurisdiction (good/service)	Gain	Comments
Brazil (mostly goods and services)	20% to 30% cost reduction (Ref) Procurement life cycle reduced from 117 days to 20 days.	ComprasNET does not have a strong auction design component but internet hosting has increased participation and reduced corruption
UK		
• Merseyside Councils (office supplies)	42% (£3.5 m)	e-Auctions plus aggregation across councils
• North Yorkshire Council (mobile phones)	29%	e-Auctions
• Department of Constitutional Affairs (court reporting services)	11.2% (£0.8/annum)	Designed procurement auction
• Inland Revenue Department (furniture)	23% (£0.9/annum)	Designed procurement auction
• Northampton County Council (communications services)	49%	Designed auction + electronic
• South East and Eastern region Police (stationery)	50% (£0.48/annum)	e-Auction
• Welsh Health Services (medical supplies)	10% (£0.6/3 years)	e-Auction
• Portsmouth Hospital (pharmaceutical supplies)	12% (£0.64/annum)	e-Auction
• Coventry Council (office, stationery, computers)	30% (stationery) 18% (computers)	e-Auction

Victoria		
• Department of Environment (environmental service procurement from private landholders)	30%/annum	Designed procurement auction + designed contract incentives
US Federal Government		
• aircraft ejection seat	28%	Designed actions
• goods and services	Not reported	Designed auctions
US State Governments		
• Massachusetts • Minnesota • Pennsylvania • Texas • Wisconsin	Not reported	Increasing use of designed auctions

6. ATTACHMENT 1: A BRIEF DESCRIPTION OF AUCTION FORMATS

Single unit auctions - Auction theory has commonly focused on single units of goods and services. Recently, research has shifted this focus to the auctioning of multiple units or multi-unit auctions and adapted single unit auctions to the multiple unit environment. Accordingly, knowledge of single unit auctions is fundamental to the understanding of the more complex multi-unit environment. This discussion shall begin with highlighting the auction mechanism that deal with single units before describing the more complex auctioning of multiple items.

Auctions mainly differ across two characteristics – information and the final price paid. In particular, knowledge of bids can be common or private and the winner may pay the highest or second highest price.

Open Auctions: Auctions are said to be open if bidding is common knowledge. An open auction refers to the action of making an 'open cry' bid in which each bidders' bid is announced and known to all bidders. The two main types of open auctions are the English and Dutch auction.

English Auction: English Auctions follow an ascending price process such that bidders can only bid up the price. The bidder who makes the highest and final bid wins the auction and pays the amount of their bid. This format is commonly used in auctions for real estate.

Dutch Auction: The Dutch auction is a descending price auction where the auctioneer announces the highest price which they are willing to sell the item for. The price then decreases set decrements until a bidder announces a bid. At this point, the auction stops and the winner is the first to make a bid and pays their bid.

Anglo-Dutch Auction: Auctions can also be combined to include a number of designs. The Anglo-Dutch auction is two-stage auction which combines the English and Dutch auctions. The first stage of the auction takes the form of an English auction where the arbitrarily chosen group of highest bidders are invited to participate in the second stage of the auction – the sealed-bid FPA (as in the Dutch auction, a bidder's dominant strategy is to bid below their true value in order to receive a profit).

Clock Auction: Clock auctions are characterised by increasing or decreasing price movements along a predetermined time schedule. Here, the buyer (seller) announces the highest (lowest) price they are willing to buy (sell) the item for. This initial price becomes the starting price which will then decrease(increase) in set decrements (increments). Sellers (buyers) remain an active participant in the auction if they are willing to sell (buy) at the announced price. The winner is the final active bidder who sells (buys) at the announced price.

Reverse Auction: The roles within an auction can be reversed such that the buyer becomes the auctioneer rather than the seller and the auction implements a descending price process as sellers compete to obtain business. The buyer announces prices to the sellers and those willing to supply the item at the announced price remain active participants of the auction. The final remaining seller is willing and able to sell the item to the buyer at the lowest price and pays this announced price.

Closed Auctions: As mentioned above, bids can also be independent and private. This type of auction is known as a sealed-bid auction and describes the situation where each bidder is restricted to the knowledge of their own bid. Hence, competitors are uninformed of each other's bids. Sealed-bid auctions can be categorised by the price which the winning bidder pays for the item i.e. the first price or second price.

First Price Auction The first price auction (FPA) can be used for both procuring and supplying items and allocates the item to the highest or lowest bidder. The winner of this auction pays their bid so that each bidders' 'profit' from the auction is the difference between their own true value for the item and the price that they pay for it. Hence, to maximise one's profit, the dominant strategy is to bid below the true valuation for the item.

Second Price Auction The second price auction (SPA) differs from the FPA in a significant way – the highest or lowest bidder wins the auction but only pays the second highest or second lowest bid submitted. Although it is similar to the FPA in that it can be used for both procuring and supplying as well as allocating the item to the highest or lowest bidder, the difference in the rule governing the price paid produces a significant difference in the respective bidding strategies. In direct contrast to the FPA, bidding one's true value in the SPA weakly dominates any other strategy. This is due to the fact that the winning bidder never pays their bid. Hence, if the winning bidder bids their true value, they will receive the item at the lower price of the second highest value and gain a profit.

Multi-unit auctions - As with any well-designed process, the design of an auction must fit the type of good or service which is to be procured or supplied. Traditionally, auctions have facilitated the sale of single units of a good or service. Recent research has focused on the selling and buying of multiple units. While the majority of auction theory pertaining to the single unit case can be adapted for the auctioning of more than one unit, the characteristics in which these units can differ must be accounted for. In particular, the auctioning of identical or homogeneous units will require a different auction design to the auctioning of heterogeneous units which can differ across dimensions.

Homogeneous goods Homogeneous units are identical across characteristics. Whist units are identical the various auctions that can be implemented vary over several dimensions such as the rules concerning the final price paid and the bidding process. The final price paid by the winner of the auction will not only depend on which institution is used i.e. English or Sealed-bid FPA, but also on the pricing mechanism implemented.

Uniform Price Auction This mechanism is used when multiple units of homogeneous goods are auctioned in equivalent, fixed quantities and allocated to each winning bidder until the allocation is exhausted. Each winning bidder pays the same price, the market clearing price, which is set equal to the lowest winning bid. This type of auction is commonly used in auctions for treasury bills and initial public offerings.

Discriminatory Price Auction - Alternatively, winning bidders can be charged the price of their bid i.e. winning bidders will pay-as-bid. Winning bidders are allocated the good and pay the amount that they bid rather than a uniform price. This pricing rule is featured in the Dutch Flower auctions.

Simultaneous Auctions - When multiple units of homogeneous goods are auctioned simultaneously, bids and prices are either dependent or independent of each other depending on the auction design.

Simultaneous-Dependent auctions share the same price rule as Uniform Price auctions and each bidder makes a single action – submits their preferred allotment and price. Conversely, Simultaneous-Independent auctions require bidders to submit bids in several simultaneous auctions and the winners pay-as-bid as in the Discriminatory Price auction.

Sequential Auctions - Multiple units can also be auctioned sequentially i.e., each lot is auctioned one at a time. This design has been utilised in procurement auctions such as Nitrous Oxide emissions permits by the State of Virginia and export permits for timber in Siberia.

Heterogeneous goods: Both goods and services can differ in several ways and an individual's demand for each good or service will reflect these differences. Accordingly, it is imperative to design an auction to ensure that a varying demand for heterogeneous goods is captured by the mechanism. Over the past 15 years both theorists and practitioners have investigated and implemented combinatorial auctions to deal with this important issue.

Combinatorial auctions - Rather than restricting bidders to bidding on a single unit, a combinatorial auction allows bidders to bid on a combination or package of units. Bidding takes place in at least two dimensions – bidding on individual units and bidding on a package of units. Goods are allocated on the basis of which bid, individual or package, generates the greatest monetary return. Hence, if a package bid is greater than the sum of the individual bids for each unit, then the units are sold as a package. While this situation could be misinterpreted as a motivation for volume discounts, the opposite may actually be true – as more units are consumed, returns increase rather than diminish. Increasing returns arise from the synergies or compliments that exist between a combination of units. Combining bids for individual items allows bidders to reveal their preferences over complements. While combinatorial auctions are commonly used for auctioning heterogeneous goods, this mechanism can also be implemented to auction homogeneous goods which are capable of generating synergies. A number of single unit auctions have been adapted for the combinatorial setting including the FPA, SPA/Vickrey and Clock auctions.

First Price Combinatorial Auction (FPCA) - Many of the procurement auctions across the world have taken a sealed-bid FPA form. As in the single unit case, the highest bid is the winning bid and the winner pays their bid. It is common to include specific rules to ensure that the auction design not only matches the goods' characteristics but also the features which characterise its market. For instance, the design may include a quota to prevent the formation of monopolies and promote greater competition. The advantages of this design has led to an increase in auction efficiency for both private and public procurement. Prominent examples include contracting to supply Chilean schools with breakfast and lunch meals as well as the London Transport Authority's auctioning of London bus routes.

Vickrey-Clarke-Groves (VCG - An extension of the SPA to the multi-unit case, the VCG also requires winning bidders to pay the opportunity cost of their bid i.e. the second highest bid. Under a simple set of assumptions, bidders' weakly dominant strategy is to bid their valuations. In a combinatorial bidding environment, bidding one's valuation reveals preferences over compliments. Although the VCG's dominant strategy is to bid one's true valuation, the mechanism is rarely used in the real world as it is highly susceptible to collusion.

Combinatorial Clock (CC) - The CC auction extends the single unit Clock auction to allow for package bidding. In a descending price auction environment, the buyer or procurer announces the highest price that they are willing to purchase the item. Suppliers who are willing and able to supply the item at the announced price remain active while unwilling suppliers drop out. The price decreases in set decrements allowing suppliers a moment to decide whether to remain active at the announced price. The final active bidder wins the auction and pays the announced price. The CC auction may be preferred to the single round sealed-bid FPCA depending on the characteristics of the item and the market which the auctioneer faces. For instance, in cases when common knowledge is lacking, the CC auction may be preferred due to its ability to generate of information feedback. Under this mechanism, bidders reveal their preferences to competitors allowing for greater competition and efficiency from the auction. The amount of information that is common knowledge can be adjusted to suit the characteristics of the market. The CC auction has been implemented successfully by a number of private sector including the auctioning of transport contracts by Sears Logistic Services. The public sector has also utilised the CC auction in selling digital spectrum licences in Australia and abroad.

7. ATTACHMENT 2: EXAMPLES OF DIFFERENT AUCTION FORMATS FOR PROCUREMENT

A limited survey of procurement auctions reveals that a wide range of auction formats have been used to procure goods and services (see Tables below). Different auction formats are used to reflect the information characteristics of the good or services (i.e., independent private values or common values), single- verses multi-unit objects, concerns about collusion, objective etc. The simplest form of auction design, the "open first price sealed-bid" has the effect for mitigating potential collusive behaviour between participants in the auction (see environmental services example in Table A.2.2), by limiting their access of information on bids submitted by competing bidders. Despite its simplicity, the "open first price sealed-bid" can cause implications such as a winner's curse through its "competitive mechanism". Bidders are unable to observe the "true" market and other competitors' bids and are likely to overestimate the value of the good/service contract being auctioned (see Kagel and Levin). This suggests there is no "one-size fits all" auction format in designing procurement auctions.

Depending on the complexities, issues and the number of objectives of the government, varying and unique auction formats should be used - for example, when there is a locational issue in procuring goods and services. Procurement transactions delivering goods and services cross regions and states within a country puts less prominent suppliers in disadvantage under a first price sealed-bid approach. Less prominent supplies are disadvantaged (less market power) relative to suppliers with greater market share who are more able to reduce transportation costs through economies of scope. The use of combinatorial auctions can reduce procurement costs by increasing the margins of competition and take advantage of cost synergies between elements of the set of goods and services needed. This type of auction was used in Chile to procure meals for school children (see Chilean meals services example in Table A.2.2). Additionally, the use of combinatorial auctions can improve the economies of scope for suppliers (by reducing transportation costs) through increasing equipment utilisation and improving efficiency (see Home Depot example in Table 3), resulting in lower overall costs for the government. Ultimately, combinatorial auctions bring scope for bidders to express their synergistic values. Again, despite the ability of combinatorial auction format in addressing complex procurement auctions, it can carry implications. Combinatorial auctions create the "winner determination problem" and if inappropriately addressed, causes allocative inefficiency problems (see Rothkopf). Other auction types, such as Vickery Clarke Groves, are being used to procure multiple heterogeneous units of services in a second price, open auction process. Table also records the use of innovations in auction design such as the use of bid schedules that allow suppliers to indicate cost discounts for increased volumes of goods or services procured. Some procurements have employed multi stage procurement processes to deal with specific complexities and clock auctions as a form of open, second price auction.

These examples illustrate have been selected to illustrate the important point that auction design should not involve a "one-size-fits-all" approach (see Klemperer). Instead, a wide range of procurement auctions will be needed to procure different goods and services.

Table A.2.1 Examples of single item single attribute procurement auction

Good/service procured	Auction format	Description/Purpose
Pharmaceutical inputs	Sealed-bid, first-price	• Ability to leverage demand and supply of inputs • Create a competitive environment amongst suppliers • Electronic platforms created an accountable and transparent procurement process S. Beall, C. Carter, and et. al., "The role of reverse auctions in strategic sourcing: Case Study Glaxo Smith Kline," Center for Advanced Purchasing Studies, Temple, AZ, USA, Tech. Rep., 2003.

Table A.2.2 Examples of multi-item procurement auctions

Good/service procured	Auction format	Description
Environmental services	Sealed-bid, first-price, single round	• Auction format to reduce collusion and lower the number of bids • Single round because bidders all have private values (not common values) and multiple rounds would facilitate information aggregation • Price minimization • No reserve price set (no need if there is a budget constraint) Stoneham et al (2003) Auctions for conservation contracts: an empirical examination of Victoria's BushTender trial, The Australian Journal of Agricultural and Resource Economics, 47:4, pp. 477–500
Brazil Government (ComprasNET)	Descending auctions	• Bidders are all pre-qualified (qualifications criteria change overtime and can change from auction to auction • Pre-bidding: Procured goods are grouped in lots (batches), then a reservation price is set (calculated from the average of three quotes from market research) and an advertisement for tender (with product description) is sent out 8 working days before bidding occurs. All information is free to download anonymously at the time. • Bidding: All interested bidders submit opening bids (no minimum bids), when auction starts – the lowest bid is announced and bidders engage in a descending auction. All new bids are strictly lower than their previous bid. All bids are anonymous. Bids close at random with a 30-minute warning. • Post Bidding: The best bid is checked whether it is below the reserve price, if it is, documents a submitted to adjudicate the lot. Otherwise, the second-best bid is checked, etc. It is rare but possible to have a winning bid higher than the reserve price. • Increase in speed of transactions • Improved transparency in government procurement • Reduced collusive behavior among market participants and the government
Motor car parts supply	Online auctions/negotiations	• Purpose to improve purchase productivity, not cost reduction • Reduce complexity in process • Improve market transparency • Ability to act on worldwide basis S. Beall, C. Carter, and et. al., "The role of reverse auctions in strategic sourcing: Case Study Volkswagen," Center for Advanced Purchasing Studies, Temple, AZ, USA, Tech. Rep., 2003.

Medical expertise	Sealed-bid, Vickrey-Clarke-Groves, second-price auction	Medical experts bid to supply expert advice on medical panels for Medical Panels Victoria. A VCG auction is used to lead to truthful revelation of wage rates for individual doctors.
Home depot	Multi-item combinatorial auction	• Provide flexibility in transportation bidding; • Provide information to bidders about the demand for various transportation lanes • Economies of scope for transporters • Pre-screening of bidders for quality filtering • Allow bidders to bid for lanes in groups W. Elmaghraby and P. Keskinocak, "Technology for transportation bidding at the home depot," Teaching Case, School of Industrial and Systems Engineering Georgia Institute of Technology, Tech. Rep., 2003
Transport services		• This is more of a summary paper of a number of Combinatorial auctions and does not provide great detail of each auction – Colgate-Palmolive, Compaq, Ford, Home Depot Y. Sheffi, "Combinatorial auctions in the procurement of transportation services," Interfaces, vol. 34, pp. 245–252, 2004.
Sears Logistics Services (SLS) - transport services	Multi-round sealed-bid FPCA	• Contract carriers to supply transport services to a number of lanes • Firms submit sealed-bids and lowest bid becomes benchmark for following round and is subsequently bid down • Firms bid on multiple lanes and the minimum amount they require to service these lanes • SLS saved US$25m or 13% in costs • Original Combinatorial Auction for transportation services J. Ledyard, M. Olson, D. Porter, J. Swanson, D Torma, 'The First Use of a Combined-Value Auction for Transportation Services' Interfaces, vol. 32, no. 5, pp. 4–12, 2002.
Chile Government –	Single-round first-price sealed-bid combinatorial auction	• Meal services are standardised such that firms only compete in prices • Firms are allowed to submit multiple bids • Meal services standardised but packaged according to territorial units/areas in Chile

		• Two types of discounts: 1) package discounts (depending on size of package), 2) density discounts (for packaging nearby units) • By conducting packaged bidding, allowed firms to express their cost synergies R. Epstein, L. Henriquez, J. Catalan, G. Weintraub, and C. Martinez, "A combinatorial auction improves school meals in Chile," Interfaces, vol. 32, no. 6, pp. 1–14, 2002
Meals for schools (Olivares, 2012)		
MARS	Auction with volume discount – bidding through a supply schedule	• Increase the number of potential participants (bidders) and stimulating competition • Allow bidders to learn from information (bids from others) to 'correct' their bids • Elicit bids incrementally so bidders do not need to specify all is preferences • Provide discounts on certain 'bundles' of supplies G. Hohner, J. Rich, E. Ng, G. Reid, A. J. Davenport, J. R. Kalagnanam, S. H. Lee, and C. An, "Combinatorial and quantity discount pro curement auctions provide benefits to Mars, Incorporated and to its suppliers," Interfaces, vol. 33, no. 1, pp. 23–35, 2003.
London Regional Transport (The London Bus Route)	First-price combinatorial auction	• Pre-auction design: Defining 'low frequency' routes and distinguishing between night and day routes • Packaging and sequencing decisions: to share fixed costs and coordinate efficiencies • Pre-qualification: Screens for financial stability and operational capacity of potential operators • Each bid is a firm but non-exclusive commitment of resources, where two bids on different routes implicitly define a bid for the package of these routes • Contracts are awarded to bids with the highest economic value (lowest bid and operator quality) E. Cantillon, & M. Pesendorfer, "Combination Bidding in Multi-Unit Auctions," CEPR Discussion Papers 6083, C.E.P.R. Discussion Papers, 2007.
Brazil (Renewable Energy – Wind Technology)	Hybrid mechanism with two stages: 1) descending price clock auction; 2) pay-as-bid sealed bid auction	• Stage One: Initiated at high price then and decrease until supply is met to discover a price ceiling. Suppliers who are willing to offer goods at this price continues to Stage Two • Stage Two: All remaining bidders remaining places a sealed bid for the supply of the goods to meet demand, and the bid must be less than or equal to the price ceiling set in Stage One • Deposit bid-bond of 1 per cent of project cost declared by the investor and regulator (guarantee is returned if contract is won and signed) • Auction winners must deposit a project completion guarantee of 5 per cent of investment costs • Requirement of 60% local content in each contract E. Rego and V. Parente, 'Brazilian experience in electricity auctions: Comparing outcomes from new and old energy auctions as well as the application of the hybrid Anglo-Dutch design,' Energy Policy, vol. 55, pp 511-520, 2013

8. ATTACHMENT 3: E-PROCUREMENT PLATFORMS

e-procurement is now a well-developed tool which has been implemented across the world in both the private and public sector. As such, there are a number of e-procurement software providers and a great deal of differentiation in the type of auction that each firm specialises in. This follows from the aforementioned importance placed on fit-for-purpose auctions and ensuring that each auction is specifically tailored to meet the characteristics of its market. While supply chain software developers have collaborated with logistic service firms to develop combinatorial auctions other software developers have focused on improving the user experience within a simpler reverse auction environment. Broadly speaking, e-procurement systems generally include the following components:

- Definition of the good or service needed
- Approval of funds
- Contract
- Tender
- Bidding and negotiation
- Settlement
- Supply
- Evaluation
- Control

When selecting the most suitable e-procurement platform the potential suppliers experience with this software should play a role in the decision-making process. In the case of complex auction design like the combinatorial auction, firms and government can limit learning costs by using a recognised and reliable software platform. Additionally, increasing the ease of which firms are able to access the auction should be of concern. For instance, if suppliers are able to access the auction through their web browser rather than download and install an additional software package will facilitate a more streamlined approach. A list of providers and a short description of their capabilities is listed in Table below.

Table A.3.1 E-procurement platforms.

Name of e-procurement platform	E-procurement Platform
EPIQ	• Provider of procurement solutions for enterprise and mid-sized customers • Epiq offers auction software that allows businesses to create their own auction events. • Dutch auctions, English auctions, second price auctions • http://www.epiqtech.com/auction_software.htm
Sensible Development	• Combinatorial auctions, multi-unit auctions http://www.sensibledevelopment.com/product-range/auction-features/advanced-auction-system-features/
Auction Flex	• Catalogued live auctions, non-catalogued live auctions, internet-only (timed) auctions, live auctions with webcast, and multi-parcel live auctions http://www.auctionflex.com/live_auction_software.htm
Purchasing auctions	• Reverse auctions http://purchasingauctions.com/
Procureport	• Reverse auctions, forward auctions, Dutch auctions, sealed-bid auctions • Develop custom auction software http://www.procureport.com/reverse-auctions.html
Buynamics	• Reverse auctions http://en.buynamics.eu/e-auction/
JDA Software	• Combinatorial auctions • Supply Chain e-auctions

	• Acquired i2 Tech (Home Depot) and Manugestics Inc. http://www.jda.com/view/scm-brochure/jda-logistics-procurement/
Manhattan Associates	• Transportation procurement solutions • Possibly acquired Logistics.com (Walmart, Compaq, Staples) http://www.manh.com/solutions/transportation-management/transportation-procurement

Other possible platforms:ariba - http://www.ariba.com/solutions/buy/procurement-solutions,
perfect commerce - http://www.perfect.com/services/bpo/,
AT Kearney - http://www.atkearneypas.com/,
Moai Technologies - http://www.moai.com/solutions/solutions_overview.asp,
orbis online - http://www.orbisonline.com/solutions.asp,
NSW Procure point - https://www.procurepoint.nsw.gov.au/,
WebBidder by DotEcon - http://www.dotecon.com/expertise/auction-software/,
CRAB - https://swing.fit.cvut.cz/vranyj1/software/crab?_s=AFYI2Ar74MPfWawR&_k=IqyFFxDedY0K3Jfy&_n&10,
eFractal - http://www.e-fractal.cz/en/Page/SpectrumAuctions.aspx,
tradeslot - http://www.tradeslot.com/combinatorial-auctions/,
Power Auctions - https://www.powerauctions.com/

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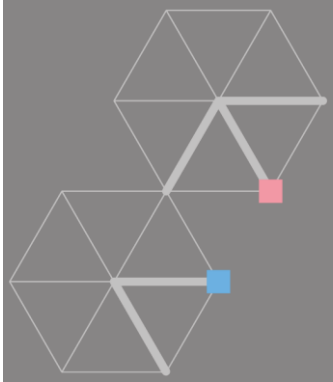

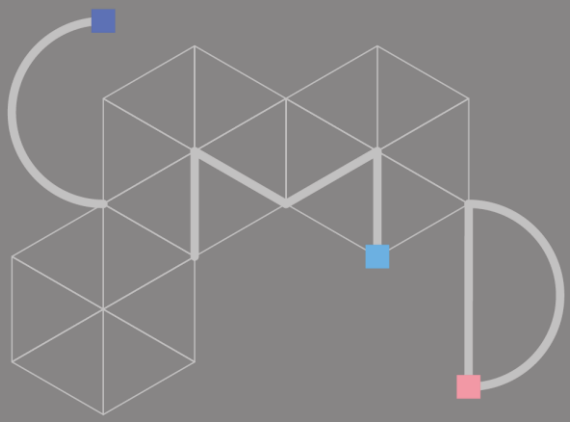

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