

PRICE TO WIN THROUGH VALUE MODELLING FOR SERVICE OFFERING

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Abstract

Purpose: To present an approach to determine the price companies should bid to win a contract to deliver product service systems, and make a profit.

Design/methodology/approach: Industrial case studies are used as the test bed. Combinations of subjective probability and value modelling have been used in this research.

Findings: Current approaches to determine the price to win for a product oriented service contract have mainly focussed on the cost of the physical asset and its' specification. There is little research, where the 'value' of the tangible and intangible aspects of a product service system to the customer is considered. The proposed approach provides the decision-maker with information on the value of their/and their competitors offering, assisting in selecting the price to bid for the service contract.

Practical implications: Our approach can be used by industry to model the key value drivers for their customers and provide information on the probability of winning and probability of making a profit. This research provides a step-by-step approach for identifying uncertainties eliciting the value of the service being offered to the customer and modelling these to estimate the probability of winning.

Social implications: This research provides practical guidance to decision makers and bid teams.

Originality/value: Highlights how the tangible and intangible aspects of a Product Service System can be quantified in monetary terms to assist in decision-making.

Keywords: Product Service Systems, Price to Win, Value Modelling, Subjective Probability, expert elicitation

1. Introduction

In some high-value manufacturing sectors complex assets, such as planes, trains and ships are no longer being sold as ‘assets’, but are offering through-life support – i.e. advanced services. These advanced services are often referred to as Product Service System (Meier et al, 2010; Baines & Lightfoot, 2013 and Tukker, 2014).

Examples of such advanced services include the AUD\$640 million contract awarded to Cobham to deliver airborne search and rescue capability from 2016 (Cobham, 2014) and the Bombardier £1.3 billion deal with Transport for London to provide new trains, depot and maintenance for the London CrossRail project (Bombardier, 2014).

Currently industry/governments are sourcing their service requirements in a number of ways. Figure 1 depicts example scenarios for an aircraft. Here the outer ends illustrate where the customers either, owns the aircraft and undertakes all the support themselves, or on the far right where the customer pays for the full service of having the mission performed. For the research presented in this paper our focus is on advanced services, where the customer is paying for a ‘service’ ranging from maintenance contracts through to full mission support.

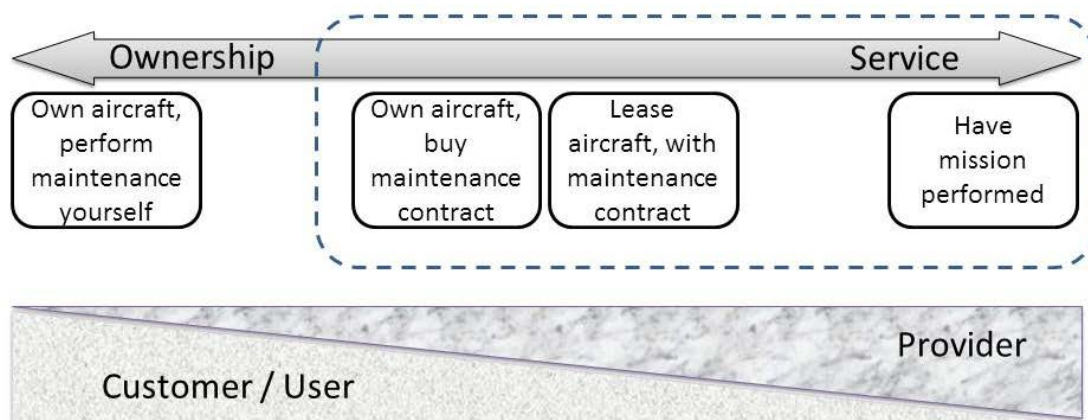


Figure 1 – Service contracts investigated in this research

Contracts being placed for an agreed outcome are not new. In the late 1980’s the roads in Sub Saharan Africa were maintained using Performance-based Management and Maintenance of Roads (PBMMR). The overriding aims of these contracts were to reduce costs and increase quality (Zietlow, 2011). Although roads may be seen as simple assets, the PBMMR moved from providing cost plus (i.e. the cost of the activity plus an agreed profit) for roads to the providers being paid for the ‘quality’ of the road ‘in-use’, often referred to as ‘value-in-use’ (Ng et al, 2010).

However, the move towards such contracts has resulted in the provider absorbing more of the risk, especially when compared with the previous cost plus contracts (Zietlow, 2011; Selviaridis & Norrman, 2014). This increases the uncertainty for the provider of the advanced service. The exposure that companies face in the transition from being a manufacturer to providing an advanced service is illustrated through reduced profit margins. In the PBMMR, one provider in Sub-Saharan Africa found their

profits reduced by 50% (Patel, 2011). This reduced profit is often termed the “service paradox” (Gebauer et al, 2005). One approach to managing the ‘service paradox’ is to model uncertainties within the bid cycle. In such cases the bidding company needs to estimate their cost for delivering such services as well as determining an appropriate price bid. The price bid will be affected by affordability challenges of the customer (Bankole et al, 2012) as well as factors such as the cost to the company and what competitors may bid. Newnes and Goh (2013) describe a structured approach for ‘Managing Uncertainty in Contract Bidding’, which models the tangible monetary factors and provides the probability of winning the contract and making a profit, as well as the expected profit value.

The advantages of ascertaining the probability of winning the contract and making a profit can be used throughout the bid cycle. Industry feedback has described the benefits of using the outputs for bid/no-bid decisions as well as determining the amount of effort and bid team to be used within the process. However, the overall output from an advanced service is the ‘value’ of the offering, which includes both tangible and intangible attributes. The inclusion of intangible attributes in the bidding process is becoming more explicit in both European Law as well as from the perspective of the customer and the provider of the service, especially when the provider is bidding for Government contracts.

2. Assessing tangible monetary factors in the UK Government Procurement

To be awarded a manufacturing and/ or servicing contract in the UK public sector; companies compete via a formalised open bidding process subject to UK and/or European law (OJEU, 2014). Interested, qualified and viable organisations that meet pre-qualification criteria are asked to submit a proposal in response to a detailed specification from the government (usually drawn up in partnership with deputised services with specialised and technical knowledge) (GOV.UK, 2013).

The contract award process can often go through a number of iterations and negotiation phases that enable both parties to discuss and agree on detail. Once finalised, responses are treated as an offer to complete the specified work for an agreed amount of money (GOV.UK, 2013). These documents are often lengthy technical tomes describing exactly what will be delivered and how it meets specified criteria. After contract award they become part of a legally binding Service Framework Agreement consisting of a series of complex contract schedules (Procurements Lawyers Association, 2012). Awarded contracts can be worth vast sums of money and it is vital that the process is both transparent and robust. A recent example is Bombardier who won a £1 billion contract to provide 65 trains for the London Crossrail project which is set to open in 2018 (Moylan, 2014; Bombardier Media, 2014; TFL, 2014).

The UK government each year on goods and services spends around £187 billion with third parties; around half of this is estimated to be to be on contracted out services (Public Accounts Committee, 2014). Implicit in each contract awarding decision is the Government’s responsibility and accountability for ensuring value for money on behalf of the taxpayer. This value for money can include engagement with SMEs, social

aspects of the contract such as regeneration and job creation. Evidence that has emerged in recent years suggests that the government does not always achieve the best for citizens on this account. Examples include both G4S and Serco who were found to have overcharged the Government in their electronic tagging contracts (Travis, 2014). The poor performance of G4S in supplying sufficient numbers of security guards for the 2012 London Olympics (Booth and Hopkins, 2012), Capita's failure to deliver court translation services (BBC, 2014), issues identified by a Department of Work and Pensions UKs audit into Atos's work capability assessments leading to removal of the contract (Independent, 2014), and misreporting of out of hours GP services by Serco (Farrell, 2013).

This suggest a serious weakness in the Government's ability to identify appropriately qualified suppliers as well as negotiate and manage private commercial contracts on behalf of the taxpayer. It also suggests that there are flaws in the adequacy of the contracting process per se, in that these contracts do not appear to have been awarded on the basis of a company's ability to complete the contracted work effectively or competently.

Both customers and potential suppliers try to understand the how to assess the factors that should have an influence on the contract award decisions. Research at the University of Bath (Newnes and Goh, 2013) demonstrates a quantitative analysis process for contract bidding that models the influencing variables and depicts their impact as a decision matrix in terms of the probability of; winning the contract, making a profit and the expected profit for a number of bid prices. However, it is recognised that decisions based purely on monetary analysis present limitations such as; noisy data misleading analysis; the quality and relevance of the data is not guaranteed (Gough, 2007); many business decisions require the analysis of independent variables whose non-linear relationships are challenging to create accurate algorithms for and ascertaining the value of the contract includes tangible and intangible attributes (Parry, 2013). Kapletia et al (2009), demonstrate that, intangible factors rather than just cost can be significant in contractor selection.

In our current research we have created a structured approach to manage uncertainty in contract bidding (Newnes and Goh, 2013). However, the initial research focussed on estimating price to win based on the tangible attributes (manly technical performance measures and cost) for analysing the proposed bid and taking account of the uncertainties. The output is a decision matrix, which shows the probability of winning the contract and the probability of making a profit. This approach was adopted to ascertain industry feedback to our modelling methods and to engage with stakeholders. The findings from our stakeholder engagement reflect the views discussed earlier in this paper, in that modelling the value of the offering is essential when modelling the price to win/value for money of a contract. Section 3, describes our current research and what was required to model the 'value' of an offering.

3. Background research – Probability of Winning and Probability of making a profit

In the initial research we created a framework for identifying the uncertainties when bidding for an advanced service contract. Four top-level influencing factors were

identified as having an influence on a companies bidding strategy (Kreye et al, 2014). These are the internal company processes, the contract conditions for the service provision, the customer whom the service is being delivered to and the competitors who will be competing in the bidding process. These influencing factors encompass requirements such as offset arrangements, affordability of the service for the customer i.e. their budget limitations, stakeholders (direct and indirect), quality of service and payment terms. Figure 2 depicts the framework with the four categories of influencing factors. These factors were created from the literature and through multiple stakeholder engagement workshops. The workshops included input from customers, bidders and stakeholders. The additional factors identified by the industrial experts included e.g. offset arrangements (Matthews, 2014) which have an influence on the bid strategy, payment terms, partnerships and trust in the bidding company/reputation. The framework provides an overview of the main influencing factors. To enable the effective use of the framework we utilized a five-step process. This process guides the user to first identify the relevant uncertainty factors, collect the information on each of the identified uncertainties, process the collected information and then model the uncertainties. Finally a decision matrix is created to assist the decision-maker in determining the price to bid. Figure 3 shows this five-step process and Table 1 shows an example decision matrix for use by the bid team. A full description of this research can be found in Kreye et al (2014) and Newnes and Goh (2013).

However, although this research provided input to the bidding process, through our engagement with industry and government feedback from stakeholders demonstrated that it was essential to consider more than the monetary aspects of the bid. In particular, industry was keen to model the value of the proposed offering to the customer and determine what the customer would be willing to pay for an advanced service.

This maps closely with the findings from the literature and government procurement described in Section 2. As highlighted the UK Government is not perceived as sourcing value for money in public sector contracting.

To estimate the value of a proposed solution to a customer intangible attributes as well as intangible attributes need to be modelled and their value determined. The method we have used to define the value model and an example of such a value modelling process is described in the remainder of this paper.

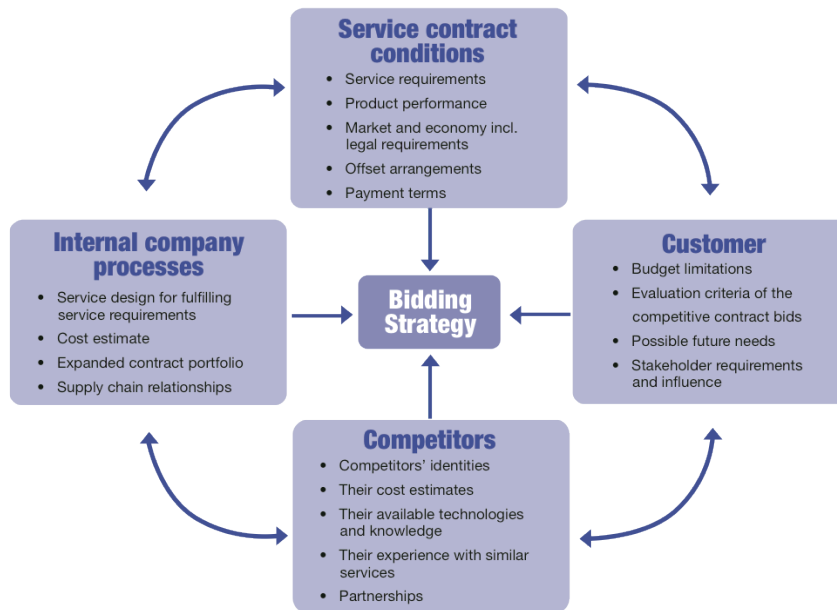


Figure 2: Framework – Managing Uncertainty in Contract Bidding

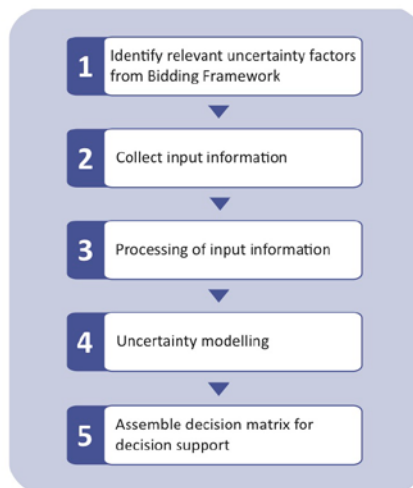


Figure 3: Five-Step Process

Decision Matrix																
Price bid		5	5.5	6	6.5	7	7.5	8	8.5	9	9.5	10	10.5	11	11.5	12
Probability of winning %	upper	100	98	97	93	88	79	71	62	51	38	24	15	8	4	0
	lower	100	98	97	93	87	77	67	56	45	33	21	12	6	3	0
Probability of making a profit %		0	3	13	28	50	86	94	98	100	100	100	100	100	100	100
Expected Profit	£M	-2	-1.5	-1	-0.5	0	0.5	1	1.5	2	2.5	3	3.5	4	4.5	5

Table 1 – Example Decision Matrix

4. *Proposed Value Model for the Probability of Winning and making a profit.*

To create a value model which assessed industries value of a particular offering we needed to identify what the customer would be willing to pay for the offering, estimate the value of any competitor offerings to the customer as well as estimate the cost of our offering. To create our modelling and evaluate the results from the model we used an example of an Unmanned Air Vehicle.

4.1 *Unmanned Air Vehicle Exemplar*

The exemplar used to undertake the value modelling is the PERsistent Green Air Vehicle (PERGAVE), which is an unmanned air vehicle. PERGAVE is an exemplar concept of operations that BAE Systems Military Air Information uses to engage with academic partners.

Table 2 lists ten requirements that the PERGAVE solution is required to meet in order to be a compliant bid to the customer, bids that are not complaint will be rejected. These are tangible requirements that the customer will use to evaluate the bid i.e. the physical attributes of the ‘product’ as part of the product service system. “Essential” offers the lowest acceptable level of capability that PERGAVE must meet for a compliant bid to the customer. “Aspirational” offers the maximum level of capability. During a bid, the provider needs to determine what level of requirements they will offer to the customer. This will depend on the affordability of the solutions to the customer as well as whether the provider has the capability to deliver such a system.

Requirement		Essential	Desirable	Aspirational
A	Maintain loiter position within 2km under wind speed	30kts	40kts	50kts
B	Operational Limits	Up to 66deg N/S any time of year	Beyond 66deg N/S during winter for 0 - 5 weeks	Beyond 66deg N/S during winter for >5 weeks
C	Time to achieve new loiter position	< 12 hours	< 9 hours	< 6 hours
D	Power / Propulsion	2 kW	10 kW	50 kW
E	Endurance Requirements	Months	Year	Years
F	Recycling	Minimum 90% recyclable on disposal	Minimum 95% recyclable on disposal	100% recyclable on disposal
G	Payload Requirements	200kg	500kg	1000kg
H	Loss rate	1e-5 / flying hour	1e-6 / flying hour	1e-7 / flying hour
I	Mission failure rates	< 1 in 5	< 1 in 10	< 1 in 25
J	Maintenance Intervals	> 5000 flying hours (6 months)	> 10000 flying hours (1 year)	> 20000 flying hours (2 years)

Table 2 – PERGAVE Performance Requirements

4.2 Value model creation

For the value model we account for tangible and intangible attributes. Table 2, depicts the physical attributes required for the PERGAVE offering. A provider may select to offer a solution which meets the 'Essential' requirements the customer has requested. If one focuses on estimating the price to win using the tangible items where the customer believes what is offered will be delivered the approach described in section 2 provides a structured approach estimate the price to win.

However, in reality customers evaluate a bid based on the technical attributes as well as whether they believe the provider is capable of delivering the offering they are proposing i.e. the customers' perception of the offering. If a company offered a solution where they stated that the PERGAVE would only require servicing every two years, the provider may wish to assess whether the customer would believe that such an aspirational target was achievable. In this research we are proposing the use of value modelling. Here, attributes such as whether the customer believes you would deliver such a maintenance interval are also considered alongside the tangible attributes. Figure 4 illustrates our value modelling approach. The customers' perception of the offering is elicited, the cost for the bidding company to deliver the offering is estimated and a price is selected based on the level of profit required and the offering from the competitors in terms of price and value.

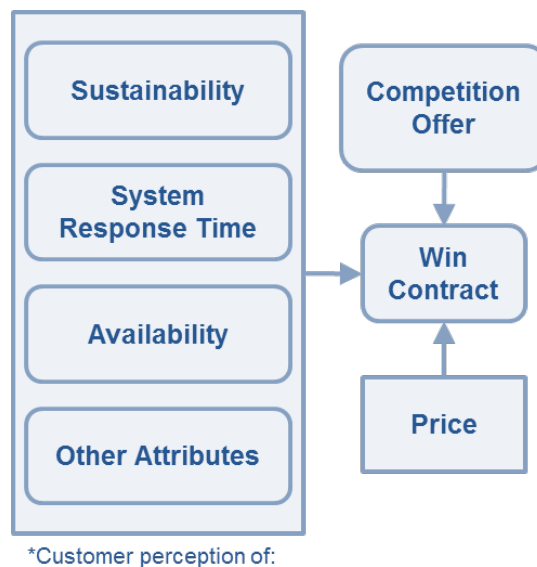


Figure 4 – Value Modelling Top-Level Inputs

To develop the value modelling and estimate the probability of winning the contract and making a profit as per the initial research we have utilised a structured approach consisting of five key steps. The five steps consist of building the Value Model, identifying the uncertainties regarding the customers' perception of your offering, quantifying your own price bid and any competitor price bids, estimating the value to the customer of our bid and the competitor bids and finally using a decision matrix to evaluate various scenarios in terms of our proposed/expected price bid.

4.2.1 Step 1 - Value model creation

The first step of the model is to build the value model that maps the customer’s “willingness to pay” as a function of important attributes of any proposed offerings. These attributes may include sustainability, system response time, availability and other attributes. This step attempts to quantify the experts’ uncertainty in what the customer would be willing to pay for a particular solution proposed.

Depending on the number of attributes to be considered, eliciting the experts opinions could become problematic, especially if there are too many questions they need to answer. Hence, the selected attribute set should be minimised in order to reduce the elicitation efforts. In previous research we have utilised Taguchi orthogonal arrays to elicit information from experts within the cost estimating domain (Saravi et al, 2013). Based on the use of this approach in other costing domains and as it is a robust process to follow a Taguchi orthogonal array was chosen as the Design of Experiment, to minimise the number of elicitation questions the experts need to answer. Naturally, if it is appropriate and timely the experts can answer a full set of questions with no rationalisation.

For the PERGAVE example Power, Payload and Maintenance Intervals were selected as the ‘hot’ buttons for the customer. Within Taguchi this would require an L9 experimental array for 3 attributes at 3 levels is shown in Table 3. The solution space explored in this example is Power (2, 10, 50) kW; Payload (200, 500, 1000) kg and Maintenance Interval (5000, 10000, 20000) hours. These represent the three levels of requirements the customer requested i.e. essential, desirable and aspirational.

Exp	Power (kW)	Payload (kg)	Maintenance Interval (hrs)	Value (£M)		
				Min	Most Likely	Max
1	2	200	5000	6	8	10
2	2	500	10000	10	12	14
3	2	1000	20000	13	15	17
4	10	200	10000	11	13	15
5	10	500	20000	12.5	14.5	16.5
6	10	1000	5000	11	13	15
7	50	200	20000	13	15	17
8	50	500	5000	11.5	13.5	15.5
9	50	1000	10000	13.5	15.5	17.5

Table 3 – PERGAVE Performance Requirements

The experts are asked to provide their opinion of the value a solution with certain attributes, e.g. in Experiment 1 (Power = 2 kW, Payload = 200 kg and Maintenance Interval = 5000hrs), is worth to the customer including the uncertainties in the values given as Minimum, Most Likely and Maximum values.

Based on this information, value models can be built to map the relationships between customer's value (or willingness to pay) for a given set of attribute values. Figure 5 illustrates a value model in 3-dimensional space, where A_1 and A_2 are attributes. This model allows us to explore our uncertainty about the customer's value for any proposed solution within the solution space. Hence, for any solutions with given attribute set $(A_1, A_2, A_3, \dots, A_n)$ we can derive the minimum, most likely and maximum values as shown in the figure.

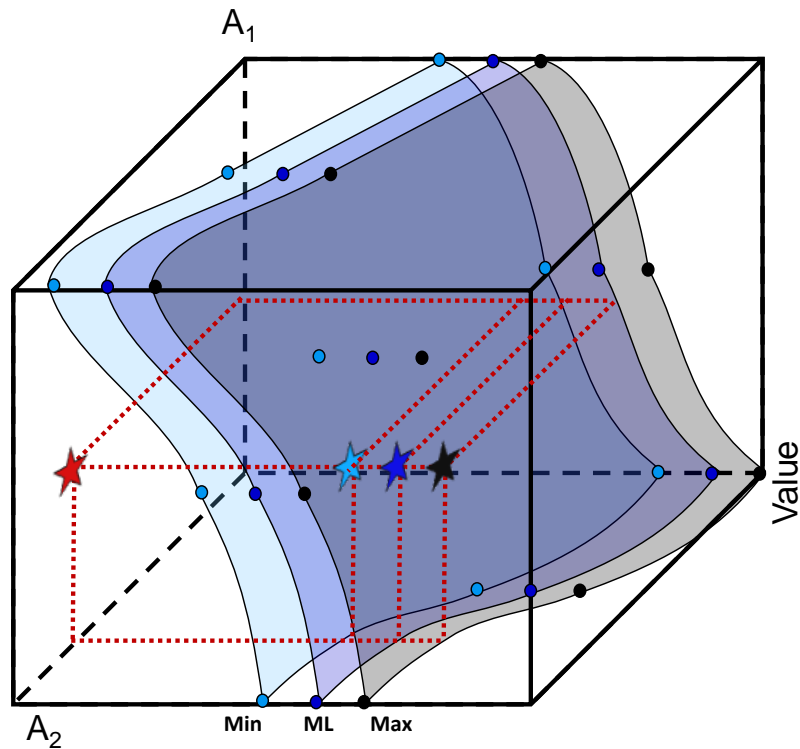


Figure 5 – Mapping the value to the customer of attribute combinations

4.2.2 Step 2 – Customers perception of the offering

This step addresses the uncertainty in a customer's belief of the offerings proposed by bidders. In other words, the customer may not believe that the provider would be able to deliver the exact offering specified. This step quantifies any intangible risk factors that are assigned against individual bids, such as their trust in the contractor's capability, past experiences etc.

Therefore for any offerings to be proposed to the customer, experts will be asked to quantify what they believe the customer's perception would be for the offering proposed to them. This step is undertaken for the bidding companies bid as well as any competitors whose bids are to be evaluated when estimating the probability of winning. The PDFs depicted in Figure 6 illustrate how uncertainties in attributes A_1 and A_2 of the proposed solution may be expanded to include uncertainties.

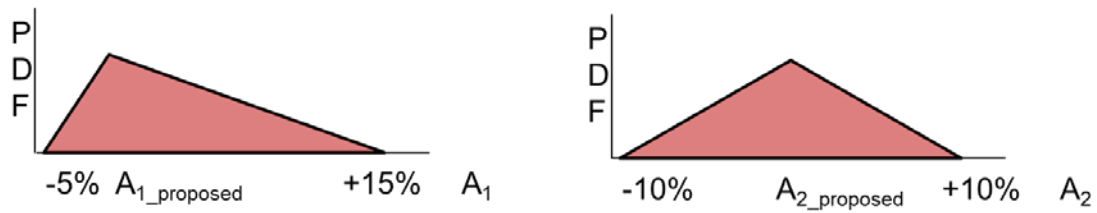


Figure 6 – Uncertainties in proposed attributes and customers perception of what will be delivered

In our example, we evaluate how our own proposed offering compared against a single competitors offering, where the uncertainties in the attributes are summarised in Table 4.

	Own proposed solution			Competitor’s proposed solution		
	Min	ML	Max	Min	ML	Max
Power (kW)	8	10	11	8	10	11
Payload (kg)	800	900	1000	800	900	1000
Maintenance Interval (hours)	4500	5000	5500	5000	6000	7000

Table 4 – Uncertainties in the attributes for bidding company and competitor solutions

If one examines the proposed solution in isolation, the competitors’ offering would be deemed as superior as the mean maintenance interval is longer whereas the other attributes are the same. This assumes the customer trusts both bidders equally. However, the probability of winning depends on the respective price bids and the customers’ perception of the offering.

4.2.3 Step 3 – Quantification of the price Bids

This step involves quantification of the price bids for our own and that of competitor’s. For our own price bid, this is a decision variable and a range of values can be evaluated to enhance our probability of winning. For the competitor’s price bid, we need to rely on the experts’ opinion to establish a baseline. This quantification may also include experts’ uncertainties in their belief. If more than one expert is consulted, their beliefs need to be combined into a single PDF and can be weighted accordingly (Newnes et al, 2013). Furthermore, if we assume that our competition is rational, they would select the price/design that maximizes their value. This scenario has not been included here but is subject of future work.

4.2.4 Step 4 – Establish expected values for our own and any competitor offerings

This step establishes the expected value for our own and the competitor's offerings. Monte Carlo simulations can be performed to propagate the uncertainties in attributes through value models.

4.2.5 Step 5 – Probability of Winning the Contract

For various price bids, we need to establish the probability of acceptance to the customer. The rationale is that the bid will be acceptable to the customer, if and only if its value exceeds the price bid. The uncertainty in the customer's value model and their perceived attribute values result in a probability of acceptance. The same rationale applies to any other competitor's bid, except that there might be uncertainties in our estimate of the competitor's price bids.

Once the acceptance to the customer is established, four scenarios can be expected.

- Both our own and the competitor's bids are not acceptable, i.e. all bidders do not offer a surplus in value against their own price bids (price > value), the bids will all be rejected. Here the customer may choose to rebaseline, and revise their work specifications.
- In the second scenario, both our own and the competitor's bids are acceptable to the customer. In other words, they both offer a surplus in value (value > price). In this situation, the customer will be looking to offer the contract to the contractor with the higher surplus. This assumes the customer is rational and their decision making is to maximise their surplus.
- In the third scenario, only our bid is acceptable. Then the customer will offer the contract to us.
- In the fourth scenario, only the competitor's bid is acceptable. Then the contract is lost to the competitor.

Based on the above, the probability of winning can be established. As our proposed solution is inferior to the competitor's, it can be seen that at a lower price (£8.5M vs £9M) we have a 87% probability of winning the contract but only 35% probability of winning if both bidders offer at £9M. Table 6 shows an example decision matrix with the price points occurring in £0.5M increments. The probability of making a profit and expected profit are taken from Table 1.

Price bid (£M)		5	5.5	6	6.5	7	7.5	8	8.5	9	9.5	10	10.5	11	11.5	12
Probability of making a profit %		0	3	13	28	50	86	94	98	100	100	100	100	100	100	100
Expected Profit (if contract is won)		-2	-1.5	-1	-0.5	0	0.5	1	1.5	2	2.5	3	3.5	4	4.5	5
Probability of winning % (FROM VALUE MODEL)	Competitor's Price = £9M	100	100	100	100	100	100	100	87	35	3	0	0	0	0	0
	Competitor's Price = £8M	100	100	100	100	100	86	21	1	0	0	0	0	0	0	0

Table 6 Final decision matrix

5. Conclusion and Future Research

Our research has shown that to meet the needs of the stakeholders within an advanced service delivery system the value of the system encompasses tangible and intangible attributes.

The background to our modelling to estimate the probability of winning a contract and the probability of making a profit has been presented. Through industrial workshops, meeting with government contractors and the analysis of recently funded bids we have shown that modelling tangible attributes has advantages at the early bidding stage (section 3). However, when bidding for advanced service contracts the feedback from industry and findings from the literature conclude that a value model is required. This value model should include the ability to estimate the 'value' of intangible attributes and account for the customers' belief on whether the provider is capable of delivering the proposed service for the price being offered.

We have proposed a value model where we utilise Taguchi design of experiments to identify the offerings to be 'valued'. The expected value of the offerings is then gathered through by eliciting the value from subject matter experts. These experts also provide a view on whether the customer believes the offering will be delivered as stated, which reflects the customers value of the actual offering they believe they will receive.

In the value modelling analysis we assume that the customer is rational. A decision matrix is created and scenarios based on the probability of winning for a particular price bid are undertaken. The rules used in the analysis are:

- Customers are rational
- If the bid price is greater than the value of the offering the bid is not acceptable to the customer and the bid will be rejected.
- If the price is less than the value of the offering the bid is acceptable to the customer and the bid would be accepted.
- When comparing whether the bidding company will win the bid we assume the bid must be acceptable and affordable to the customer, and the bidding company which has the largest positive difference between price and value will win.

The value model described in this paper has been assessed and verified by our industry partners and we are now undertaking live case study trials to validate our approach.

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