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PRICE-QUALITY RATIOS IN VALUE-FOR-MONEY AWARDS

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ABSTRACT. This article presents a simple and objective formula to determine a tender's price-quality ratio, for the purpose of value-for-money awards, which is literally quality divided by price (Q/P). Most formulas used in public procurement today first translate prices into points, in a process which has several flaws, and in the end they do not produce any actual ratios, a fact which makes them less objective. To adjust the proposed Q/P formula to the relative weight of the price criterion from the buyer's point of view, all tenders start out with a fixed quality score to compress or expand quality differences between them. Tenders then compete for the remaining range of quality points up to the maximum, and in the end have their quality score divided by the price that they offer.

INTRODUCTION

In public procurement, a value-for-money award means the award of a public contract to the tenderer offering the best price-quality ratio, as opposed to awards based on the lowest price or the lowest cost. Value-for-money awards enable public buyers to accept a higher price in return for higher quality. In order to determine which tender offers the best value for money, formulas are used that take into account both price and quality in order to generate a final score. However, the formulas most broadly used in practice contain several flaws. First, they do not rely on the tenderers' prices themselves, but on methods to first convert these prices into points. Usually these conversion methods are needlessly complicated, and they are often discriminatory due to the fact that differences in scores are not

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always proportional to differences in actual prices. Second, the result is usually not an actual ratio. The 2014 EU Public Procurement Directive, for example, speaks explicitly of awards based on price-quality *ratios*,[1] but the outcome of, for instance, the formula of a weighted price score plus a weighted quality score is actually a *sum*. While this can serve as an approximation of a ratio, it becomes problematic notably in markets with low competition and a high risk of collusion between tenderers, where tenderers collect points largely irrespective of the fact that, in proportion to their quality, their price is exaggerated. It is for these reasons that we propose, instead, to apply the most immediate method to determine a tender's price-quality ratio, which is, quite literally, to divide each tender's quality by its price. This shows directly and objectively how much quality is offered per dollar. Since the Q/P formula does not convert the price into points but uses the price itself, it avoids the weaknesses of price scoring; and since it produces a ratio for each tender independently from the content of the other tenders, it allows for a convincing comparison, not only between competitors but also against a benchmark of minimum acceptable value for money. The greatest methodological challenge in developing a practical application of the Q/P formula was to adjust it to the relative weight of the price and the quality criterion from the buyer's point of view. After all, a buyer might accept only a slight extra charge for added quality, which means that the price is still the most decisive factor, or he or she might be willing to spend much more for quality increases, so that added quality matters more while the price matters less. We solve this question in a simple way: the price weight serves as the baseline quality score. If the price-quality weighting is 60:40 in favor of the price, all admissible and technically compliant tenders receive 60 out of 100 quality points from the start. Tenders offering only basic quality retain their initial 60 points, while higher-quality tenders can receive up to 100 points. In the end, tenders' quality scores will be spread between 60 and 100, and each tender's quality score (in points) is divided by that tender's price (in currency units). Whoever obtains, or rather offers, most quality per money, wins the award.

In the following sections we shall briefly discuss the weaknesses of traditional price scoring techniques and of the addition of price and quality points; we shall present how value for money is determined as a ratio through a division under the Q/P formula; and we shall show, using practical examples, how that Q/P formula can be effectively adjusted to the weighting of the award criteria. Finally, we shall illustrate graphically the logic of the described weighting-adjusted quality-price ratio.

THE FLAWS OF TRADITIONAL PRICE-QUALITY SCORING

Value-for-money awards are the method of choice in case the buyer is willing to accept a higher price as long as the higher price is justified by sufficient added quality. This stands in contrast to lowest-bid awards, where the object of the purchase is defined, and where the purchaser will have to reject better-quality offers as soon as they cost more than a less expensive offer. Value-for-money awards are in principle sensible choices because their logic comes closest to the logic of normal private purchases made in everyday life. The difference between everyday private purchases and public procurement, however, is that while private customers can make their choices intuitively – opting either for the less expensive or for the more expensive but better product – public buyers must seek to objectivize their assessment in order to justify their award decision. This is where formulas are employed, which typically translate the buyer's quality perception into points, and put this into some relation with the price, which is typically also converted into points. We shall first discuss the weaknesses of the conversion of prices into points, and the weaknesses of overall price-quality scoring methods, before elaborating the formula that we propose as an alternative.

As regards price scoring, a staggering variety of mathematical formulas exists to translate prices into points for the purpose of public procurement – some of them highly complicated, many of them flawed (Fuentes-Bargues & C. González-Gaya 2013; Waara & J. Bröchner 2006). Some methods accord maximum points to the lowest bid and then a decreasing number of points to the others depending on their distance to the lowest. Others award zero points to the highest bid and the maximum score to the lowest, linearly distributing the scores for everyone else in between. To make price differences less important, some methods award minimum scores to all tenderers and interpolate from there to the lowest bid. Some formulas end up giving maximum scores to almost everyone. Still others award maximum points to those tenders that are closest to the average price offer.

It should be noted that any formula that makes the score of one tender dependent on the content of another tender includes an element of arbitrariness in the evaluation and, at worst, exposes the process to deliberate manipulation by colluding tenderers. In extreme cases, tenderers will win or lose an award merely thanks to the presence or absence of other tenderers, for example because the lowest, the highest, the average or the median price is drawn closer or further away from the main cluster of competitors, which in turn shrinks or exaggerates score differences between them. Even price scoring in relation to a fixed reference price makes score differences between tenders dependent on the eventual distance between that reference price and the prices that are actually offered.

Regarding practical application, the most fundamental flaw of price scoring is that formulas are often needlessly convoluted, which among other things makes their results even more unpredictable. A sufficiently complex polygonal function – involving the standard deviation of prices multiplied by the square root of the number of bidders divided by the lowest bid, for example – will have as a consequence that neither the tenderers nor, presumably, the procurement officer, will be able to anticipate even intuitively what score will be generated for any given price.

Another fundamental flaw of price scoring is that, depending on the formula, point distribution curves are not always linear, leading to arbitrary discrimination between tenderers. In a perfectly linear function, a 25% increase in price with respect to a lower bid could be justified by a 25% increase in quality. If the curve is bent, however, some tenders will be disadvantaged and will have to offer more value for money than others in order to compensate for this, or run a higher risk of losing the award, irrespective of their quality score. For example, if all tenders get nearly the same price score in the end, the advantage of low-range prices is almost cancelled out. If scores are fixed based on functions of the average price, both the lowest and the highest bid get penalized irrespective of their quality. If the score curve between the highest and the lowest price is convex, medium-range offers are the victim of a penalization for no proper reason.

Consider the widely used function-of-the-lowest-bid method, which converts prices into points by awarding the maximum number of points to the tender offering the lowest price. The basic formula for any bidder, if the maximum price score is 100, is

Price score = (lowest bid / your bid) x 100

In the example below (as shown in Table 1), the price of tender B is exactly half-way between A and C, but its score is not: under fair, i.e. linear conditions, it would receive 75 points, but in fact it receives only 67. This penalty of eight points, which is a penalty of 10% of the score that B would actually deserve, arbitrarily lowers B's chances of winning the contract, once quality scores are added to the price scores, just because its price happens to be mid-range.

TABLE 1
Discriminatory effects of price scoring based on the lowest bid

Tender	Price	Applied formula	Price score
A	$ 50	(50 / 50) x 100	100
B	$ 75	(50 / 75) x 100	67 (!)
C	$ 100	(50 / 100) x 100	50

Perhaps anomalies of this type are the reason why contracting authorities start developing ever more complicated mathematical formulas: to compensate for biases, or to reward mid-range offers. Yet as noted, this sometimes leads to formulas that are unintelligible, or that are discriminatory with respect to offers in other ranges.

Once prices have been converted into points, they are put in relation with the respective quality score. Here another major flaw of price scoring, in combination notably with the addition of price scores and quality scores, is that most popular formulas do not produce any actual price-quality ratios (Dimitri 2013). If weighted quality is added to a weighted price score, the result is a sum, not a ratio; if weighted quality is multiplied by a price score, the result is a product. While this may be acceptable if it serves as an approximation of an actual price-quality ratio in real life, it may become problematic in oligopolistic markets. This is because results cannot be compared to a previously determined minimum acceptable price-quality ratio. It is sufficient to assume that the two large service providers on the market compete for a contract, both offering barely acceptable quality at an inflated price. Both tenders will usually collect a number of points – under the function-of-the-lowest-bid formula the lowest bid will even get the maximum number of points for the price. It may be recalled that this formula relates a tender's price not to its own quality, but just to the prices of other tenders, adding quality afterwards. This puts the buyer in a difficult situation as he or she is unable to persuasively argue that the tenders are unacceptable. After all, the winner scored full points on the price and enough points on the quality; it is the price-quality *ratio* that is unacceptably low, but that is not what the formula generated.

Yet another, relatively subtle constraint arising from the addition of a price score and a quality score is that, depending on the formula used, the weight of the price criterion must never drop below 50%, for otherwise the price criterion can get cancelled out entirely. Assume tenderers can obtain up to 70 points for quality, and up to 30 for their price. If tenderer A obtains 65 quality points and tenderer B obtains less than 35, it becomes impossible for B, even with the most competitive price, to compensate the quality difference, as there are simply not enough price points available to do so. In this context, a price weight below 50% imposes an implicit minimum quality threshold, restricting competition at the low end of the market in a way of which tenderers, and perhaps even the buyers, are not necessarily aware.

QUALITY DIVIDED BY PRICE

Instead of converting prices into points – which is already problematic by itself – and then adding them to the quality score – which is problematic for different reasons – we recommend adopting and using the clearest and most immediate method to determine value for money. We divide, quite literally, value for money, or quality by price. In other words, a tender's quality score gets divided by its own offered price:

Value for money = Quality / Price

The result is the amount of quality in score units for each currency unit. If the currency is dollars, then the contracting authority will see exactly how much quality it will obtain for each dollar that it is going to spend.

The Principle of the Quality / Price Formula

Let us say we received four tenders, A, B, C and D, offering different quality at different prices as shown in Table 2. The quality is expressed by evaluators in points, according to their quality perception. Evaluators should, as always, express their real perception of quality differences between tenders. If all tenders end up with nearly the same quality score in the end, then quality differences are virtually neutralized and only the price will decide in the end.

TABLE 2
Value-for-money scoring using the Q/P formula

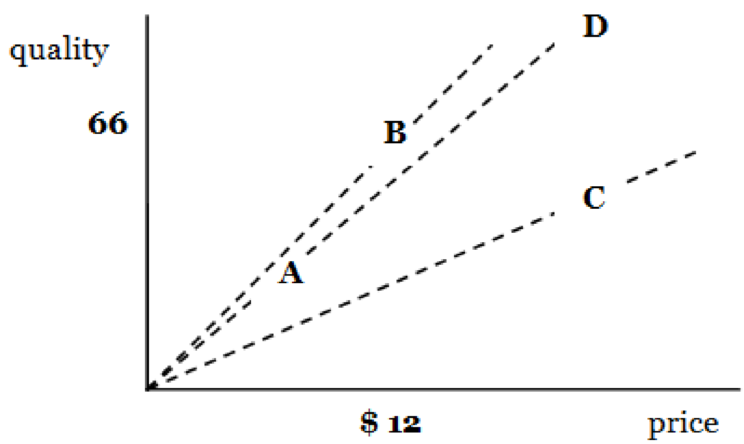
Tender	Quality score	Price	Quality/Price
A	50	$ 10	5.0
B	66	$ 12	5.5
C	60	$ 15	4.0
D	75	$ 15	5.0

Tender A asks the lowest price and offers 5 quality per dollar. Tender B is more expensive, but its higher price is more than compensated by its higher quality. It means that, compared with Tender A, its price is higher but the quality difference is more significant than the price difference. Tender C is even more expensive, but here the high price is not justified: it offers less quality per dollar than the first two tenders do. Tender D offers the same value for money in a high price range as Tender A does in a low price range. They are tied: in order to win at least against Tender A, Tender D would have had to offer an even higher quality than it just did, or a slightly lower price than it just did. The final outcome is that Tender B wins. Not because it is the least expensive (it is not), nor because it offers the most expensive luxury (it does not), but because it offers the most quality per dollar.

Incidentally, this example also allows for another comparison with the traditional method discussed earlier, where prices are converted into points as a function of the lowest bid, and then added to the quality score. With exactly the same prices, quality scores, and relative weight of award criteria as above, Tender A as the lowest bid would have received the maximum 100 points for the price, Tender B would have received 83. With quality points added to the price scores, Tender A would have beaten Tender B, with 150 to 149 points in total, in spite of the fact that Tender B actually offers better value for money.

Coming back to price-quality ratios, if we place the four tenders on a graph (Figure 1), we clearly see that what firms try to do is increase their quality faster than they increase their price, or rather: to add more additional quality for each additional dollar. The linear graphs that cross the four tenders represent all hypothetical tenders with the same price-quality ratio as the ones depicted; the winner is the tender that finds itself on the steepest curve, which in this case, as noted, is Tender B. Tender B offers steep quality increases for each additional dollar it charges, while Tender C – and any other hypothetical tenderer with the same price-quality ratio – offers much less extra quality per extra dollar.

FIGURE 1
Graphical Representation of Price-Quality Ratios



ADJUSTING FOR RELATIVE PRICE WEIGHT

While the above example demonstrated the principle of the quality/price formula, any practical application of this formula requires a method to adjust it to the relative weight of different award criteria. After all, the relative weight of the price criterion and the relative weight of the quality criterion express the buyer's willingness to spend extra money on increased quality beyond mere basic technical compliance. For example, when buying a dishwasher for a canteen, a public buyer might be willing to pay a basic price for the machine itself, say $ 8,000, and another $ 2,000 if it runs very silently. In that case, the total value of the award at maximum quality is $ 10,000, of which the quality criterion "silence" represents 20%. This means the relative weights of price and quality are 80:20 in favor of the price.[2] If the buyer appreciated silence so much that he or she would even be willing to accept an extra cost of $ 8,000, so a price of up to $ 16,000 in total, on a silent machine, the relative weights of price and quality would have been 50:50.

Assuming, however, that the buyer is not quite as obsessed with silence and the weighting is still 80:20, the objective is now to compress relative quality differences between tenders to match this weighting. A compression of the score distance between basic quality (a normally noisy dishwasher) and the best quality (a very silent dishwasher) is necessary so as not to allow the best-quality tender to justify too drastic a price increase. This compression is achieved by taking the relative weight of the price criterion (80) and making this the baseline quality score for all technically compliant tenders. This means that the noisiest dishwasher starts at 80 points for its quality, and the most silent model obtains up to 20 points more than the basic, 100 being the maximum quality score.[3] After all, the buyer is expecting to pay 80% of the maximum price simply to achieve the necessary minimum standards, and to pay the remaining 20% on additional quality. This also means that 80% of the maximum quality points are spent on reaching minimum standards; thus, everyone should start with that baseline score, so that the real competition will unfold over the last 20 points. The formula for such a weighting-adjusted quality-price ratio is therefore

$$\mathbf{VFM = (W_P + Q) / P}$$

Where: VFM is value for money of the tender

- W_P is the relative price weight, or the proportional value of the basic solution to the best solution
- Q is the quality score, or the value-added of the tender in comparison with the basic solution
- P is the Price of the tender directly expressed in currency units ($)

The following example (Table 3) illustrates an evaluation with three tenders, A being the basic model offering no additional silence at all.

TABLE 3
Q/P Award at 80:20 Price-Quality Weighting

Tender	Basic score for having basic quality	Added quality ("silence")	Total quality score	Total price	Quality/Price in $1,000[1]
A	80	0	80	$ 8,000	10.0
B	80	5	85	$ 9,000	9.4
C	80	20	100	$15,000	6.7

Note: [1] In this example the prices are expressed in units of 1,000 dollars simply for better readability. It is not strictly necessary, but it facilitates comparison in high price ranges.

It turns out the least expensive offer wins, Tender A gets the contract, because the two others overcharged for their silence mode. After all, silence was somewhat important but not decisively important to the buyer, as even the best silence was worth only 20% of the estimated total value. To 80% the award decision was determined by the price. What if silence had been more important, weighting for example 40% of the total value at maximum quality, meaning a weighting of 60:40? In that case all technically compliant tenders would have received 60 points to start with, not 80. This means their silence could have made much more of a difference, the range between basic (60) and best (100) would have been broader. With the same prices as above, and added quality scores adjusted to the new range, the result would have been the Table 4.

TABLE 4
Q/P Award at 60:40 Price-Quality Weighting

Tender	Basic score for having basic quality	Added quality ("silence")	Total quality score	Total price	Quality/Price in $1,000
A	60	0	60	$ 8,000	7.5
B	60	10	70	$ 9,000	7.8
C	60	40	100	$ 15,000	6.7

Tender B would have received 10 out of (now) 40 points for its silence, 70 quality points in total, and a value-for-money score of 7.8 total quality per 1,000 dollars. While Tender C still overcharges for its silence, Tender B would already have beaten Tender A, because now the buyer would have cared more, and been willing to pay more, for extra silence. This result is achieved because in the first scenario Tenders A and B had almost the same quality score (80 and 85, respectively) and Tender A cost less. In the second scenario, with silence being worth more, with the spread expanded, and with the distance between Tenders A and B doubled (now it is 60 versus 70), the higher-quality tender is better able to distinguish itself from the basic and to thereby justify its higher price.

We add, for the sake of completeness, a third scenario where quality is almost all that matters. This normally applies to knowledge-heavy service contracts, where tenderers should not be incentivized to compete on price and instead should try to outperform their competitors on quality. But again, for the sake of completeness, let us assume that the buyer requires a silent dishwasher at almost any cost, and that the price-quality weighting is 20:80, with the price criterion weighting a mere 20. Thus, all technically compliant tenders receive 20 quality points as a baseline, so that they have all of 80 points to compete for, making their quality count (Table 5).

With still the same relative quality and the same price, Tender C finally beats all the others. The fact that Tender C is almost twice as expensive as the basic model proposed by Tender A makes almost no difference anymore, because now quality is the overwhelmingly decisive award criterion.

The Q/P formula works equally in the case of multiple award criteria – for example not only silence, but also robustness,

TABLE 5
Q/P Award at 20:80 Price-Quality Weighting

Tender	Basic score for having basic quality	Added quality ("silence")	Total quality score	Total price	Quality/Price in $
A	20	0	20	$ 8,000	2.5
B	20	20	40	$ 9,000	4.4
C	20	80	100	$ 15,000	6.7

environmental criteria and after-sales services. In each case, the buyer estimates the basic price corresponding to basic quality, adds how much he or she would be willing to spend extra for each additional quality trait, and divides the monetary value of each criterion by the total maximum value to fix the relative weights. The weight of the basic quality is, as before, the baseline quality score for all tenders that comply with minimum technical standards. And as before, it is essential that the employed quality assessment methods are designed to distribute points over the whole available range. A product or service that only complies with baseline requirements must obtain only the baseline score and no additional points, whereas the product or service having the maximum useful quality must receive the maximum quality score.

Evaluators must in any case resist the human temptation to award points already for basic quality, since each quality point justifies a higher price, while point inflation needlessly compresses quality differences and thereby inflates the weight of the price criterion. Maximum quality, meanwhile, is defined as the maximum useful quality worth paying extra for. Excessive luxury that goes beyond that should receive the same maximum score as maximum usefulness itself, because from that point onwards we are not willing to justify any higher prices.

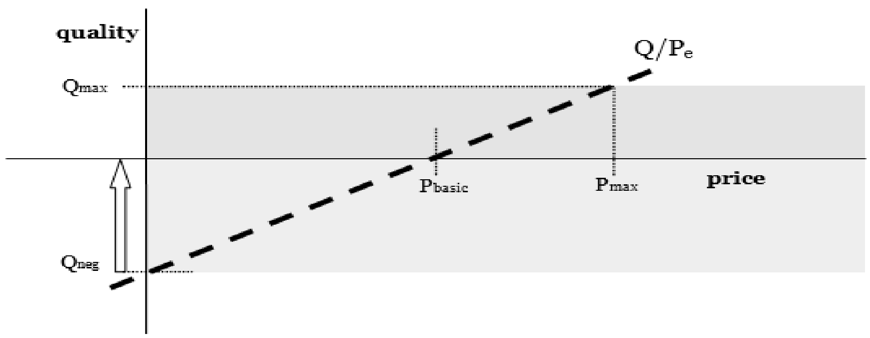
Of course none of this will guarantee that real prices will be as estimated – no formula can guarantee that – but it does allow buyers to prevent high-quality tenders with exaggerated prices, compared to prices for basic quality, from winning the award. Considering the flaws of the other price scoring methods discussed, it becomes clear how much fairer the Q/P method is. First, the score distribution is linear: medium-range bidders have the same chance to get the same value-for-money score as low-range and high-range bidders. Second, the method works independently from the content of the competing tenders. Even near-monopolists can be firmly told that, when their price-quality ratio is compared to a previously set benchmark of a minimum acceptable price-quality-ratio, their price is simply out of proportion to the value they offer.[4]

MATHEMATICAL JUSTIFICATION

When turning the Q/P formula into a practically usable tool for public buyers, the greatest challenge was to find a method to adjust the formula to different weights of the award criteria in a way that would be intuitively accessible and not too mathematical. The task was, in each case, to compress or expand price differences or quality differences between tenders to reflect the weight of the respective criterion. One possible method would have been to put the quality score and the price to the power of decimals, such as $Q^{0.2}/P^{0.8}$. Yet while this is mathematically valid, it is hardly something that is intuitively comprehensible. Another method would have been to subtract a certain amount from all price offers to compress price differences between them, but this seemed counter-intuitive and could potentially result in negative prices. In the end, the proposed method is to award all technically compliant tenders a baseline quality score, reflecting the relative weight of the price criterion, and let them compete for the remainder of the range. As a result, quality spreads are expanded or compressed in line with the buyer's appreciation of the worth of extra quality.

Graphically, this is shown as follows. Even zero added quality, meaning simply basic quality, will have a certain price. The move up to maximum quality on the quality axis will be accompanied by a move to the right on the price axis until the maximum acceptable price. The curve Q/P_e reflects the buyer's price estimate for basic quality and his or her spending limit for best quality: the curve represents all hypothetical tenders with a price-quality ratio that is deemed acceptable for any given price. Below the estimated basic price, the quality turns negative, and the curve crosses the quality axis at zero price. The distance between this crossing point and zero quality, in relation to the distance between zero quality and maximum quality, is precisely the proportion of the price weight in relation to the quality weight. Thus, if we add the price weight to the initially negative quality score for all tenderers, we shift the curve upwards so that it crosses zero quality at zero price, while the Q/P_e curve remains correctly tilted according to the established weights of the award criteria. From that moment onwards, the tenders can compete for the remainder of the distance up to maximum quality. Actual tenders will not necessarily find themselves on the actual Q/P_e curve, which is after all based on estimates. However, any linear curve drawn through any of these tenders, representing all other hypothetical tenders with the same price-quality ratio, will cross the price axis at the same spot as the Q/P_e curve does. The tender with the steepest curve, whether that curve is even steeper than the estimate curve or not, by definition offers the best price-quality ratio (Figures 2A and 2B).

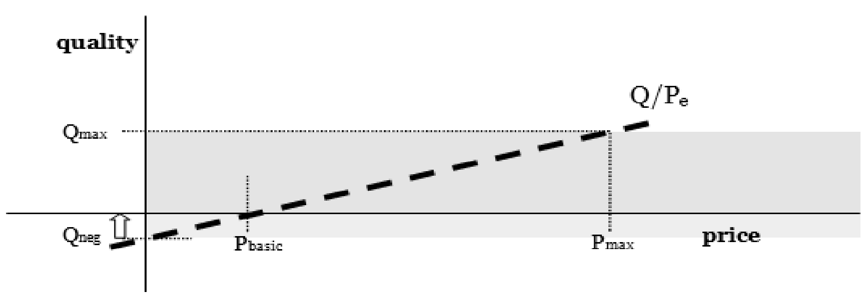
FIGURE 2A
Adjustment of Quality Scores to Price Weight under Q/P Awards, Price-Quality Weight of 60:40



$P_{basic} / P_{max} = -Q_{neg} / (Q_{max} - Q_{neg})$

Where:
P_{basic} is the price corresponding to basic quality,
P_{max} is the maximum price the buyer is willing to pay for maximum quality,
Q_{neg} is the theoretical negative quality at zero price,
Q_{max} is the maximum quality, and
Q/P_e is the curve of estimated acceptable price-quality ratios.

FIGURE 2B
Adjustment of Quality Scores to Price Weight Under Q/P Awards, Price-Quality Weight of 20:80



In the two figures above, the weight of the price criterion differs because the buyer is willing to spend either less (Figure 7A) or more (Figure 2B) on extra quality in relation to the basic price for basic quality. In other words, the buyer's price elasticity is low in the first case, and high in the second. However, in both cases, the basic estimated price, in relation to the maximum acceptable price, is equal to the basic required quality in relation to maximum desirable quality. If all tenders are given a baseline quality score of 60 out of 100 (Figure 7A) or 20 out of 100 (Figure 7B), which corresponds to the weight of the price criterion relative to the weight of the quality criterion, then tenders' quality evaluation can start on a spread that is proportional to the margin of acceptable extra spending.

CONCLUSION

The purpose of this article is to encourage public procurement practitioners to adopt a formula that simply, fairly and directly generates price-quality ratios for incoming tenders. It is submitted that the simplest, fairest and most direct formula is, literally, quality divided by price. This relieves buyers of the need to use formulas in order to convert prices into points, since Q/P uses the price itself, and not an artificial function of the price. Tenderers will be able to anticipate that value-for-money is calculated literally as value-for-money, and not as the outcome of an operation that is complicated at best and skewed at worst. Q/P produces linear functions where the result for each tender is independent from the content of other tenders, so no tender is penalized for finding itself on the wrong spot on the price curve. Operators on markets with limited competition can be rejected for having a poor price-quality ratio, since Q/P actually produces a ratio, and not just a sum of scores like other formulas do. At a practical level, the steps for buyers to take are clear: (1) think what price corresponds to basic acceptable quality, (2) add how much you are willing to spend extra on the best quality, (3) divide the basic-quality price by the sum, this gives you the relative weight of the price criterion, (4) give this weight as a baseline quality score to all tenders, so that they can compete on added quality up until the maximum score – if the price represents 70% of the award decision, let all tenders start at 70 quality points out of 100 – and finally, (5) divide each tender's total quality score by its own price. The tender with the highest figure wins, since it offers most value for money, or most quality per dollar.

ACKNOWLEDGMENTS

The necessity to design more objective award formulas had been raised by the European Court of Auditors in the context of inter-institutional dialogues, and we are grateful for the inspiration this has given us to develop the present solution.

NOTES

1. Article 67 (2) of Directive 2014/24/EU of 26 February 2014 on public procurement.
2. Strictly speaking these are not weights as they are used when adding scores, since under Q/P we are not adding but dividing. However they are the functional equivalent of traditional weights, they are understood and should be published as such.
3. Of course the total scale does not strictly have to be 100 points. What is important is the proportion. If the price-quality weight is 80:20, then all tenders offering at least basic quality should get 80 points out of 100, or 160 out of 200, or 8 out of 10, or 4 out of 5.
4. See Kiiver and Kodym (2014) for further details of value-for-money awards, as well as other recommendations on procurement design

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