Demand Curve Approach,
an award method to choose the most suitable tender

Ir. J.C. (Hans) Kuiper

EMVI-Research

info@emvi.eu

Summary: This article presents a new EMAT award method in which the demand curve plays the leading role. It describes how the commonly used linear weighted factor method can be adapted to 'play' with the intersection of the production cost curves and the demand curve. The PQ area is divided into two parts via a demand curve: below the demand curve the supply of additional quality points is encouraged, above it is discouraged. In this way the contracting authority communicates its preference for quality and costs.

Keywords: Demand Curve Approach, EMAT, MEAT

Submission category: Practitioner Paper

A lack of unity in technology

Why are there so many EMAT-tools to solve one problem? Stilger et al. (2017) compared 38 EMAT award methods. But there are more. It is often said that each method has its own properties and that choosing the right method is tailor-made. How can all these methods coexist? Why didn't one method survive as the fittest? Something like this doesn't happen in construction engineering, where the same techniques are used throughout the sector.
The demand curve approach is a candidate to become the fittest.

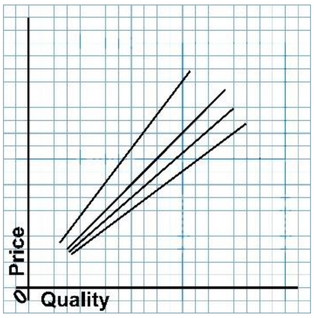
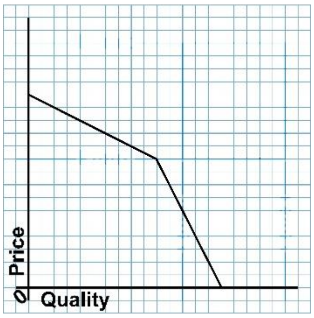
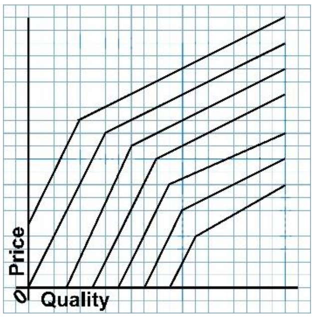
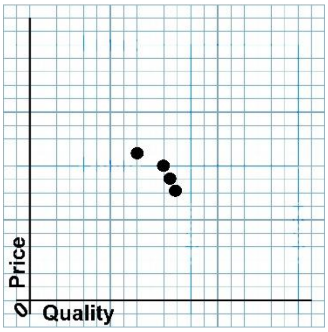
Some differences from other methods

The demand curve approach is an absolute method. It differs from other methods because it guides tenderers to the best overall evaluation score, located somewhere in the middle of the PQ area, while most other EMAT formulas guide to a border of the PQ area or do not guide at all. For example, the general evaluation formula P/Q ratio does not focus on a specific price or quality level, but the demand curve approach does. The demand curve acts as an attractor.
The demand curve approach has no counterintuitive properties. A counterintuitive property is when, because of the overall evaluation formula, the real weight of price decreases with higher prices, or when the real weight of quality increases with higher quality. The often-used formula P/Q ratio is counterintuitive because the real weight of price decreases with higher prices, when quality is held constant.
The demand curve approach avoids falling into pitfalls that other methods have.
The demand curve approach can be explained step by step using economic principles.
The tailor-made part of the job is to determine a reference solution, its price and quality, both divided into ‘need to have’ and ‘nice to have’. The application of demand curve approach can be standardized in the organization of the contracting authority.

The Demand Curve Approach, a short introduction

In Table 1 I pitch my newly developed approach in 4 images, illustrating the text in the summary.

Table 1 How the Demand curve approach is intended to work

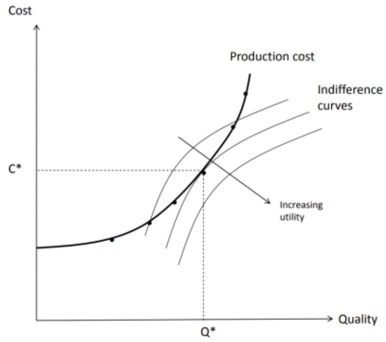
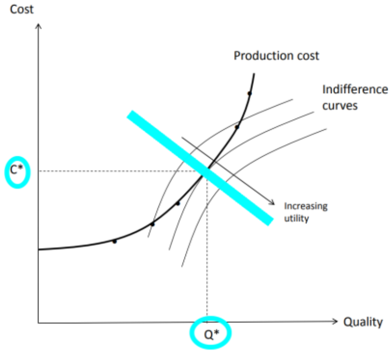
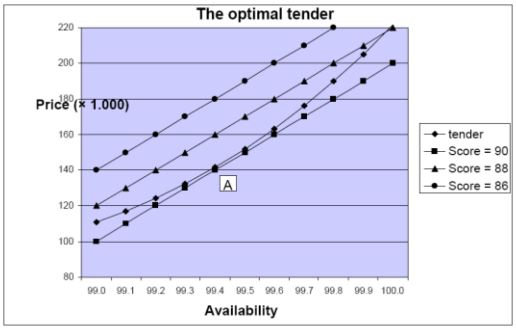
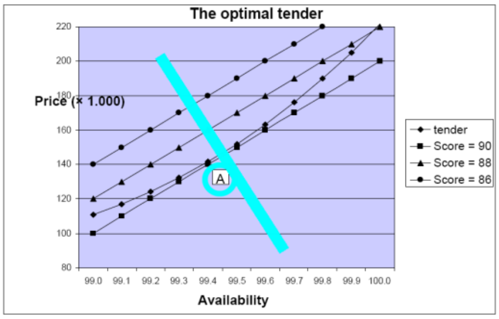
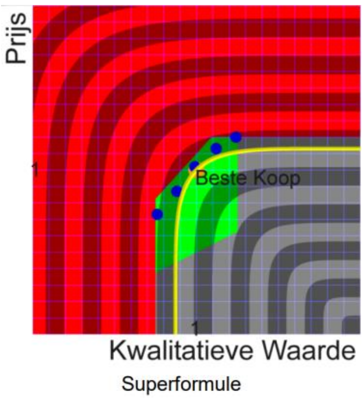
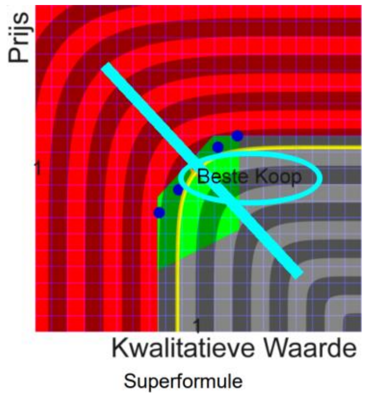
A set of production cost curves, for 4 different tenderers. The flatter the line the better the price-quality-ratio. Each tenderer can supply any PQ-combination, provided it is on his cost line.	
The demand curve, with a kink on de expected price and quality, the so-called reference solution. The PQ-area is divided into two parts via a demand curve: below the demand curve the supply of extra quality points is encouraged, above it discouraged.	
The set of indifference curves. The kinks are on the demand line. The steep lines encourage extra quality, the flat lines discourage.	
The ideal tendered bids, according to the contracting authority's preference for quality and costs. All suppliers with their best possible EMAT-score, i.e. on the intersection of their cost line and the demand curve. Remark: In this ideal case the winner has the lowest price *and* the best quality.	

My discovery of the demand curve in EMAT

I have not found any EMAT award method in the literature that explicitly uses a demand curve. Yet, a few authors were very close to the discovery, as shown in the images in Table 2.

All authors show the interaction between the production cost curve and the indifference curves. These three images all have in common that the cost curve finds the best indifference curve without achieving the maximum possible quality. The points (C*,Q*), 'A' and 'Beste Koop' (Best Buy) are all part of a still hidden demand curve. None of the authors have linked this phenomenon to the presence of a demand curve. I did and visualized these demand curves by drawing the blue lines in their images on the right.

Table 2 First signs of a demand curve in literature

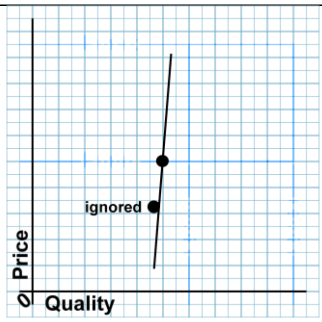
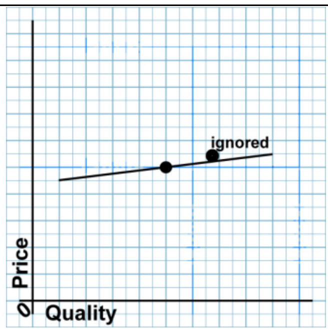
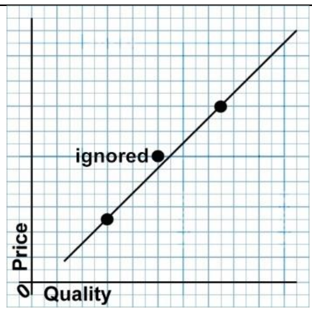
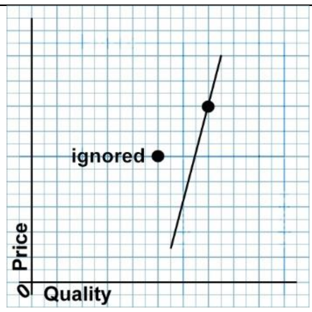
<table>
<tr><td>
</td><td>
</td></tr>
<tr><td colspan="2">(Lundberg and Bergman, 2011)</td></tr>
<tr><td>
</td><td>
</td></tr>
<tr><td colspan="2">(Chen, 2006)</td></tr>
<tr><td>
</td><td>
</td></tr>
<tr><td colspan="2">(Kuiper, 2016)</td></tr>
</table>

Before I elaborate on my demand curve approach, I would first like to mention some pitfalls and describe what a supplier selection without formulas could look like.

Some pitfalls in a tender process

Let's ignore the pitfall where there are no valid bids at all.

Tabel 3 Pitfalls analysed

Pitfall	Visualisation	Mismatch in math
1) The favourite ignored bid is much cheaper and of slightly lower quality than the selected bid.		The indifference lines are too steep, i.e. W_q/W_p is too high.
2) The favourite ignored bid is slightly more expensive but has much better quality than the selected bid.		The indifference lines are too flat, i.e. W_q/W_p is too small.
3) The favourite ignored bid is a 'Goldilocks bid', which is very close to expectations.		The straight indifference line cannot point out the Goldilocks bid as the winner. The indifference line needs a kink.
4) The selected bid is from a different range and has a higher price and higher quality than the ignored favourite bid.		The indifference lines are too steep, i.e. W_q/W_p is too high.
5) The selected bid is from a different range and has a lower price and lower quality than the ignored favourite bid.		The indifference lines are too flat, i.e. W_q/W_p is too small.

Sometimes, different EMAT formulas indicate a different winner. If so, the chance increases that the buyer is not satisfied with the result. Let's look at those cases, which are often characterized by a close call. There are valid bids, but the award method used produces a different winner than expected. This case, where an attractive bid is unintentionally ignored, has five manifestations:

1. The favourite ignored bid is much cheaper and of slightly lower quality than the selected bid.
2. The favourite ignored bid is slightly more expensive but has much better quality than the selected bid.
3. The favourite ignored bid is a 'Goldilocks bid', which is very close to expectations. Two other bids, each on either side of the ignored bid and both of different ranges, make it impossible to select the 'Goldilocks bid'.
4. The selected bid is from a different range and has a higher price and higher quality than the ignored favourite bid.
5. The selected bid is from a different range and has a lower price and lower quality than the ignored favourite bid.

The mathematics of the linear weighted factor method cannot avoid all five pitfalls. The demand curve approach shows its added value in preventing all these pitfalls.
Table 3 visualizes each pitfall in the PQ-area and analyses what is wrong in the mathematics used. We see that to avoid all pitfalls, sometimes a steeper indifference curve is needed and sometimes a flatter one. And that property is, as we will see, what the demand curve approach offers on each side of the demand curve.

Select the winner with common sense in three steps.
In this section I present an approach that avoids the pitfalls mentioned above. Without any mathematics. I'll describe the math that this approach covers later.
In an example we suppose a tender with nine valid bids. These can be visualized in a point cloud in the PQ-area. As shown in the left image in table 3. Each point represents a bid by its price and quality. In three steps we select the winner without any formula, on logic, on common sense and on our preference for quality and costs.
Step 1, based on logic:

- Eliminate those bids that have a higher price and lower quality than at least one of the other bids.

Now there remain five relevant bids.
Step 2, select the potential winners based on common sense:

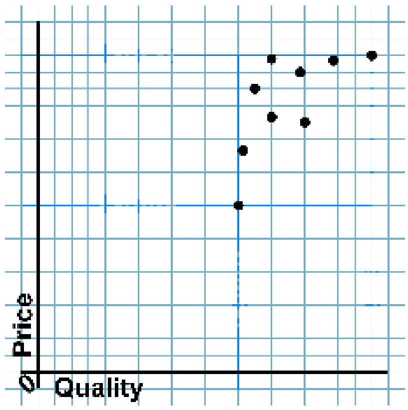
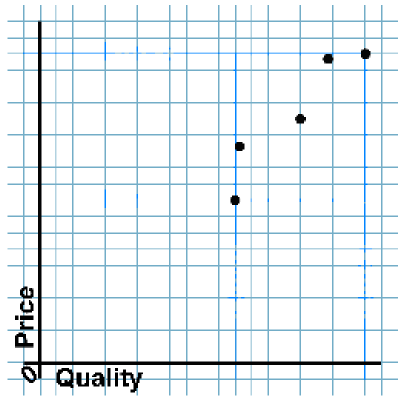
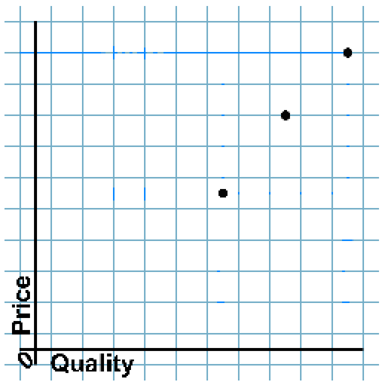
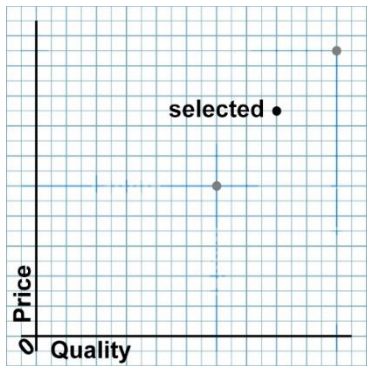
- Eliminate those bids with an obvious lower quality and a similar price.
- Eliminate those bids with an obvious higher price and a similar quality.

Now we are at the point where there are no arguments for eliminating the remaining bids other than the buyer's preference for quality and cost. The buyer can select his favourite.
Step 3:

- From the remaining bids, select the best match regarding the expectations as the 'Most suitable tender'.

In this example, the winner is a ‘Goldilocks’ bid, but with a different expectation, the ‘Best Price’ bid or the ‘Best Quality’ bid could also be selected as the winner. The presence of a nearby demand curve should legitimize our choice.
We need to develop an EMAT formula that supports these aspects and avoids all pitfalls.

Tabel 4 - Select a winner in 3 steps without mathematics

<table>
<tr><td>
</td><td>
</td></tr>
<tr><td>a: Nine valid bids in a point cloud</td><td>b: Step 1: Five relevant bids left</td></tr>
<tr><td>
</td><td>
</td></tr>
<tr><td>Step 2: Three potential winners left</td><td>Step 3: One winner selected as best match</td></tr>
</table>

The demand curve approach in 6 steps

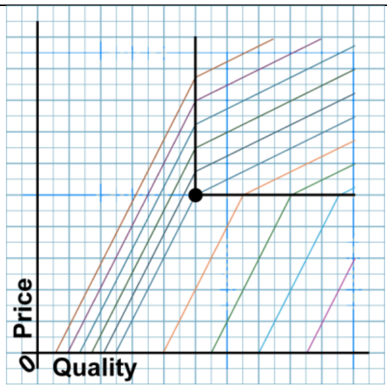
The RFP provides an overview of all requirements and award criteria: 'must-haves' and 'nice-to-haves'. Competitors can distinguish themselves from each other on the 'nice-to-haves'. In public procurement money is scare. Financial restrictions make that only a part of all ‘nice-to-haves’ is part of the expectation.

- P_{ref} is determined as cost-plus of all ‘must-haves’ and a part of the ‘nice-to-haves’.
- Q_{ref} is determined using all elements of the cost calculation.

P_{ref} and Q_{ref} together form an anchor point, they represent buyer’s expectations. In the visualisation both are used as the units for the scale along the price-axis and quality-axis.

- Determine a demand curve thru the anchor point P_{ref}, Q_{ref}.
- Determine the slope (W_q/W_p) of the indifference curves below the demand curve, steep enough to encourage the supply of more quality points but not too steep to fall into pitfall 1.
- Determine the slope (W_q/W_p) of the indifference curves above the demand curve, flat enough to discourage the supply of more quality points but not too flat to fall into pitfall 2.
- Determine the EMAT formula according to the mathematics in Appendix A and make all elements part of the RFP.

Table 5 Some different demand curves



a) User's 'delight'

b) 50%/50%

c)

d) Taxpayer's 'delight'

The shape of the demand curve

The procurer must have an accurate cost calculation (P_{ref}) of the desired quality level (Q_{ref}). To be credible, the anchor point (P_{ref},Q_{ref}) is logically situated on the demand curve. Table 5 shows a variety of possible demand curves. These curves split the PQ-area into two parts. Below the demand curve, the supply of quality is encouraged, above the demand curve it is discouraged. Therefore, the demand curve acts as an attractor, resulting in a bid close to the demand curve.

The shape of the demand curve is determined by how we deal with windfalls and setbacks. I propose a demand curve determined by two lines with a kink at the anchor point.

Suppose we have luck, and a tenderer performs 10% better than assumed. That determines the slope of the demand curve to the right of the anchor point.

How do we want this better performance to be reflected in the bid? An offer with 10% more quality (figure a) or an offer with 10% lower price (figure d)? Or an offer with 5% more quality and a 5% lower price (figure b)? Or another division (figure c)? That choice determines the slope of the demand curve on the right side of the anchor point. A horizontal demand curve means 10% more quality. A vertical demand curve means a 10% lower price.

Also, suppose we are out of luck, and the best tenderer performs 10% worse than assumed. That determines the slope of the demand curve on the left side of the anchor point. How do we want this worse performance to be reflected in his bid? An offer with 10% higher price (figure a) or an offer with 10% lower quality (figure d)? Or an offer with 5% less quality and a 5% more price (figure b)? Or another division (figure c)? That determines the slope of the demand curve on the left side of the anchor point. A horizontal

demand curve means 10% less quality. A vertical demand curve means a 10% higher price.
In both cases, windfalls and setbacks, a (decreasing) demand curve between horizontal and vertical divides the 10% over price and quality (figure b and c).

Shape of the indifference curves, kinked lines
The encouragement and discouragement come from the slope of the indifference curves. Steep lines encourage, flat lines discourage.
Each indifference curve has the shape of a kinked line. Several indifference curves together look like a fishbone, with the demand curve as the backbone.

Standardization
To manage the first two pitfalls the W_q/W_p-ratios above and below the demand curve must be determined carefully. The W_q/W_p-ratios must by tested in trial runs, in several one-to-one pairwise simulations.
I think the public buyer authority can standardize both the shape of the demand curve and the slope of the indifference curves. These are not project specific.

Cost and Value
Cost expertise and value analysis are essential in public procurement. For determining costs and value. Combined, they form a very powerful tool that makes it possible to convert the cost of project parts (WBS) into the cost of project functions and units of quality. Quality points represent anything of value that the contracting authority considers important to pay for. Think on product quality, process quality, durability, sustainability, delivery time, guarantee conditions, social return, innovation, risk analysis, etc, etc.

Mindset: be open regarding your expectations about P_{ref} and Q_{ref}
To receive bids that meet his expectations, the buyer must be open to the bidders regarding his own expectations, both in terms of cost and quality. By communicating P_{ref} and Q_{ref} in the RFP. This means that the tenderers know what price-quality ratio the buyer has in mind.

Visualisation of the PQ-area
Visualisation is a powerful tool because it makes clear immediately:
- customer expectations, by means of the demand curve
- the bids submitted
- the ranking of the bids if we draw the indifference curve through each bid.
- A trained eye can also notice counterintuitive properties of the indifference curves.

Some final remarks
- In my opinion, the ‘Best price-quality ratio’, as used in Directive 2014/24/EU, is not the right term to indicate the goal we are looking for in public procurement. I think the term ‘Most suitable tender’ is a better one.
- The Demand Curve Approach is an absolute method and is easy to explain using basic economic principles.
- I am pleased to mention that I am helping the Dutch Tax Administration implement the Demand Curve Approach.

Reference list

- Chen, T.H., 2006. De economische dimensie van het criterium “economisch voordeligste aanbieding”. Tijdschrift Aanbestedingsrecht en Staatssteun (3), 101-110.
- Dorth, P.C. van, 2023. 10 jaar EMVI-Superformule.
- Kuiper, J.C., 2009. De Economisch Meest Voordelige Inschrijving gevisualiseerd. Bouwkostenkunde en Huisvestingseconomie 28 (2), 4-11.
- Kuiper, J.C., 2016. Beste Koop bepaald met de Superformule
- Lundberg, S., Bergman, M.,2011. Tender Evaluation and Award Methodologies in Public Procurement.
- Schotanus, F., Siersema H.J.,2023. Beste Prijs Kwaliteit Verhouding: De Basis.
- Stilger, P.S, Jan Siderius, van Raaij, E.M., 2017, A comparative study of formulas for choosing the economically most advantageous tender. JOURNAL OF PUBLIC PROCUREMENT, VOLUME 16, ISSUE 1, 88-124

Appendix A
The Math behind the Demand Curve Approach

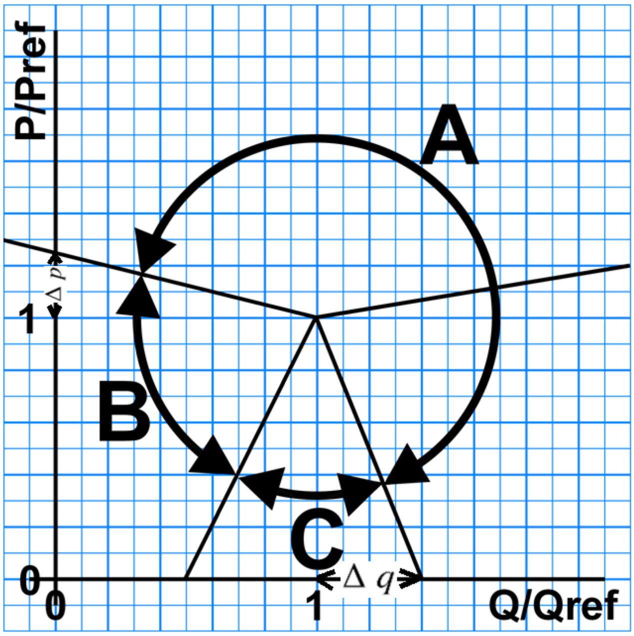


Figure 1 – Division of the PQ-area in three parts A, B and C

The calculation of the overall evaluation score is a linear function EMAT(Q,P):

$$EMAT_i = 1 + C_x \cdot \left(W_{px} \cdot \left(\frac{P_i}{P_{ref}} - 1 \right) - W_{qx} \cdot \left(\frac{Q_i}{Q_{ref}} - 1 \right) \right)$$

We recognize the properties of the weighted factor score. To ensure that the function values continue each side of the demand curve, we need an additional factor Cx.
The value of C_X, W_{pX} and W_{qX} depends on the area A, B and C

Table 6 – parameters in A, B and C

	A	B	C
C_X	$C_A=1$	$C_B = \frac{W_{pA} \cdot \Delta p + W_{qA}}{W_{pB} \cdot \Delta p + W_{qB}}$	$C_C = \frac{W_{pA} + \Delta q \cdot W_{qA}}{W_{pC} + \Delta q \cdot W_{qC}}$
W_{pX}	high	low	
W_{qX}	low	high	

In the areas B and C $W_{pB}=W_{pC}$ and $W_{qB}=W_{qC}$. In A, B and C: $W_p+W_q=1$.
In a RPF it fulfils to mention the outcome for the values of Cx.