A Literature Review on Methods for Supplier Selection Akin to Awarding on Value

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ABSTRACT: The following paper examines the presence of Awarding on Value (AoV) in the literature and if there exist comparable approaches to AoV. This is a price correction mechanism for bid evaluation in a Most Economically Advantageous Tender (MEAT) perspective. Results are based on a literature review for which scientific articles have been found via the search engines Scopus and Science Direct by using the search terms "Awarding on Value", "Most Economically Advantageous Tender", and "multi-criteria decision-making". The final sample of reviewed articles contains 55 articles. The literature review identified no awarding method akin to AoV, however adaptions of AoV were found. Furthermore, it became clear that there is a demand for AoV in the literature (e.g. Procurement Guidelines of the World Bank) and beyond authors are positive about the method. The added value of this paper is that is shows up linkages of AoV and helps to increase the awareness of the approach.

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1. INTRODUCTION

Nowadays, supply chain management becomes steadily more important and hence the quality of purchasing decisions also becomes more important (de Boer, Labro & Morlacci, 2001). Supplier selection is a crucial element in supply chain management and determining for successful performance (Sciancalepore and Telgen, 2012; Duren and Dorée, 2008; Porter, 1985). During the last decades the focus in supplier selection has shifted from lowest price to getting the best qualitative and economic performance (Santema, 2011; Duren and Dorée, 2008). Contractor evaluation and selection is a challenging task where one has to deal with many uncertainties. It is a multi-attribute decision problem with trade-offs between competing objectives. Researchers identified a great number of criteria used for supplier selection. For example Lin and Chen (2004) found 183 criteria and Watt, Kayis and Whiley (2009) even found 901 criteria used in their literature review. Another development is the urge of more systematic and transparent approaches in supplier selection (see e.g. Carter, Carter, Moczka, Slaight, & Swan, 2000).

Achieving a good balance between costs and delivered quality is especially important for the public sector since it spends a great amount of money in purchasing and is accountable to their citizens. Money spent in public procurement amounts to 16.3% of the EU Gross Domestic Product in 2003 (Lewis, 2007) and therefore represents a significant purchasing power. Hence, selecting the supplier with the best tender in terms of value for the money spent is important but also difficult. Furthermore, public procurement is widely regarded as a powerful tool to make governments more efficient (Sciancalepore & Telgen, 2012).

To ensure efficiency, accountability and transparency of public procurement there are rules that need to be followed. For example the European Union Article 53 of the EU Public Procurement directive specifies the supplier selection process. Public entities can either award public contracts on Lowest Price or Most Economically Advantageous Tender (MEAT). The MEAT procedure assesses also other factors in addition to price. Examples of those other criteria are "quality, [...] technical merit, aesthetic and functional characteristics, environmental characteristics, running costs, cost effectiveness, after sales service and technical assistance, delivery date and delivery period or period of completion" (European Union, 2004).

In the literature there are many different approaches that aim to identify the MEAT. The one this paper discusses in further detail is the Awarding on Value (AoV) approach (CROW, 2007). It is a scoring method developed in the Netherlands as an improved way of finding the MEAT.

> This method addresses the assessment of the qualitative features of the bids from a monetary perspective: for each criterion, the impact in terms of added value is established. Then the bid price is corrected by subtracting the total added value of the bid. (Sciancalepore & Telgen, 2012, p. 1)

AoV is mainly used in the Netherlands and is gaining more and more popularity over there. However, until now the majority of literature is in Dutch. The developers of CROW (S. Roetman & T. Reeuwijkas, personal communication, May 26, 2014) as well as the researcher Sciancalepore and Telgen (2012) are not aware of comparable selection approaches to AoV that also use the translation of multiple criteria into one common one to identify the MEAT.

The research goal of this literature review is to find out if there are similar methods, translating different criteria into one common one and to compare them to the awarding on value approach, which translates non-price criteria into monetary terms. Therefore the research question of this paper is:

Are there similar decision approaches to Awarding on Value presented in the literature?

In order to accomplish the research goal a literature review will be conducted to identify existing approaches to finding the MEAT and especially methods that translate non-price criteria into monetary terms and thereby determine the winner.

This paper is structured as follows: AoV is explained in detail followed by the methodology section. Next is the literature review of existing methods for supplier selection that are similar to AoV. Afterwards comes the result and discussion part and finally a conclusion section summarizes the findings of the paper.

2. AWARDING ON VALUE

2.1 Description of Awarding on Value

AoV was developed by CROW (Jansen et al., 2007), a Dutch organization for traffic, transportation and infrastructure. The original name is “Gunnen op waarde” (in English Awarding on Value). The method is a price correction mechanism for bid evaluation in a MEAT perspective.

The main feature of the AoV method is that the offered price (P_i) gets adjusted by the added value the tender has for the contractor. Each bid is evaluated; accordingly a corrected price (CP_i) is calculated, as the bid price to which the added value of the bid quality gets subtracted.

The method considers the commercial and the technical proposal. The commercial part is represented by the bid price and the technical part of the proposal consists of the technical value of the bid. Thereby, bids with lower performance than required get rejected, while minimum acceptable proposals score a value of 0 and have consequently no added value for the contractor. The best possible performance would be assigned a value equal to 1. A bid with a performance that lies in between get values according to its performance that lies between 0 and 1. Consequently q_i is the quality score of the i-th bid and determined by substracting the minimum acceptable technical value (Q_{min}) from the actual technical value of the bid (Q_i) the result is then divided by the best possible technical value (Q_{max}) minus the minimum acceptable technical value (Q_{min}).

$$q_i = \frac{Q_i - Q_{min}}{Q_{max} - Q_{min}} \tag{1}$$

Bids with $Q_i < Q_{\min}$ are rejected

Furthermore, a maximal added value considered as possible (V_{max}) needs to be determined. This maximum value is the highest amount the contractor is willing to pay for best quality. To determine the added value of the individual bids, their score for the technical proposals gets multiplied with this highest possible value (V_{max}). Finally, the added value is subtracted from the commercial part (P_i) to arrive at the corrected price (CP_i). The supplier with the lowest corrected bid price gets awarded the offer.

$$CP_i = P_i - V_{max} q_i \tag{2}$$

AoV is also suitable for more complex cases. If there are many different qualitative factors one determines the added value for

each individual criterion. Consequently, the actual price will be corrected through several factors.

$$CP_i = P_i - \sum_j V_{max_j} q_{ij} \quad (3)$$

Table 1: Example of Awarding on Value assessment

Bid #	Price P (€)	Technical quality score Q	Technical quality q_i	Technical Value Vq_i (€)	Corrected price CP_i (€)	Rank
A	150,000	80	0.60	60,000	90,000	1
B	200,000	96	0.92	92,000	108,000	3
C	120,000	62	0.24	24,000	96,000	2

2.2 An example of Awarding on Value

Table 1 shows a case where AoV is applied. There are three bids for this tender. The Delta Value has been set to V=100,000€, and the minimum acceptable technical score is Q_{min}=50 (on a maximum technical score Q_{max}=100). Then bidder A will be awarded the tender, as he offers the best corrected price:

2.3 Advantages and disadvantages of Awarding on Value

Sciancalepore and Telgen (2012) mention several benefits and drawbacks of the AoV method. One of the advantages is that it allows the comparison of data with different measure units, by translating the performance into monetary terms. The resulting corrected price shows the actual costs for the contractor and the winner is not determined through abstract points, but through monetary terms that everyone is familiar with. This output is easy to understand for both sides. Additionally, the application of AoV requires only the definition of the maximum possible value for the criteria and scaling the bid quality accordingly. Furthermore, requirements of fairness and transparency are respected. All bidders are evaluated equally and the awarding mechanisms and parameters are made known to all suppliers in the call for tenders. Therefore, bidders have the possibility to estimate their own corrected value and adjust it to the contractor's needs.

A drawback of AoV is that is requires the determination of the maximum added value, bidders can achieve (V_{max}) and this might be very subjective. However, this problem can be overcome through the usage of a committee, which will also help to avoid unfair and illegal events.

2.4 Classification of Awarding on Value

In literature different phases in the supplier selection process, such as formulation of criteria, pre-qualification of potential suppliers, and final choice phase (de Boer et al., 2001; Ho et al., 2009), are defined. The AoV method can be sorted to final choice phase, since the winner will be determined with AoV. One could also combine AoV with a pre-qualification phase to limit tenders to the ones that are actually capable of performing the task. However, this step is not necessary since it could also be included in AoV itself as criteria that have to be fullfilled (Q_{min}).

Moreover, AoV can be categorized to price-correction systems. Price correction systems are characterized by: "the price of each bid is taken as it is (there is no translation into points), but it is corrected by using additional costs or benefits determined by the qualitative features of the bid. […] So the bid price is used as it is, while quality is translated in a percentage score and then in price." (Sciancalepore & Telgen, 2012, p.3). AoV is further characterized that it transforms the relevant criteria into one common one, which is already given, like money, to enable a better comparison of the alternatives. Therefore AoV can as well be categorized under multi-criteria decision making.

3. METHODOLOGY

This paper will focus will focus on the translation "Awarding on Value"; however other names are also possible. Since AoV is intended to be used for supplier selection in the spirit of the EU Directives about finding the MEAT the author started to identify possible similar methods in the field of supplier selection methods, which are also meant to identifying the MEAT. In this context the search terms "Most Economically Advantageous Tender" and "Awarding on value" were selected. AoV itself was chosen on the one hand to check directly for related articles that might refer to the method and on the other hand since the aim of this method is to award on value, as the name itself already says, so also literature dealing with dealing with identification on certain values next to monetary terms can be identified.

Next to this AoV is about considering multiple criteria. Hence, it can be categorized under multiple-criteria decision methods. The special feature of AoV is that it translates performance of different criteria into one already existing index. Therefore, this literature review looks at multi-criteria decision-making methods in general to identify a similar method. Thereby might also approaches with different names be identified. Furthermore, multi-criteria decision-making methods are also taken into account and to avoid being too narrow "multi-criteria decision-making" is used as an individual search term.

The listings of two search engines, Scopus and Science Direct, were taken as a basis to identify possible literature for this paper. "Most Economically Advantageous Tender", "Awarding on Value", "Best Value Procurement" and "Multi-criteria decision-making" were taken as search terms and not in combination with supplier selection or similar terms, as the literature is dispersed and the search would have been too narrow, not allowing for other possible formulations and potentially neglecting interesting publications. A distinction between professional and academic literature as well as quantitative and qualitative studies was not made, to avoid neglecting possible contributing information.

Figure 1 displays that typing "Most Economically Advantageous Tender" as key word into Scopus, led to 15 hits. Since the number of results is relatively low no further filter was applied for this search term in Scopus. 505 hits were achieved in Science Direct with the same term. Through the topic filter the results were limited to "Contractor", "Contract", "Public Procurement", "European Commission", "European Union", "Directive" and "European Parliament" and this reduced hits to 31 search results. The topics that were excluded through this step are: "Power Station", "Member State",

"India", "Ship", "Renewable Energy", "Underground Space", "Firm", "Station Practice", "Modern Power", "Developing Country", "Project Management", "Project" and "Exchange Rate". The reason for the exclusion of those topics is that they are less likely to be directly related to supply management and especially supplier selection.

Typing "Awarding on Value" as key word into Scopus, led to 167 hits. Applying the language filter and sorting out all languages besides English and German, led to 153. Using the subject filtering option and thereby limiting results to "Engineering", "Social Sciences", "Economics, Econometrics and Finance", "Decision Science" and "Business, Management and Accounting" led to 118 hits. In this step the subject areas "Medicine", "Computer Science", "Environmental Science", "Agricultural and Biological Science" and "Art and Humanities" were excluded, since they are not directly related to the supplier selection. The key word filter was not applied here, since the titles and abstracts of the remaining results are low enough to go through all titles and abstracts.

9,828 hits were achieved in Science Direct with the same term. With the topic filter the results were limited to "Public Enterprise", "Euro" and "World Bank" and hits were reduced to 98. Topics that were excluded through this step are: "continuing Education", "Maxillo facial Surgery", "China", "Thin film", "Delta", "Schiff Base", "Readera Euro", "Tropical medicine", "Reader", "Health care", "Omega", "India", "Metal Ion", "X-ray Diffraction", "Dairy Science", "nmr", "Soft Ware" and "Stock Option". Those topics were excluded as well, since they are likely to be directly related to supply management and especially supplier selection. Furthermore, do not seem to be correlated with value determination or decision-making.

Using the search term "multi-criteria decision-making" in Scopus resulted in 6,049 hits. After limiting the results to "English" and "German" ones 5,814 were left over. Due to the fact that Multi-criteria decision-making is used in several different areas the author did not restrict the subject area. Nevertheless, the keyword filter was used. Limiting the results to "decision-making", " decision theory", "decision support system", "multi-criteria", "multi-criteria analysis", "supplier selection" and "multi-criteria decision-making" as key words and thereby excluding "fuzzy sets", "hierarchical systems", "analytic hierarchy process", "decision makers", "optimization", ""sustainable development", "fuzzy logic", "GIS", "TOPSIS", "Computer simulation", "sensitivity analysis", "uncertainty analysis", "geographic information systems" and "Linguistics" led to 4,573 hits.

Typing "multi-criteria decision-making" into ScienceDirect resulted in 140,560 hits. The results were limited to "supply chain", "decision support", and "information system". Afterwards the following topics were excluded due to low relevance for this paper: "neutral network", "soft ware", "china", "delta", "health care", "patient", "genetic algorithm", "breast cancer", "child", "climate change", "risk assessment", "expert system", "artificial intelligence", "support system", "operational research", "monte carlo", and "mental health". Due to the large number of hits, topics that seem to be less correlated with awarding mechanisms were excluded. After applying the topic filter 2,120 hits were left over.

Afterwards, the titles and abstracts of the remaining articles were scanned in order to identify which articles are about awarding mechanisms or other decision-making approaches similar to AoV and could contribute to this review. However, due to limited access to the database not all articles were available as full documents.

The titles and abstracts of the publications were scanned for the aforementioned key words and individually judged according their relevance, leading to a preliminary sample of 105. Unfortunately, not all full texts of the listings could be accessed (27) via the available network, which reduced the sample size to 78. To approach the focus of the review, the introductions as

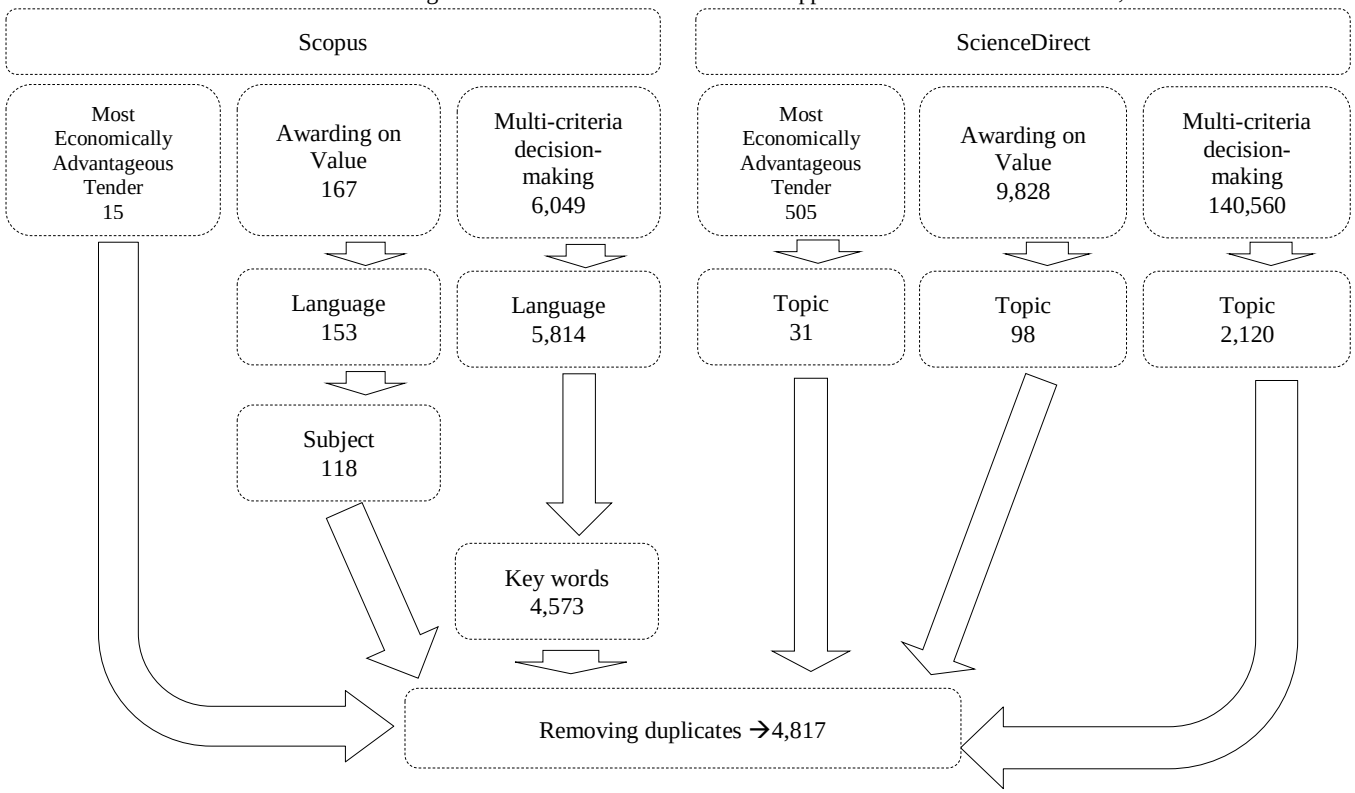

Figure 1: Search scheme

well as discussions and conclusions parts of all remaining literature were examined, thereby focusing on key words like the identified dimensions of supplier selection or paraphrasing hinting at decision mechanisms comparable to AoV, leading to an exclusion of 22 articles. The citations of the residual articles were reviewed, identifying another 27 potentially relevant articles, of which 22 could be accessed. Again, introductions and discussions/conclusions were read and 6 irrelevant articles excluded that did not cover issues related to awarding mechanisms. The resulting total sample of 72 publications was reviewed based on the full text leading to an exclusion of 8, because of lacking methods descriptions or similarities to AoV, and a final sample of 64 articles. A graphical representation of the process is shown in figure 2.

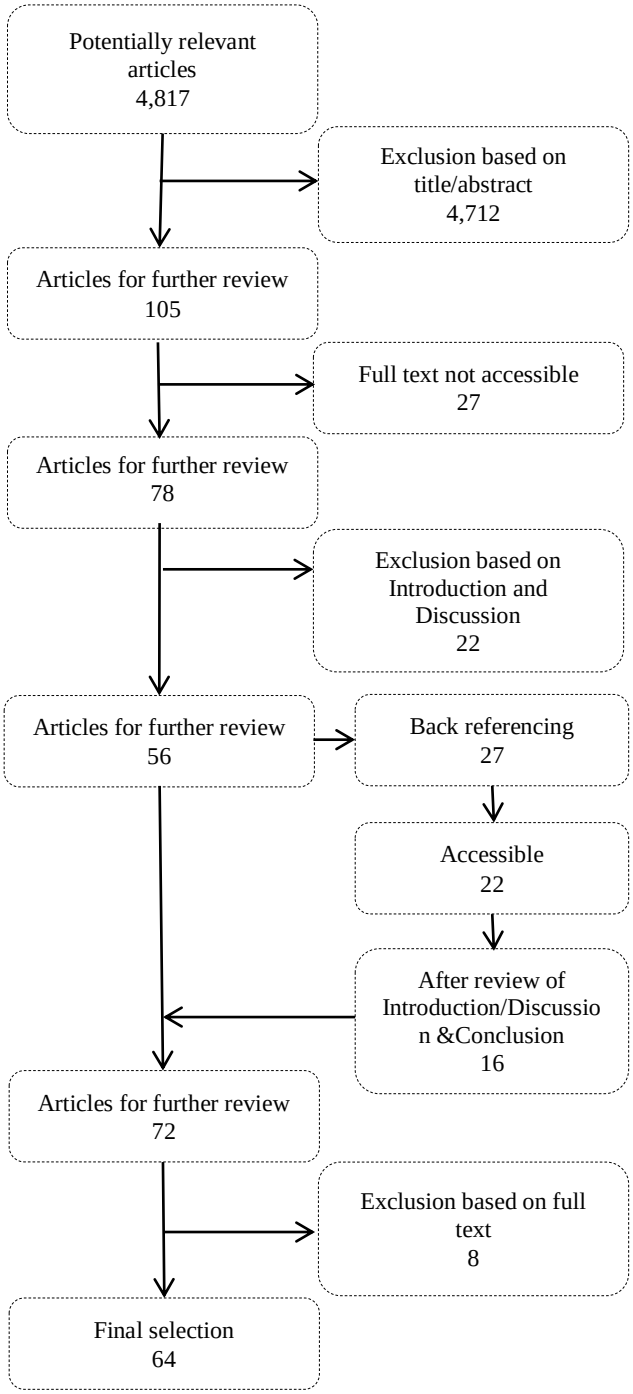

Figure 2: Article Selection Process

4. RESULTS

4.2 Presence of Awarding on Value in the literature

As already stated before most literature about the AoV approach is in Dutch, however there are already some articles in English talking about it. Dreschler (2008, 2009), Sciancalepore and Telgen (2012) and Sebastian, Claeson-Jonsson, and Di Giulio (2013) even published several articles where AoV is mentioned or even discussed more extensively. All of these articles directly refer to CROW as the developer of the awarding mechanism. Sciancalepore and Telgen (2012) and also Roetman andVan Reeuwik (personal communication, May 26, 2014) state that they are not aware of comparable methods to AoV. Moreover, Dombrowski (2014) and Bussink (2014) conducted a survey about AoV to detect the awareness and understanding of AoV in different countries and found that the method is barely known outside the Netherlands; however they found that it is also used in Africa.

After reviewing several articles (e.g. Vego, Kučar-Dragičević, & Koprivanac, 2008; Dursun, Karsak, & Karadayi, 2011; Achillas et al., 2013; Karmperis, Aravossis, Tatsiopoulos, & Sotirchos, 2013) about practices used in waste management it became clear that the context is complex and often several different decisions approaches are applied in combination (Dursun et al., 2011; Achillas et al., 2013; Karmperis et al., 2013). Common decision support frameworks used in waste management are life-cycle assessment, cost-benefit analysis and multi-criteria decision-making (Kamperis et al., 2013). Morrisey and Browne (2004) talk about optimizing models and categorize cost-benefit analysis and life-cycle assessment to them. Those methods are somehow comparable to AoV since they also translate possible impacts on the environment or social impacts into monetary terms by using either "estimating the costs of avoiding a negative effect (e.g. the cost of pollution control on an incinerator) or to establish how much individuals are willing to pay for an environmental improvement." (Morrissey & Browne, 2004, p.299). However, there are no minimum requirements or maximum possible value that can be achieved for each criterion. So they are only akin to AoV in terms of one characteristic, the translation into monetary terms. Consequently, in the reviewed articles about waste management no connection to AoV or a comparable method was found.

There are a lot of different approaches to decision-making in environmental management (Morrissey & Browne, 2004; Linkov et al., 2006; Hermann, Kroeze, and Jawjit, 2007; Lipuščeк, Bohanec, Oblak, & Stirn, 2010). Common assesment methods are also life-cycle assement, multi-criteria analysis and additionaly environmental performance identicators. However, most approaches use the criteria with their own dimensions and translate those into a single fictive score or a set of environmental scores. Furthermore, asseing the life-cylcle impacts and costs is of major importance for environmental management and this is difficult to quantify just in monetary terms and determine a maximum value for it. Following no comparable methods in terms of the above mentions special characteristics of AoV could be identified in the subject area of environmental management.

4.2 Awarding on Value in supplier selection

4.2.1 Best Value Procurement

A popular procurement method used in the Netherlands is Best Value Procurement/Performance Information Procurement System (BYP/PIPS) (Kashiwagi, 2011) developed by Dean

Kashiwagi (Santema, van de Rijt & Witteveen, 2011). BVP aims at reducing risks for the contractor by selecting top performers and also considers both price and performance. The Directorate General of Public Works and Water Management applied BVP in several projects to find the highest quality vendor within budget (Santema et al., 2011). The system of Kashiwagi was mainly followed except for qualitative criteria. Thereby AoV has been used instead of relative scoring. The results of this approach were positive and one can say that a combination of AoV and BVP can lead - under the right circumstances - to successful procurement according to the MEAT principle and EU guidelines.

4.2.2 Quality-to-price scoring

Bergman and Lundberg (2013) talk about quality-to-price scoring. This is another approach that uses transferring non-price criteria into monetary terms. They describe quality-to-price scoring as follows:

> As a first step in quality-to-price scoring, the procurer sets a monetary value on the quality offered by the bidders (or on the quality difference, relative to a minimum or maximum quality level). In a second step this value is combined with the bid in one of four alternative ways. Quality in excess of the minimum quality level gives a value that can be subtracted from the bids to get an evaluation price. Alternatively, the difference between the offered quality and the maximum quality level results in a penalty that is added to the bid to get the evaluation price. Furthermore, the quality discount or surcharge can either be absolute, i.e., the same for all bidders that offer the same quality, or proportional to the bidder's own bid. (Bergman and Lundberg, 2013, p. 80) They provide four possible quality-to-price scoring rules. The variables were adjusted to the ones used for AoV.

$$CP_i = P_i - b\,Q_i \tag{4}$$

$$CP_i = P_i + b\,(Q_{max} - Q_i) \tag{5}$$

$$CP_i = P_i\,(1 - b\,Q_i) \tag{6}$$

$$CP_i = P_i\,(1 + b\,(Q_i - Q_{max}) \tag{7}$$

The steps required for quality-to-price scoring are similar to the ones used in AoV. Both approaches monetize non-price criteria and set off this added value against the costs. To obtain the added value the procurer also needs to define a maximum amount he is willing to "pay" for offered quality above the required minimum. A difference between AoV from CROW and quality-to-price scoring is that the method, described by Bergman and Lundberg (2013), also refer to the possibility of adding the value of the quality gap relative to the maximum quality level on top of the bid price. Another distinction is that Bergman and Lundberg use b instead of q_i, where b is the value per quality point. Another distinction is that there is no value for minimum quality (Q_{min}) present in the formulas of quality-to-price scoring.

Therefore Quality-to-price scoring can be seen as a special case of AoV. If one takes the first two formulas of AoV and combines them:

$$CP_i = P_i - V_{max} \times \frac{Q_i - Q_{min}}{Q_{max} - Q_{min}} \tag{8}$$

Afterwards Q_{min} will be set to "0":

$$CP_i = P_i - \frac{V_{max}}{Q_{max}} \times Q_i \tag{9}$$

Since b in the price-to-quality formula from Bergman and Lundberg (2013) is the value per quality point it can also be expressed as:

$$b = \frac{V_{max}}{Q_{max}} \tag{10}$$

Consequently formula 4 is a special case of AoV if one combines formula 1 and 2 and sets Q_{min} to zero:

$$P_i - b \times Q_i = P_i - \frac{V_{max}}{Q_{max}} \times Q_i \tag{11}$$

However, it is not clear if quality-to-price scoring is directly interrelated with AoV from CROW. According to one of the authors they found this method in real tenders (M. Bergman, personal communication, June 4, 2014).

4.2.3 Price correction system

Doornbos (2005) and Dreschler (2009) elaborate on supplier selection mechanisms. They distinguish between point systems, value/price ratio systems, and price correction systems. By using the point system all criteria, including the price, are translated into points and the tender with most points becomes the winner. Ratio-systems at first calculate a basic value and afterwards determine the added value of each bid compared to the basic value and then divides the total value of the bid by its price. The bid with the highest value/price ratio wins. Price correction systems are characterized by: "The price correction system rewards extra performance of bids with an added value, which may be subtracted from the price. The bid with the lowest corrected price wins." (Dreschler, 2009, p. 15). Dreschler (2009) mentions AoV in the context of price correction systems. As Bergman and Lundberg (2013) he also describes the possibility to add something to the corrected price, in case of unsatisfying performance (negative added value). According to Dreschler (2009) point systems were commonly used in the civil sector until price correction systems became suddenly popular in the year 2005.

5. DISCUSSION

There is already some literature about AoV present (e.g. CROW, 2007; Dreschler 2008; 2009; Santema, van de Rijt & Witteveen, 2011; Sciancalepore & Telgen 2012). However, most authors work or come from the Netherlands, the country of origin of AoV, and besides there is not much literature published in other countries. This observation was also detected in the survey from Dombrowski (2014) and Bussink (2014) who found a high awareness for AoV among Dutch purchasers and other people working in this field, while a low awareness in other countries especially in underdeveloped countries.

Anyway there are some authors who recognized the need for a method like AoV (Sykes; 2012; Herman et al., 2006). In a related issue, which was not found on Scopus or Science Direct, a statement from The World Bank in its procurement guidelines was found. The following is specified by The World Bank:

> Bidding documents shall also specify the relevant factors in addition to price to be considered in bid evaluation and the manner in which they will be

> applied for the purpose of determining the lowest evaluated bid. For goods and equipment, other factors may be taken into consideration including, among others, payment schedule, delivery time, operating costs, efficiency and compatibility of the equipment, availability of service and spare parts, and related training, safety, and environmental benefits. The factors other than price to be used for determining the lowest evaluated bid shall be, to the extent practicable, expressed in monetary terms in the evaluation provisions in the bidding documents. (World Bank, 2011, p.23)

Similarly Sykes (2012) also mention the need for an approach "where an adjustment (addition to or subtraction from) each bidder's tender price is made to reflect features in the proposal that have positive or negative value." (p.9). Therefore one can say that there is a demand for methods like AoV, but they seem to be not well known yet.

Price-to-quality scoring from Bergman and Lundberg (2013) as a special case of AoV comes closest to the approach developed by CROW. Since the authors found this method through studying real cases it is not obvious if it is directly connected to AoV. Nevertheless, it includes the most special characteristics like the maximum possible value for a criterion, the possibility to subtract added quality from the actual price and the corrected price of the bid. Additional quality-to-price scoring has the possibility to add something to the actual price for insufficient performance and the formulas do not contain a minimum required quality.

Dreschler (2009) talks about AoV in the context of price correction systems. He refers to CROW and even studied some cases where AoV was applied in construction projects in the Netherlands. Dreschler (2009) identified a rise in the use of price correction system in the civil sector from 2005 on.

Academic implications of this paper are that it shows up possible linkages between AoV and similar awarding mechanisms in the literature. Furthermore, possible scenarios as well as combinations of AoV are shown that can be adapted by purchasers and other managers. Additionally, the awareness of AoV might be increased among researchers, especially since the literature about this method written in English got extended whereby a broader audience can be reached.

5.2 Limitations and further research

There are also some limitations of this research. Most literature about AoV is in Dutch and there is no uniform English translation for "Gunnen op Waarde". For example Bergman and Lundberg (2013) talk about quality-to-price scoring. Consequently, there is the possibility that other translation exists that this literature review missed. Only three search terms were applied which might also result in missing important information. Next to that, the selected search terms were applied in two search engines. However, other search engines might have found other information that could also be interesting for this research. Another limitation is the restricted licenses of the library. Leading to some possible interesting articles could not be accessed. Additionally, there might be existing methods that are not published at all or not in an academic context and could therefore not be apprehended in the search process. Moreover, the search for original papers has been conducted in journals that publish in English and German and thus other journals that publish in other languages were not considered.

Further research could focus on other search engines or sources of information and might thereby identify other information also dealing with AoV or something similar to it. Using different search terms could enable a broader and more complete overview about this awarding mechanism. Furthermore, the development of AoV over the years as well as its application in other countries and possible changes can be observed. There is also the possibility to extend the search to more languages to identify possible approaches that are not published in English or German.

6. CONCLUSION

After reviewing numerous articles from several sources no comparable approach to awarding on value has been found. However, adaptions of AoV could be identified. Furthermore, authors talking about AoV were positive about the method and its applicability to find the MEAT. However, applying MEAT is more complicated and time consuming than simply using lowest price (Dreschler, 2009) but is also provides some benefits like the possibility to account for quality differences. Additionally, other sources like the World Bank Procurement Directives talk about the importance to monetize non-price criteria, albeit they do not mention AoV which leads to the assumption that the method is not well enough known, although there is a demand for it.

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9. APPENDIX

8.1 List of abbreviations

AoV	Awarding on Value
MEAT	Economically Most Advantageous Tender
CROW	Centrum voor Regelgeving en Onderzoek in de Grond-, Water- en Wegenbouw en de verkeerstechniek (centre for regulation and research in civil engineering)
i	the i-th bid
q_i	quality score of the i-th bid
Q_i	value of the i-th bid
Q_{min}	minimum acceptable quality
Q_{max}	best possible technical value
P_i	actual price of the i-th bid
CP_i	corrected price of the i-th bid
b	value per quality point

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