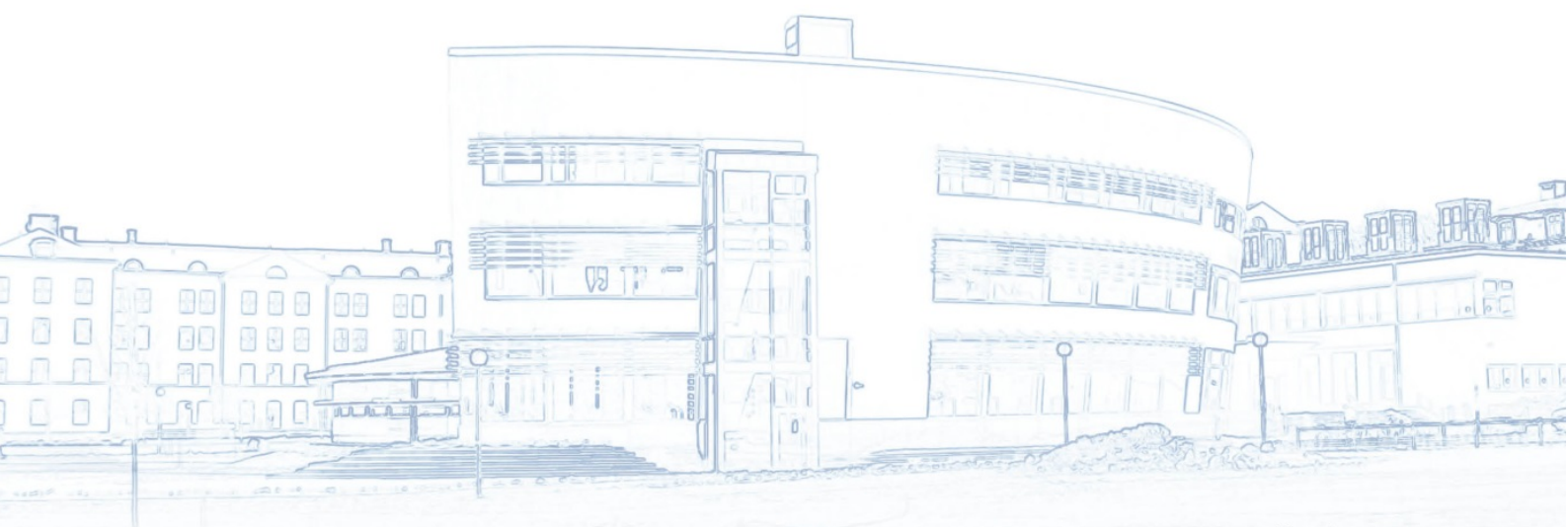


## Invalid weighting in gender-neutral job evaluation tools

*Stig Blomskog*



© Stig Blomskog 2016

Working paper No 54  
urn:nbn:se:hig:diva-21248



Working paper / University of Gävle  
ISSN 1403-8757

Working Papers are published electronically and are available from  
<http://hig.se/Ext/En/University-of-Gavle/Research/Publications.html>

Published by:  
Gävle University Press  
gup@hig.se

# Invalid weighting in gender-neutral job evaluation tools

Stig Blomskog

Faculty of Engineering and Sustainable Development

Department of Industrial Development, IT and Land Management

Visiting researcher in Decision, Risk and Policy Analysis

Senior lecturer in Economics at Södertörn University

E-mail: [stig.blomskog@sh.se](mailto:stig.blomskog@sh.se)

Phone: +46-8-608 4052

Mob: 070-37 10 969





# Abstract

In this paper we argue that invalid weighting instructions are recommended in three international gender-neutral job evaluation tools, which are used for correcting for possible gender-biased wage setting at work places. One of the tools is recommended by ILO.

In these tools the evaluation and the ranking of the jobs at a workplace will be based on an overall assessment of various job-related requirements as skills, responsibility, effort and working condition. The overall assessment will be represented by weighted sum of scales. An essential assumption made in these tools is that the weights assigned to the scales can represent the relative importance of the job-related requirements.

However, we claim that the weights cannot in a meaningful way say anything about the relative importance of these job-related requirements. We support our claim by a formal reconstruction of a job evaluation tool based on so called Multi-Criteria Decision Making. The implication of the reconstruction is that the weights will play a key role in the basic pay setting of the jobs.

We further argue that, due to this mistaken interpretation of the weights in the instructions, the user of these tools will likely not realize the close link between the weighting of the job-related requirements and the basic pay setting of the jobs. We therefore conclude that an application of these invalid weighting instruction might hamper the purpose of gender-neutral job evaluation of achieving a rational and gender-neutral pay setting at workplaces.

The paper ends with a recommendation that valid weighting instructions should be developed by means of Multi-Criteria Decision Making.



# Table of Contents

Abstract .....	i
Table of Contents .....	iii
1. Introduction .....	1
2. Meaning of weighting decision in job evaluation – a formal reconstruction .....	3
The meaning of scales in job evaluation .....	4
The meaning of weights and interpretation of the weighting decision in a job evaluation situation .....	5
A valid weighting procedure – a demonstration .....	9
Invalid weighting instructions – a comment .....	11
3. Invalid weighting instructions – the evidence .....	12
Final comments about the assessment of the validity of the weighting instruction .....	17
4. Conclusion .....	18
References .....	19
Appendix: The meaning of weights in additive value models .....	20





# 1. Introduction

In this paper we argue that invalid weighting instructions are recommended in well-established gender-neutral job evaluation tools. One example of such a tool is constructed by job evaluation experts at the International Labour Office (ILO). The weighting instructions contained in this and in two other tools will be analysed in this paper.

Such gender-neutral job evaluation tools have become a key method for identifying and correcting for possible wage discrimination by gender at work places. Many EU countries and countries like Australia, Canada, New Zealand and the US use this method. Equal pay legislation requires employers to implement gender-neutral job evaluations in many countries. This wage policy strategy is commonly named Comparable Worth Policy.<sup>1</sup>

The outcome of a job evaluation is a rank-order over the jobs, which serves as a base-line for achieving a gender-neutral pay setting at the work place. The rank-order is based on an overall assessment of various kinds of requirements, which the job holders are expected to fulfil when they carry out their job tasks. These job-related requirements are various aspects of the so called four main-criteria: *skills, responsibility, effort* and *working conditions*. A general convention is that the overall assessment of the jobs shall be represented by means of *weighted sum of scales*. The construction of such *additive value models* requires that weighting decisions have to be taken. The weighting decisions will most likely have an essential influence on the outcome of the job evaluation and consequently on the pay setting decisions related to the job evaluation. It is therefore important that valid weighting instructions are designed in gender-neutral job evaluation tools. This means that the weighting instructions must proceed from a correct interpretation of the meaning of weights in additive value models, which determine the ranking of the jobs.

However, we claim that invalid weighting instructions seem to be recommended in gender-neutral job evaluation tools when additive value models are applied. To avoid a misunderstanding we want to point out that it is not the use itself of additive value models we criticize. The reason for our criticism is that the weighting instructions are based on an *incorrect interpretation of the meaning of weights when additive value models are applied in job evaluation*. The analyses and the argumentation in the paper are divided into two parts.

In the *first* part of the paper, we present a formal interpretation of the meaning of the weights in job evaluation when additive value models are applied. Our interpretation implies that the weights will represent – as we name it – a *compensatory basic pay setting of the jobs*. This interpretation is not present in the three job evaluation tools analysed in the paper.

In the *second* part of the paper, by using our formal interpretation of the weights, we show that the weighting instructions in three job evaluation tools are based on an

---

<sup>1</sup> England (1999) defines comparable worth policy as “strategy policies that ensure that jobs do not pay less because they are filled by women.” Comparable worth policy is adopted in many countries, e.g., in Australia, Canada, EU countries, New Zealand and in the US.

incorrect interpretation of the meaning of the weights in additive value model. The tool designers seem to assume that the weights can represent, what they name, the *importance* of the job-related requirements, which are the grounds for the overall assessment of the jobs. However, this is not, as we show in the paper, a correct or even meaningful interpretation of the weights in additive value models. This means that the users of these tools will likely not relate their weighting to a compensatory basic pay setting of the jobs. Thus, there are reason to believe that these invalid weighting instructions hamper the aim of gender-neutral job evaluation to achieve a well-considered and gender-neutral pay setting at the workplaces.

The weighting instructions we will assess is contained in three gender-neutral job evaluation tools: 1) *Steps to Pay Equity* developed by job evaluation experts at the Swedish Equal Opportunities Ombudsman (Harriman and Holm 2001). The tool was tested and validated in the Equal Pay project, which EU Commission financially supported; 2) *ISOS* developed by job evaluation experts at the *Universitat Politècnica de Catalunya* (Corominas et al, 2008); 3) *Promoting equity – gender-neutral job evaluation for equal pay: a step-by-step guide* (hereafter, the *ILO tool*) developed by job evaluation experts at the International Labour Office developed (Chicha, 2008).

The theoretical starting point for our assessment is that job evaluation should be interpreted as a multi-criteria decision problem. This interpretation makes it possible for us to use the results of an extensive number of studies about weighting accomplished within the research area of Multi-Criteria Decision Making (MCDM). A classical reference to MCDM is Keenye and Raiffa (1976). Another important reference is Keenye (1992), who states that weighting is as mentioned above “the most common critical mistake” (p. 147-148) in multi-criteria decision making, which is, as we will claim, present in gender-neutral job evaluation tools. Following Keenye we also believe that similar mistakes are made in many other areas, for example in public procurement where weighting decisions have to be taken.

The analyses in the paper will, so far as it is meaningful, be held on an informal level. The analyses will be based on reasoning about the meaning of weights and weighting decisions contained in Belton and Stewart (2002), where the theoretical parts are framed in a rather informal way.

Finally, we want to point out that the scope of the paper is *not* to develop and recommend certain weighting methods for gender-neutral job evaluation. Our analysis is delimited to assess the validity of weighting instructions contained in the three job evaluation tools named above. But the result of our paper might of course be a motivation for developing more valid weighting methods.

The rest of the paper proceeds as follows. In section *two* we explain the meaning of weights in additive value models and its implication for how to interpret the weighting decisions in job evaluation. In section *three* we assess the validity of the weighting instructions stated in the three job evaluation tools mentioned above. Section *four* concludes the findings in the paper.

## 2. Meaning of weighting decision in job evaluation – a formal reconstruction

Our assessment of the validity of the weighting instructions proceeds from the claim that valid weighting instructions have to be based on a correct meaning of the weights applied in additive value models. This means that if a weighting instruction proceeds from an incorrect interpretation of the meaning of weights in additive value models, we claim that the weighting instruction is not valid. To explain the specific meaning of the weights in job evaluation we find it necessary to make a formal reconstruction of a typical job evaluation procedure. The formalisation is based on multi-criteria decision making (see e.g. Belton, 2002, particularly chapters 4–6). Our formalisation proceeds as follows.

The outcome of a job evaluation procedure is a rank-order over the jobs identified at the work place. The rank-order is based on an overall assessment of various kinds of requirements, which job holders are expected to fulfil when they carry out job tasks related to their jobs.<sup>2</sup> An internationally accepted convention is that these job-related requirements should be various aspects of the so called main-criteria: *requirement of skills, requirement of responsibility, requirement of effort and working conditions*.<sup>3</sup>

Starting from these main criteria a typical job evaluation procedure occurs in a number of stages as follows:

*Stage 1:* Decision makers (DMs)<sup>4</sup> divide the main-criteria into an appropriate number of sub-criteria, which are named *factors*. Each factor  $i$  ( $i=1, 2, \dots, m$ ) represents a specific kind of requirement (demand or difficulty level) that is related to the various jobs at the work place. A common praxis is that each factor is divided into a number of ranked requirement levels, which can be related to the jobs.

*Stage 2:* For each job the DMs construct a requirement profile which contains descriptions of the requirement levels related to the job per each factor. The requirement profile for each job is designated as:

$$(1) \quad R(a) = \langle R_1(a), \dots, R_n(a) \rangle,$$

where:  $R_i(a)$  = Requirement level related to job  $a$  regarding factor  $i$ .

The requirement levels described in the profile for a job  $a$  are interpreted as the requirements the holders of job  $a$  are expected to fulfil when they carry out the job tasks related to job  $a$ .

---

<sup>2</sup> Thus, it is important to note that it is *not* the performance of the job holders that is assessed in job evaluation.

<sup>3</sup> These four main criteria (factors) are, for example, stated by the European Commission in *Code of practice on the implementation of equal pay for work of equal value* (1996).

<sup>4</sup> DMs are a group of persons who carry out job evaluations and are responsible for the result of job evaluation in terms of pay setting at the work place.

*Stage 3:* An established praxis in job evaluation is that the overall assessment of the requirement profiles related to the jobs is represented numerically by means of an additive value model. This means that each job is assigned a total scale value, i.e.

$$(2) \quad V(a) = \sum w_i v_i(a),$$

where:  $V(a)$  = Total scale value representing the overall assessment of the requirement profile related to job  $a$ .

$v_i(a)$  = Scale value representing the ranking of the requirement level related to job  $a$  per factor  $i$ .

$w_i$  = Weight assigned to the scale  $v_i(\cdot)$ .

*Stage 4:* Based on the total scale values, the jobs are classified into various pay grades. The classification serves as a *base-line* for achieving a gender-neutral pay setting at the work place. This means that male and female employees holding two different jobs which are classified in the same pay grade *should* be given the *same basic pay*. This means that a pay differential between these two job holders has to be based on explicit and reasonable gender-neutral reasons. If the employers cannot present any legitimate reasons for a pay differential the male and the female employees should be given the same pay. Thus, when two jobs are assigned the same total scale value should be interpreted as the *basic pay setting decision* that holders of the two jobs should be given the same basic pay, i.e.

$$(3) \quad \text{If } V(a) = V(b), \text{ then } a =_p b,^5$$

where: “ $a =_p b$ ” means “holders of job  $a$  should receive the same basic pay as holders of job  $b$ ” or shorter “job  $a$  should receive the same basic pay as job  $b$ .”

This basic pay setting principle is, as we will argue, the ground for a correct interpretation of the meaning of weighting decisions in job evaluation. However, this *essential relationship between basic pay setting decisions and weighting decisions* seems *not* to be - at least not explicitly - considered in gender-neutral job evaluation tools. We will point this out in the next section. Before we can explain the meaning of the weights and how they are related to the basic pay setting decisions we have to briefly explain the meaning of the scales in the additive value model.

### The meaning of scales in job evaluation

For each factor  $i$  the DMs assign a scale value to each job. The constructed scales will represent rank-orders over the requirement levels related to the jobs per each factor. This means that a statement as  $v_i(a) > v_i(b)$  implies that regarding factor  $i$  the DMs rank the requirement level related to job  $a$  *higher than* the requirement level related to job  $b$ .

---

<sup>5</sup> This pay setting principle seems to correspond to the intention expressed in the slogan “equal pay for jobs of equal value”, which is used as a basic argument for the so called comparable worth policy.

However, it is well known that the scales in an additive model have to be on the form of interval scales, i.e. permissible transformations are defined as:

$$v_i^* = \alpha_i v_i + \beta_i.$$

It is of course important that the DMs correctly understand how to construct and interpret interval scales in a job evaluation. However, to what extent valid scaling instructions are provided in the three job evaluation tools will not be discussed in the paper. In our discussion below about the meaning of the weights in a job evaluation, we assume that valid interval scales are constructed.<sup>6</sup>

In job evaluation it is common that the scales are constructed such that the highest ranked requirement levels for the factors are assigned the same scale value, and lowest ranked requirement levels are assigned the scale value equal to one, i.e.

$$v_1(R_1^h) = \dots = v_i(R_i^h) = \dots = v_n(R_n^h) > v_1(R_1^l) = \dots = v_i(R_i^l) = \dots = v_n(R_n^l) = 1,$$

where:  $R_i^h$  = The highest ranked requirement level in factor  $i$ .

$R_i^l$  = The lowest ranked requirement level in factor  $i$ .

The difference between  $R_i^h$  and  $R_i^l$  will be named the *range* of factor  $i$ , which can be represented numerically as:  $\Delta v_i^R = v_i(R_i^h) - v_i(R_i^l)$ .

The meaning of weights and interpretation of the weighting decision in a job evaluation situation

When the scales have been constructed the DMs have to assign weights to the scales. This give rise to the key question in this paper:

*What kind of decisions or judgments will the weights actually represent in a job evaluation situation?*

To answer this question we proceed from a simple example where the job evaluation is only based on two factors. We assume that two jobs  $a$  and  $b$  have been assigned scale values such that:

$$v_1(a) - v_1(b) > 0 \quad \text{and} \quad v_2(b) - v_2(a) > 0.$$

The DMs assign weights to the scales such that both jobs receive the same total scale value, i.e.

$$(4a) \quad w_1 v_1(a) + w_2 v_2(a) = w_1 v_1(b) + w_2 v_2(b).$$

The consequence of the DMs' scaling and weighting decisions is that both jobs will be classified in the *same pay grade* and will therefore receive the *same basic pay*. The

---

<sup>6</sup> See e.g. Keeney and Raiffa, (1993, chapter 3) for a formal proof that scales in additive value model have to be in the form of interval scales. Belton and Stewart (2002) suggest and discuss a number of scaling procedures when interval scales have to be constructed in multi-criteria decision problems.

essential question we have to answer is how the DMs weighting decision should be interpreted. What kind of judgement do the DMs actually express by this weighting decision? We can answer the question by reformulating the expression (4a) such that:

$$(4b) \quad w_1(v_1(a) - v_1(b)) = w_2(v_2(b) - v_2(a)).$$

This expression implies that the *difference* between the jobs  $a$  and  $b$  regarding the requirement defined in factor 1, which we denote as

$$\Delta_1(R_1(a), R_1(b)),$$

is *balanced* or *compensated* for by the *difference* between jobs  $b$  and  $a$  regarding the requirement defined in factor 2, denoted as:

$$\Delta_2(R_2(b), R_2(a)),$$

such that both jobs should receive the same basic pay, i.e.  $a =_p b$ .

An equivalent way to interpret this weighting decision is to say that DMs judge that the difference between the requirement levels related to jobs  $a$  and  $b$  in factor 1 should have the *same influence on the basic pay setting* as corresponding difference in factor 2. This *compensatory basic pay setting decision*<sup>7</sup> can formally be stated as:

$$(5) \quad \Delta_1(R_1(a), R_1(b)) \sim \Delta_2(R_2(b), R_2(a))$$

which is to be read as:

*The difference between jobs  $a$  and  $b$  regarding factor 1 should have the same influence on the basic pay setting as the difference between jobs  $b$  and  $a$  regarding factor 2.*

This decision can then be numerically represented by assigning weights to the scales such that the following equality holds:

$$w_1 \Delta v_1 = w_2 \Delta v_2 \quad \text{or} \quad \Delta v_1 = \frac{w_2}{w_1} \Delta v_2,$$

$$\text{where } \Delta v_1 = v_1(a) - v_1(b) > 0 \quad \text{and} \quad \Delta v_2 = v_2(b) - v_2(a) > 0.$$

Because the purpose of the weighting is to determine a ratio ( $w_2 / w_1$ ) we can stipulate that  $w_1 = 1$ , which implies that:

$$\Delta v_1 = w_2 \Delta v_2.$$

Thus, based on the constructed scales in the job evaluation situation the compensatory basic pay setting decision determines a unique numerical weight  $w_2$ , where  $w_1 = 1$ . In

---

<sup>7</sup> Killingsworth (1987, p. 728) makes a similar observation that job evaluation is based on such compensatory pay setting decisions, something which is not mentioned in the three job evaluation tools assessed in the paper. He says that “At the first glance, then, comparable worth amounts to nothing more radical than insistence that the economic theory of compensating wage differentials be taken seriously”.

other words, the assigned weights would represent the DMs' judgment about what compensatory basic pay setting they find as reasonable at the work place.

By using this example we can illustrate the problem by invalid weighting instructions, which do not explain that the weights will represent certain basic compensatory pay setting decisions. In the *first* place, if the DMs use such invalid weighting instructions there is no obvious reason to believe that the DMs interpret their weighting decision in terms of basic compensatory pay setting decisions as:

$$\Delta_1(R_1(a), R_1(b)) \sim \Delta_2(R_2(b), R_2(a)).$$

The use of invalid weighting instructions means most likely that the DMs will not be aware of the compensating pay setting decision they have committed themselves to when they assign weights to the scales. *Secondly*, it might be the case that DMs would be willing to adjust their weighting when they come to understand that the implication of their weighting in terms of compensatory basic pay setting. They might find the compensatory basic pay setting as not reasonable as a ground for the pay setting at the work place.

Thus, the application of invalid weighting instructions might give rise to a weighting, which do not represent the DMs' "true" believes about a reasonable weighting in the job evaluation carried out at the work place. We therefore conclude that invalid weighting instructions seem difficult to combine with the aim of gender-neutral job evaluation to achieve a rational and gender-neutral pay setting at the work place.

We will end this section by demonstrating a possible weighting procedure that can be applied in job evaluation. But at first we will make two comments. The *first* comment concerns the formal meaning of weights as scaling constants. To see the formal meaning of weights as scaling constants we can transform the scales in the example such as

$$v_1^* = \alpha_1 v_1 + \beta_1 \text{ and } v_2^* = \alpha_2 v_2 + \beta_2,$$

which implies that:

$$\begin{aligned} \Delta v_1^* &= \alpha_1 \Delta v_1 = \alpha_1 (v_1(a) - v_1(b)) > 0 \quad \text{and} \\ \Delta v_2^* &= \alpha_2 \Delta v_2 = \alpha_2 (v_2(b) - v_2(a)) > 0. \end{aligned}$$

This in turn implies that:

$$\Delta v_1^* = w_2^* \Delta v_2^* \text{ where } w_2^* = \frac{\alpha_1}{\alpha_2} w_2.$$

Thus, when the scales are transformed the weights have to be adjusted. The original weights will otherwise, due to the scale transformation, not represent the DMs' compensatory basic pay setting decisions, i.e. the original weights will no represent the decision that:

$$\Delta_1(R_1(a), R_1(b)) \sim \Delta_2(R_2(b), R_2(a)).$$

This compensatory basic pay setting decision can therefore be represented by:

a weight  $w_2$  related to the scales  $v_1(\cdot)$  and  $v_2(\cdot)$

or

a weight  $w_2^* = \frac{\alpha_1}{\alpha_2} w_2$  related to the scales  $v_1^* = \alpha_1 v_1 + \beta_1$  and  $v_2^* = \alpha_2 v_2 + \beta_2$ .

Thus, the formal meaning of weights as scaling constants implies that the DMs have to know how the scales are constructed before they can assign weights to the scales that shall represent the DMs compensatory basic pay setting decision. In other words, the weighting procedure cannot be regarded as independent of the scaling procedure. However, in job evaluation it seems to be assumed that weighting and scaling are two independent procedures, something we will point out in the next section (see also Appendix for interpretation of the weights in a kind of Body Mass Index).

The *second* comment is that the compensatory basic pay setting decisions can be based *directly on comparisons of differences between requirement levels* that are defined for each factor in the job evaluation situation. This means that instead of comparing two jobs as in the example above, the DMs can define two ranked requirement levels in the first factor, designated as  $R_1^{x_1}$  and  $R_1^{y_1}$ , and two ranked requirement levels in the second factor, designated as  $R_2^{x_2}$  and  $R_2^{y_2}$ . The DMs try to define the requirement levels such that the *difference* between the two levels in the first factor is compensated for by the *difference* between the two levels in the second factor. This compensatory basic pay setting decision can be formally stated as:

$$\Delta_1(R_1^{x_1}, R_1^{y_1}) \sim \Delta_2(R_2^{x_2}, R_2^{y_2}).$$

We suggest the following reading of this comparison:

*DMs judge that a move from the requirement level  $R_1^{y_1}$  to the requirement level  $R_1^{x_1}$  in factor 1 should have the same influence on the basic pay setting as the corresponding move from the requirement level  $R_1^{y_2}$  to the requirement level  $R_1^{x_2}$  in factor 2.*

This compensatory basic pay setting decision can be expressed as the weighting decision that:

$$\Delta v_1 = w_2 \Delta v_2,$$

$$\text{where } \Delta v_1 = v_1(R_1^{x_1}) - v_1(R_1^{y_1}) > 0 \text{ and } \Delta v_2 = v_2(R_2^{x_2}) - v_2(R_2^{y_2}) > 0.$$

Thus, the compensatory basic pay setting decision determines a unique value of the weight  $w_2$  related to the constructed scales  $v_1(\cdot)$  and  $v_2(\cdot)$ . It is important to note that the DMs cannot take this weighting decision before they know how the scales have been constructed, something which is not emphasized in the three tools we will discuss in next section (see also Appendix).



### A valid weighting procedure – a demonstration

We end the section by demonstrating a valid weighting procedure which might be appropriate for weighting in job evaluation. However, we do not claim that this procedure should be applied in job evaluation. Such recommendation has to be based on more extensive studies, something which is beyond the scope of this study.

We start the presentation of the weighting procedure by assuming for simplicity that the job evaluation is based on two factors, i.e. the basic pay setting of the jobs is grounded on only two factors. The DMs start the job evaluation by constructing scales representing the ranking of the requirement levels per each factor. We assume that the scales are constructed as is common in job evaluation, which means that:

$$v_1(R_1^h) = v_2(R_2^h) > v_1(R_1^l) = v_2(R_2^l) = 1.$$

The weighting procedure can now occur in two steps, which is also a common recommendation in job evaluation tools as will be seen in next section. In the first step, DMs have to rank the factors. We assume that factor 1 is ranked higher than factor 2. The ranking decision is based on the rule that factor 1 is ranked higher than factor 2 if the move from the lowest to the highest requirement level in factor 1 should, according to the DMs, have a greater influence on the basic pay setting than the corresponding move in factor 2. This ranking decision can be formally stated as:

$$\Delta_1(R_1^h, R_1^l) \succ \Delta_2(R_2^h, R_2^l).$$

As we will point out in the next section, the ranking recommended in the three job evaluation tools is not based on this kind of ranking rule. This ranking can in turn be numerically represented by an inequality as:

$$v_1(R_1^h) - v_1(R_1^l) > w_2(v_2(R_2^h) - v_2(R_2^l)),$$

where we stipulate that  $w_1 = 1$ . The weight  $w_2$  has to take values in the interval  $0 < w_2 < 1$ , because the scales are constructed such that:

$$v_1(R_1^h) - v_1(R_1^l) = v_2(R_2^h) - v_2(R_2^l).$$

Note that the inequality do not, of course, determine a precise value for weight  $w_2$ . Any value in the interval  $0 < w_2 < 1$  is consistent with the inequality above. The determination of a precise value of  $w_2$  is done in a second step.

In the second step, the DMs have to define a requirement level  $R_1^x$  in factor 1, which is ranked between the requirement levels  $R_1^h$  and  $R_1^l$ . In terms of scales values the ranking can be represented as:

$$v_1(R_1^h) > v_1(R_1^x) > v_1(R_1^l).$$

The requirement level  $R_1^x$  has to be defined such that the DM judge that it is reasonable that a move from the lowest defined level  $R_1^l$  to the level  $R_1^x$  should have the same influence on the basic pay setting as the corresponding move in factor 2 from the lowest

requirement level  $R_2^l$  to the highest requirement level  $R_2^h$ . This obviously demanding judgment can formally be stated as:

$$\Delta_1(R_1^x, R_1^l) \sim \Delta_2(R_2^h, R_2^l).$$

Given that scales have been constructed for both factors this compensatory basic pay setting decision determine a precis value for the weight, which is defined as follows:

$$v_1(R_1^x) - v_1(R_1^l) = w_2(v_2(R_2^h) - v_2(R_2^l))$$

or as

$$w_2 = \frac{v_1(R_1^x) - v_1(R_1^l)}{v_2(R_2^h) - v_2(R_2^l)}.$$

To summarize, the essential decision that have to be taken in order to determine the weights is the compensatory basic pay setting decision stated above. In the three job evaluation tools this kind of decisions are not mentioned at all. This means that the DMs might not understand that by assigning weights to the scales, which are constructed in the job evaluation situation, they have committed themselves to accept certain compensatory basic pay setting.

From the expressions above we can immediately realize that the weighting decision cannot be regarded as independent of how the scales are constructed. If the DMs do not have correct knowledge about how the scales are constructed their weighting decisions are based an incorrect information. This might of course give rise to not well-considered weighting decisions (see also Appendix).

To make the example more concrete we can assume that factor  $I$  represents requirement of skills. We assume that the scale representing the requirement of skills is defined in terms of years of training, where scale value for the two requirement levels  $R_1^l$  and  $R_1^x$  are defined as:

$$v_1(R_1^l) = \text{one year of training and } v_1(R_1^x) = \text{four years of training}.$$

We assume that factor 2 represents requirement of responsibility where the two levels  $R_1^l$  and  $R_1^h$  are verbally defined. The compensatory basic pay setting decision

$$\Delta_1(R_1^x, R_1^l) \sim \Delta_2(R_2^h, R_2^l),$$

can now to be read as:

*The DMs judge that the move from the requirement level of one year to four years of training should have the same influence on the basic pay setting as the move from the lowest defined level to the highest defined level regarding requirement of responsibility.*

This compensatory basic pay setting decision can also be represented such that two – hypothetical - jobs  $a$  and  $b$ , where their requirement profiles are as:

$$R(a) = \langle R_1^l(a), R_2^h(a) \rangle \quad \text{and} \quad R(b) = \langle R_1^x(b), R_2^l(b) \rangle$$

should be given the same basic pay, i.e.  $a =_p b$ .

Using this weighing procedure it is straightforward to define weights for an arbitrary numbers of factors as follows:

$$w_i = \frac{v_1(R_1^{x_i}) - v_1(R_1^l)}{v_i(R_i^h) - v_i(R_i^l)} \quad \text{if and only if} \quad \Delta_1(R_1^{x_i}, R_1^l) \sim \Delta_i(R_i^h, R_i^l), i = 1, \dots, n.$$

The weight  $w_i$  represents the compensatory basic pay setting decision that the DMs judge that a move from  $R_1^l$  to  $R_1^{x_i}$  in factor 1 should have the same influence on the basic pay setting as the move from  $R_i^l$  to  $R_i^h$  in factor  $i$ . This definition of the weights presumes that the factors have been ranked based on the rule in step 1 stated above such that factor 1 is the highest ranked factor among the factors defined in the job evaluation situation.<sup>8</sup>

#### Invalid weighting instructions – a comment

As we claimed above, if the weighting instructions do not inform the DMs such that their weighting is not based on this kind of compensatory basic pay setting decision, the weighting instructions are invalid. The weighting instructions are invalid because the DMs will most likely not understand what compensatory basic pay setting decision they actually have been taken when they assigned weights to the scales in the job evaluation situation. It might be the case that the DMs would be willing to adjust their weighting when they are informed about the relation between their weighting decision and the compensatory basic pay setting decisions the weights actually will determine. Such weighting can be named a *biased weighting* because it does not properly represent the DMs' opinion about a reasonable compensatory basic pay setting at the workplace.

Besides the outcome of such biased weighting the fundamental problem with invalid weighting instructions might be that the weighting decisions will be based on irrelevant arguments regarding the basic pay setting of the jobs at the workplace. This means that invalid weighting instruction seems to hamper or preclude the aim of gender-neutral job evaluation to achieve a well-argued and gender-neutral pay setting at the workplace.

We end the section by pointing out that there is a general agreement in MCDM that weighting decisions in multi-criteria problems are tedious and demanding decision procedures. To support the DMs a number of weighting methods have been developed within MCDM.<sup>9</sup> The various methods have different advantages and disadvantages. However, this kind of weighting methods seems not to be known by designers of the three job evaluation tools, which will be analysed in the next section.

---

<sup>8</sup> Salo and Hämäläinen (2001) construct a similar weighting procedure and apply it on a realistic multi-criteria problem.

<sup>9</sup> See e.g. Belton and Stewart (2002) for a presentation of weighting procedures used in multidimensional criteria problems.

### 3. Invalid weighting instructions – the evidence

In this section we will assess the validity of the weighting instructions contained in three gender-neutral job evaluation tools: *Steps to Pay Equity*, *ISOS*, and *Promoting equity – gender-neutral job evaluation for equal pay: a step-by-step guide*.

The job evaluation tool *Steps to Pay Equity* (see Harriman and Holm, 2001) is developed by job evaluation experts at the Swedish Equal Opportunities Ombudsman. The tool was tested and validated in the Equal Pay research project, which the EU Commission financially supported.

The job evaluation tool *ISOS* is developed by job evaluation experts at the *Universitat Politècnica de Catalunya* (see Corominas et al, 2008).

The job evaluation tool *Promoting equity – gender-neutral job evaluation for equal pay: a step-by-step guide* (see Chicha, 2008) is developed by job evaluation experts at ILO. This ILO tool is a guide for gender-neutral job evaluations. Requests for help – from states, unions, and other groups that deal with gender and labour issues – drove its development. Its target groups consist of equal opportunity officers, HR managers, and gender and financial (wage equity) specialists. This tool is based on (1) reviews of job evaluation methods and other materials that were developed and used in various countries, and, (2) case studies and research in gender studies and HR management. The tool was tested and validated in ILO-supported training events.

We start to assess the weighting instruction contained in the three tools by examining the following three quotations:

*Steps to Pay Equity* (Harriman and Holm, 2001, p. 12) explains weighting like this:

Users must, on the basis of their own specific objectives, determine what weight to attach to the various factors. Different companies have different values depending upon the focus and goals of the operations and what work is performed. *This will be expressed in the weight given to the various factors in Steps to Pay Equity*. The individual company is best equipped to make such assessments [our emphasis].

The *ISOS* (Corominas et al, 2008, p. 21) has similar instructions:

The system of *weights reflects the importance that each organisation grants to each family of factors, factors and sub-factor*. A method to determine the weights that must be assigned to each factor that can be considered totally scientific or objective does not exist; in addition, configurations that can be considered suitable for some organisation must adopt the weights to its own specificities regarding activity sector or type of organisation and jobs to be evaluated [our emphasis].

And the *ILO tool* (Chicha, 2008, p. 70) states:

The *weighting of evaluation factors involves determining their relative importance and assigning a numerical value to each of them*. It has an extremely important impact on the value of jobs. Even when extreme caution has been exercised during the preceding steps, inconsistencies and bias can nevertheless be introduced at this point [our emphasis].

According to the instructions, the purpose of weighting is that the DMs shall assess the importance of the various factors defined in the job evaluation situation. Thus, the

suggestion is that the numerical weights shall reflect or represent DMs' assessed relative importance of the factors, whereby the relative importance of the factors should somewhat depend on a company's values and business objectives. One problem with the suggestion is that the meaning of the notions 'importance' and 'relative importance' is not explained in the instructions. The tool designer seems to assume that the meaning of the notion 'relative importance' in a job evaluation context is well-defined. This assumption implies that the DMs understand what kind of arguments that are relevant for assessing relative importance of the factors and what kind of the consequences the assessment of relative importance give rise to in a job evaluation context. However, we will not dwell on this conceptual problem, because we claim that there is a fundamental problem about the proposal that the weights shall represent the relative importance of the factors defined in a job evaluation situation.

The fundamental problem is that the weights in an additive value model cannot meaningfully represent the DMs' assessment about the relative importance of the factors. The reason is that the weights are scaling constants, which coordinate the scales. But this means the weights might have to be adjusted if the scales are transformed as we demonstrated in section two. The problem can be demonstrated by a simple example as follows:

Assume that in a specific job evaluation where the basic pay setting depends only on two factors, a DM decide that factor 1, representing requirement of skills, is more important than factor 2, representing requirement of responsibility, and for that reason, the DM assigns weights such that  $w_1 > w_2$ . Now assume that there are two jobs  $a$  and  $b$  which are assigned the same total scale value, i.e.

$$w_1 v_1(a) + w_2 v_2(a) = w_1 v_1(b) + w_2 v_2(b),$$

$$\text{where } v_1(a) - v_1(b) > 0 \text{ and } v_2(b) - v_2(a) > 0.$$

Because scales  $v_1(\cdot)$  and  $v_2(\cdot)$  are interval scales, permitted transformations are defined as:

$$v_i^* = \alpha_i v_i + \beta_i, \quad i = 1, 2.$$

Whether or not the DMs' ranking of the jobs with respect to the factors is represented by the scales  $v_1(\cdot)$  and  $v_2(\cdot)$  or by the scales  $v_1^*(\cdot)$  and  $v_2^*(\cdot)$  is arbitrary and the choice between the information-equivalent scales should not, of course, change the overall ranking of the jobs and in turn the basic pay setting decision that the jobs  $a$  and  $b$  should receive the same basic pay. Consequently, the weights might have to be adjusted when the scales are transformed, for example, as in this scale transformation:

$$v_1^* = w_1 v_1 \text{ and } v_2^* = w_2 v_2.$$

If we substitute the scales  $v_1^*(\cdot)$  and  $v_2^*(\cdot)$  for the scales  $v_1(\cdot)$  and  $v_2(\cdot)$  in the additive value model, then it is easy to see that the weights must be adjusted like this:

$$v_1^*(a) + v_2^*(a) = v_1^*(b) + v_2^*(b).$$

Based on the assumption that the weights represent the relative importance of the factors, inspection of the last expression now implies that both factors are of equal importance. But it appears to be very strange that the relative importance of the factors can change due to permitted and arbitrary scale transformations. Note that nothing has changed besides the permissible and arbitrary scale transformations. The example demonstrates that whatever the relative importance concept means, weights assigned to scales in an additive value model cannot meaningfully represent the relative importance of the factors. This mistaken interpretation of the weights is repeated in the next quotation:

Consistency can be ensured by examining the weight assigned to each factor being assessed in light of the goals and values of the enterprise. An element which has great importance for the enterprise should not be given low weight and vice versa. (See Chicha 2008, p. 72).

In this quotation it is also evident that the tool designer assumes that the weights can meaningfully represent the importance of the factors, which the tool designer here also seems to name elements. Based on these quotations we can conclude that *tool designers have not correctly interpreted the meaning of weights in an additive value model*. This conclusion will be supported by our examination of other quotations contained in the weighting instructions in the tools.

In next two quotations a specific weighting procedure is presented:

Step 1. First, rank the different factors in the order of their *importance* for the company. This makes it easier to assess how reasonable the final weighting is according to step 2 below.

Step 2: Determine the weight of each factor and distribute them according to the main areas. (see Harriman and Holm, 2001, p. 13).

... to construct the weighting grid, it is necessary first to rank the factors and assign them a relative weight in terms of percentage (see Chicha 2008, p. 71).

The weighting instructions stated in the two quotations are similar to the weighting procedure described in the end of previous section in the sense that the weighting decision shall start with a ranking of the factors followed by assigning precise numerical weights to the scales. Note that the term “scales” or “scores” are not mentioned in the instructions.

The purpose of the ranking of the factors is, as argued by the tool designer, to make it easier to determine and assess if the final weighting is reasonable. But these instructions are obviously invalid. The instructions do not support the DMs in how to take compensatory basic pay setting decisions which should determine the weights assigned to the scales constructed in the job evaluation situation. This means that the DMs might assign weights to the scales without considering how the scales are constructed in the job evaluation situation and without considering the consequences of their weighting in terms of compensatory basic pay setting. This means that the DMs most likely will not be able to perform a critical reflection to what extent their weighting has a reasonable influence on the basic pay setting. This should be regarded as a defect of a weighting instruction since it does not support the DMs to take well considered weighting decisions.

It seems that the tool designers assume that the scaling and weighting procedure can be regarded as two independent decision procedures. Such weighting is in the MCDM literature named *direct rating*, which will comment on in the end of the paper.

We will end our assessment of the weighting instructions by comments on three further quotations as follows:

*Given that weighting has a direct effect on wages, it is essential that it be closely linked with the goals of the organisation and the type of work characterizing it [our emphasis] (see Chicha, 2008, p. 72).*

We agree with the tool designer that it seems reasonable that the argumentation for a certain weighting in a job evaluation situation should in some sense be linked to the goals and type of works of the organisation. However, it is confusing that the tool designer claims that this link is based on a presumption, as they say “Given that weighting has a direct effect on wages.” We find this presumption strange, since the meaning of weights in a job evaluation is actually to represent compensatory basic pay setting decisions as is explained in section two. This means that the weighting will, due to its very meaning in a job evaluation, have effects on wages in terms of basic pay settings of the jobs at a work place. The presumption stated in the quotation indicates, we think, that the tool designer makes a different interpretation of the weights than we make in this paper. They seem to believe that weights can represent importance of the factors, something which is, as we demonstrated above, not meaningful.

In the next quotation the tool designer claims that:

*In general, most experts agree on the following per centage [sic] ranges as approximate guidelines with regard to the relative importance of factors:*

20% to 35% for qualifications

25% to 40% for responsibility

15% to 25% for effort

5% to 15% for working conditions. (See Chicha 2008, p. 71.)

We have no reasons to claim that this agreement among experts is not true. But a correct interpretation of the weights as scaling constants gives rise to the question in what sense these agreements is of any interest. Even if the experts agree concerning what numerical weights should be assigned to the scales, they might of course come to realize that they deeply disagree concerning what compensatory basic pay setting that they find as reasonable. This might be the case because what compensatory basic pay setting decisions the weights will represent depends on how the scales are constructed in the specific job evaluation situation. Further, even if the scales would be defined in a similar way in two different job evaluation situations, there is no reason to expect that similar weights will be assigned to the scales. It might be the case that different wage policies have for good reasons been adopted at the two work places, which have an impact on the compensatory basic pay setting decisions and in turn on the weighting decisions. And given the presumption that similar scales have been defined in the two job evaluation

situations, different compensatory basic pay setting decisions will give rise to different weighting decisions.

We will end the assessment by discussing the following quotation.

For example: In a company which develops software programs a high weight will be assigned to the analytical skills criterion. In a day-care centre the responsibility for people criterion will be of utmost importance, in a public works enterprise responsibility for equipment will be one of the key factors (See Chicha, 2008, p. 72).

We agree with the tool designer that it seems intuitively plausible that analytical skills might in some sense be very important for a company which develops software programs. It might be important in the sense that if the staff, which develops software programs, is not sufficiently analytically skilled it would have a strong negative impact on the performance of the company. But, as we have pointed out above, even if a factor such as requirement of analytical skills is in some sense important for a company developing software programs, it does not imply that a high numerical weight should be assigned to the scale representing the ranking of the requirement levels of analytical skills related to the jobs. This can be demonstrated by the following example:

Assume that the factor 1 defines requirement of analytical skills and factor 2 defines requirement of responsibility. The DMs construct the scales as is common in job evaluation, i.e.

$$v_1(R_1^h) - v_1(R_1^l) = v_2(R_2^h) - v_2(R_2^l).$$

In the next stage the DMs assign weights to the scales such that  $w_1 < w_2$ , which implies that:

$$w_1 \cdot (v_1(R_1^h) - v_1(R_1^l)) < w_2 \cdot (v_2(R_2^h) - v_2(R_2^l)).$$

The DMs reason for this weighting decision is that the DMs assess that the difference between the lowest and highest level regarding requirement of analytical skills, denoted as

$$\Delta_1(R_1^h, R_1^l)$$

is negligible compared to the difference between the lowest and highest level regarding requirement of responsibility, denoted as

$$\Delta_2(R_2^h, R_2^l).$$

The DMs assess therefore that the difference  $\Delta_1(R_1^h, R_1^l)$  should have a relative low influence on the overall assessment and on the basic pay setting of the jobs compared to the difference  $\Delta_2(R_2^h, R_2^l)$ . The DMs express this assessment by the weighting decision stated above.

But it is, of course, still possible for the DMs to claim that analytical skills are in some sense very important for the software company. The example demonstrate that deciding about the importance of the factors and taking weighting decisions when additive value



models are applied in job evaluation are two conceptually distinct decision problems. But it seems that the tool designers of these three job evaluation tools are not aware of the distinction between those two decisions. This observation might be explained by the fact that the tool designers do not construct the job evaluation tool and the weighting instructions by means of an adequate theoretical frame work offered by MCDM.

#### Final comments about the assessment of the validity of the weighting instruction

The conclusion of our examination of the quotations presented above is that the meaning of weights are misinterpreted in the weighting instructions contained in the three studied job evaluation tools. We therefore conclude that the weighting instructions are not valid in the sense that they do not correctly inform and guide the DMs in a way such that they are able to take weighting decisions properly representing their believes about a reasonable compensatory basic pay setting at the workplace. This gives rise to the question how this kind of invalid weighting actually works when they are applied at work places.

However, to our knowledge no systematic studies of weighting decisions taken during gender-neutral job evaluations are found in the literature. But such invalid weighting procedures used in other types of multidimensional evaluation contexts have been extensively evaluated in multi-criteria decision making (MCDM). These methods are usually called *direct rating methods*. What is typical for such weighting procedures is that DMs directly rate in some sense the importance of the relevant factors. The direct rating method seems not to presume that DMs should consider how the scales are constructed in the decision situation. Obviously, these direct rating methods are similar to weighting procedures suggested in the three job evaluation tools studied above. So results of the evaluation of the direct rating method within MCDM are relevant for assessing weighting procedures used in gender-neutral job evaluation tools.<sup>10</sup> Belton and Stewart (2002, p. 289) summarise conclusions of these MCDM studies by means of a strong recommendation:

... avoid questions which involve the less well-defined notion of “importance” in the abstract, since these may generate highly misleading results if the intuitive notion of importance and the desired trade-off ratio do not coincide.

The expression “desired trade-off ratio” in the quotation corresponds in job evaluation, according to our interpretation above, to a desired compensatory basic pay setting. Based on this conclusion of the functioning of direct rating in multi-criteria decision procedures, we claim that research should to be directed toward developing valid weighting procedures for the use in gender-neutral job evaluations. Such research should be based on the extensive theoretical and empirical knowledge received from MCDM studies on weighting procedures in multidimensional decision and evaluation problems.

---

<sup>10</sup> In von Nitzsch and Weber (1993), Pöyhönen and Hämläinen (2001), Weber and Borcherding (1993) direct rating methods are evaluated and compared with other types of weighing procedures.

## 4. Conclusion

In this paper we have assessed the validity of weighting instructions contained in three gender-neutral job evaluation tools. The assessment started from our interpretation of the meaning of weights in additive value model. Considering the formal meaning of weights in additive value models we conclude that the weights will in job evaluation represent the DMs' compensatory basic pay setting decisions. This means that valid weighting instructions should provide a guidance and support for the DMs to take such compensatory basic pay setting decisions.

However, the outcome of our assessment is that the weighting instructions contained in three gender-neutral job evaluation tools do not support the DMs to take compensatory basic pay setting decisions. This means that the DMs will probably not understand the implication if their weighting regarding the basic pay setting of the jobs at the work place. This in turn means that it will hamper the DMs' possibility to reflect in a rational way upon the consequences of their weighting decisions in terms of basic pay setting of the jobs. The use of these kind of invalid weighting instruction seems therefore to hamper the aim of using gender-neutral job evaluation to achieve a rational and gender-neutral pay setting at the work places.

We think that the remedy of the problem is to develop valid weighting procedures which are based on the theoretical framework available within the research area of Multi-Criteria Decision Making. Besides the outcome of valid weighting instructions job evaluation tools constructed by means of a well-established scientific theoretical framework as Multi-Criteria Decision Making might improve the willingness of employers to use such tools to achieve a gender-neutral pay setting at work places. The problem today is surely not that employers think that gender-biased pay setting at work places is acceptable and for that reason are not willing to use job evaluation. The reluctance towards job evaluation among some employers might instead be explained by the fact that they have low confidence about the validity of the gender-neutral job evaluation tools constructed by job evaluation experts. Our findings presented in this paper gives support to such a view.

## References

- Armstrong, M., Cummins, A., Hastings, S. and Wood, W. (2003), *Job Evaluation – A Guide To Achieving Equal Pay*, Kogan Page, London.
- Belton, V. and Stewart, T.J. (2002), *Multiple criteria decision analysis: an integrated approach*, Kluwer Academic Publishers, Dordrecht.
- Chica, M.T. (2008), *Promoting equity: gender-neutral job evaluation for equal pay: a step-by-step guide*, International Labour Office, Geneva.
- Choo, E.U., Schoner, B. and Wedley, W. (1999), "Interpretation of criteria weights in multicriteria decision making", *Computers and Industrial Engineering*, Vol. 37, pp. 527-541.
- Corominas A., Coves, A.M., Lusa, A. and Martinez, C. (2008), "ISOS: a job evaluation system to implement comparable worth", *Intangible Capital*, Vol. 4 No. 1, pp. 8-28.
- Dyer, J. S. and Sarin, R.A. (1979), "Measurable multiattribute value functions", *Operations Research*, Vol. 22, pp. 810-822.
- England, P. (1999), "The case for comparable worth", *Quarterly Review of Economics and Finance*, Vol. 39, pp. 743-755.
- Fischer, G.W. (1995), "Range sensitivity of attribute weights in multiattribute value models", *Organisation, Behaviour and Human Decision Processes*, Vol. 62 No. 3, pp. 252-266.
- Harriman, A. and Holm, C. (2007), *Steps to Pay Equity*, Equal Opportunities Ombudsman, Stockholm.
- Keeney, R.L. and Raiffa, H. (1993), *Decision with multiple objectives*, Cambridge University Press.
- Killingsworth, M.R. (1987), "Heterogeneous preferences, compensating wage differentials, and comparable worth", *Quarterly Journal of Economics*, Vol. 102 No. 4, pp. 727-742.
- Pöyhönen, M. and Hämäläinen, R.P. (2001), "On the convergence of multiattribute weighting methods", *European Journal of Operational Research*, Vol. 129, pp. 569-585.
- Salo, A and Hämäläinen, R.P. (2001), "Preference Assessment by Imprecise Ratio Statements", *Transactions on System, Man and Cybernetics – Part A: System and Humans*, Vol. 31, pp. 533-545.
- Von Nitzsch, R. and Weber, M. (1993), "The effect of attribute ranges on weights in multiattribute utility measurements", *Management Science*, Vol. 39, pp. 937-943.
- Wakker, P. (1989), *Additive representations of preferences: a new foundation of decision analysis*, Kluwer Academic Publishers, Dordrecht.
- Weber, M. and Borcherding, K. (1993), "Behavioural influences on weight judgments in multiattribute decision making" *European Journal of Operational Research*, Vol. 6, pp. 1-12.

## Appendix: The meaning of weights in additive value models

The presence of “the most common mistake”, according to Keenye (1992), concerning the interpretation of the weighting in multi-criteria problems as in job evaluation might be explained by the fact that the scales in these additive value models represent the DMs’ *assessments* or *preferences* over various features of the items, which are to be evaluated and ranked. This means that scales are not explicitly related to any units as is the case for measures of various objective features such as weight, length, temperature. Because the formal meaning of weights in additive value models are to coordinate the scales it is very important that the DMs understand how the weights are related to the scales in an additive value model. We think this relationship can be explained by constructing an additive value model based on measurement scales. We try to explain this relationship by the following example.

We assume that DMs intend to construct a certain kind of Body Mass Index (BMI). The DMs decide to use an additive value model as follows:

$$(1) \quad BMI = w_1 \cdot Weight - w_2 \cdot Length.$$

We assume that the feature weight is measured in *kg* and the feature length is measured in *cm*. To use the BMI the DMs must at first assign weights to the scales. DMs decide to assign weights to scales as:

$$(2) \quad w_1 = 1 \quad \text{and} \quad w_2 = 0.2,$$

which means that the expression (1) can be expressed as:

$$(3) \quad BMI = 1 \cdot Weight - 0.2 \cdot Length.$$

The essential question now is how the weighting should be interpreted. However, from expression (3) it is easy to see the DMs’ weighting means that an increase of *one* kg, i.e.

$$\Delta Weight = 1 \text{ kg},$$

will be compensated for by (or balanced against) an increase in length of *five* centimeter, i.e.

$$\Delta Length = 5 \text{ cm},$$

such that the BMI does not change, i.e.

$$(4) \quad \Delta BMI = 1 \cdot \Delta Weight - 0.2 \cdot \Delta Length = 1 \cdot 1 \text{ kg} - 0.2 \cdot 5 \text{ cm} = 0.$$

The interpretation of the meaning the weights can also be clarified by a concrete example as follows. An individual *a* has the weight 84 kg and the length 170 cm and individual *b* has the weight 86 kg and the length 180 cm. As a result of the weighting of the scales the BMI defined in (3) or (4) implies that the two individuals receive the same BMI-value.

This result can be interpreted in terms of the compensatory weighting decision such that the difference between the individuals regarding the weight, i.e.  $\Delta Weight = 2$  kg, is compensated for by the difference regarding length, i.e.  $\Delta Length = 10$  cm, such that both individuals receive equal BMI-value.

From this example we can draw the following conclusions. In the *first* place, it would obviously not be possible for the DMs to take this kind of compensatory weighting decision if they would not know the unit of the measures of the features weight and length. The same presumption has to be fulfilled in job evaluation, i.e. the DMs have to know how the scales are constructed.

*Secondly*, it is easy to realize that if the unit of the scales would change, i.e. if any of the scales are transformed, the DMs have to adjust the weights. For example, if the DMs would prefer to measure the feature length in the unit inch means that the compensating relation stated in (4) has to be expressed as:

$$(5) \quad \Delta BMI = 1 \cdot \Delta Weight \text{ (kg)} - 0.5 \cdot \Delta Length \text{ (inch)} = 0.$$

In expression (5) the weight  $w_2 = 0.2$  stated in (4) has been adjusted to the weight  $w_2 = 0.5$  when the length is measured in the unit inch instead of the unit centimeter.<sup>11</sup>

The expression (5) implies that one unit increase in the feature weight, i.e.

$\Delta Weight = 1$  kg, has to be compensated for by the increase  $\Delta Length = 2$  inches in order to be consistent with the compensation stated in (4) corresponding to  $\Delta Length = 5$  cm. As the example demonstrates if any of the scales are transformed it might be necessary to adjust the weights. This means the weighting cannot be regarded as independent of how the scales are constructed. Note that this seems to be assumed in the job evaluation tools analyzed in section 3.

*Finally*, in analogy to the statement in the three job evaluation tools we assume that the DMs interpret their weighting as representing their believe about the relative importance of the features weight and length regarding the ranking of individuals with respect to the body mass. This means that their weighting stated in (4), expressed as the ratio

$$(6) \quad \frac{w_1}{w_2} = \frac{1}{0.2} = 5,$$

would imply that the importance of the feature weight is five times as important as the feature length regarding the assessment of the body mass of the individuals. But this numerical statement about the relative importance is obviously not meaningful since its truth value changes due to permitted transformations of the scales in the additive value model. As we noted, if the feature length is measured in the unit *inch* the weights have to be adjusted, as stated in expression (5), such that the ratio is

$$(7) \quad \frac{w_1}{w_2} = \frac{1}{0.5} = 2,$$

---

<sup>11</sup> We use the approximation that one inch is equal to 2.5 cm.

which means that the feature weight now only would be *two* times as important as the feature length regarding the assessment of individuals' body mass. But the relative importance cannot reasonably depend on a decision that the DMs prefer to measure the feature length in the unit inch instead of the unit centimeter. This means that the notion relative importance should not be confused with the weights in an additive value model. Given the unit of the scales the weights will represent a compensatory or tradeoff relation as expressed in (4) or (5) between the features that are relevant for the overall assessment of the items in a multi-criteria decision problem.

## Working Paper Series:

45. Proofs of Derivations in Memory Polynomial Baseband Modeling of RF Power Amplifiers. Per N. Landin, Kurt Barbé, Wendy Van Moer, Magnus Isaksson and Peter Händel. Department of Electronics, Mathematics and Natural Sciences. 2011.
46. Odd and Odd-Even Memory Polynomial Representations. Per N. Landin and Daniel Rönnow. Department of Electronics, Mathematics and Natural Sciences. 2013.
47. Svensk avfallshantering. Diskussion kring dagsläget och branschens forskningsbehov. Ola Eriksson & Johanna Jönsson Eriksson. Avdelningen för bygg- energi- och miljöteknik. 2013.
48. 48. Biogas i Gästrikeregionen – BiG. En systemanalys. Ola Eriksson & Teresa Hermansson. Avdelningen för bygg- energi- och miljöteknik. 2013.
49. Hållbar konsumtion och hållbar avfallshantering – vad är det? Ola Eriksson & Teresa Hermansson. Avdelningen för bygg- energi- och miljöteknik. 2013.
50. Regional avfallsplanering Slutrapport frånprojekt finansierat av Forskningsstiftelsen Gästrikeregionens Miljö. Ola Norrman Eriksson & Teresa Hermansson. Avdelningen för bygg- energi- och miljöteknik. 2013.
51. Avfallsprevention i stålindustrin. Exempel från Sandvik Materials Technology. Ola Eriksson & Teresa Hermansson. Avdelningen för bygg- energi- och miljöteknik. 2013.
52. Perspektiv på biogas. En antologi om biogas som drivmedel med fokus på teknik, miljöpåverkan och samhällsnytta. Ola Eriksson. Avdelningen för bygg- energi- och miljöteknik. 2013.
53. Materialåtervinning och klimatnytta Hur räknar återvinningsaktörer i Sverige? Karl Hillman. Avdelningen för bygg-, energi- och miljöteknik. 2013.
54. Invalid weighting in gender-neutral job evaluation tools. Stig Blomskog. Department of Industrial Development, IT and Land Management. 2016.

**Published by:**  
Gävle University Press  
University of Gävle

January 2016



**Postal address:** SE-801 76 Gävle, Sweden  
**Visiting address:** Kungsbäcksvägen 47  
**Telephone:** +46 26 64 85 00  
[www.hig.se](http://www.hig.se)