

# Application of intercriteria analysis in the finance and accountancy positions

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**Abstract:** In the paper application of the InterCriteria analysis (ICA) approach to data about position specific benchmarks in finance and accountancy sectors in Poland is represented. The aim is to analyse the correlations between the salary benchmarks for compensation model and find the dependencies between the positions (Finance Director, Finance Manager, Chef Accountant) in eight towns in Poland (Warsaw, Wroclaw, Lodz, Gdansk, Szczecin, Katowice, Krakow, Poznan).

**Keywords:** InterCriteria analysis, Compensation model, Intuitionistic fuzzy sets, Index matrix, Multicriteria decision making.

**AMS Classification:** 03E72.

## 1 Introduction

In this paper an application of the ICA approach in the bank sector is presented. The investigation is the next of serial research works for analyzing some of the banking activities [11, 12, 13]. The purpose of the development is to identify the most correlated criteria in the position specific benchmarks in the finance and accountancy sectors. In the current investigation we analyze the data over the period 2012–2014. By applying the ICA approach over of salary benchmarks and constraints for compensation model we can observe the behavior of the criteria over the time, the

most dependent criteria, the opposite criteria or criteria that frequently are independent from each other.

The compensation model as presented in [12] is heavily dependent on the quality of salary benchmarks and constraints selected to assist in management decision making. Our application of ICA approach is to find a better way of identifying relationships between data for the input benchmarks and to be able to correctly select external constraints used in the compensation model design.

## 2 Presentation of InterCriteria Analysis method

The InterCriteria analysis approach is introduced in [3]. The method is based on two mathematical formalisms - theory of intuitionistic fuzzy sets and theory of index matrices. Intuitionistic fuzzy sets were first defined by Atanassov [4, 5] as an extension of the concept of fuzzy sets defined by L. Zadeh [14]. The theory of index matrices was introduced in [1].

The ICA method estimates the objects on the base of several criteria. The number of the criteria can be reduced by taking into account the correlations of each pair of criteria presented in the form of intuitionistic fuzzy pairs of values [4]. The intuitionistic fuzzy pairs of values are the intuitionistic fuzzy evaluations in the interval  $[0, 1]$ . The relations can be established between any two groups of indicators  $C_w$  and  $C_l$ .

In the current research the ICA approach is used to discover the correlations between the salary benchmarks for compensation model and to find the dependencies between the positions Finance Director, Finance Manager, Chef Accountant and salary in eight towns in Poland: Warsaw, Wroclaw, Lodz, Gdansk, Szczecin, Katowice, Krakow and Poznan.

Let us have a number of  $C_q$  group of criteria (salary in towns),  $q = 1, \dots, n$ , and a number of  $O_p$  objects (positions),  $p = 1, \dots, m$ . So we use the following sets: a set of group of criteria  $C_q = \{C_1, \dots, C_n\}$  and a set of objects  $O_p = \{O_1, \dots, O_m\}$ .

We obtain an index matrix  $M$  that contains two sets of indices, one for rows and another for columns. For every  $p, q$  ( $1 \leq p \leq m, 1 \leq q \leq n$ ),  $O_p$  in an evaluated object,  $C_q$  is an evaluation criterion, and  $a_{O_p, C_q}$  is the evaluation of the  $p$ -th object against the  $q$ -th criterion, defined as a real number or another object that is comparable according to relation  $R$  with all the rest elements of the index matrix  $M$ .

$$M = \begin{array}{c|cccccc} & C_1 & \dots & C_k & \dots & C_l & \dots & C_n \\ \hline O_1 & a_{O_1, C_1} & \dots & a_{O_1, C_k} & \dots & a_{O_1, C_l} & \dots & a_{O_1, C_n} \\ \dots & \dots \\ O_i & a_{O_i, C_1} & \dots & a_{O_i, C_k} & \dots & a_{O_i, C_l} & \dots & a_{O_i, C_n} \\ \dots & \dots \\ O_j & a_{O_j, C_1} & \dots & a_{O_j, C_k} & \dots & a_{O_j, C_l} & \dots & a_{O_j, C_n} \\ \dots & \dots \\ O_m & a_{O_m, C_1} & & a_{O_m, C_k} & & a_{O_m, C_l} & \dots & a_{O_m, C_n} \end{array} .$$

The next step is to apply the InterCriteria Analysis for calculating the evaluations. The result is a new index matrix  $M^*$  with intuitionistic fuzzy pairs  $\langle \mu_{C_k, C_l}, \nu_{C_k, C_l} \rangle$  that represents an intuitionistic fuzzy evaluation of the relations between every pair of criteria  $C_k$  and  $C_l$ . In this way the index matrix  $M$  that relates the evaluated objects with the evaluating criteria can be transformed to another index matrix  $M^*$  that gives the relations among the criteria:

$$M^* = \begin{array}{c|ccc} & C_1 & \dots & C_n \\ \hline C_1 & \langle \mu_{C_1, C_1}, \nu_{C_1, C_1} \rangle & \dots & \langle \mu_{C_1, C_n}, \nu_{C_1, C_n} \rangle \\ \dots & \dots & \dots & \dots \\ C_n & \langle \mu_{C_n, C_1}, \nu_{C_n, C_1} \rangle & \dots & \langle \mu_{C_n, C_n}, \nu_{C_n, C_n} \rangle \end{array}$$

<i>Degrees of Correlation</i>	<i>Type of consonance</i>
[0; 0,05]	Strong Negative Consonance (SNC)
[0,05; 0,15)	Negative Consonance (NC)
[0,15; 0,25)	Weak Negative Consonance (WNC)
[0,25; 0,33)	Weak Dissonance (WD)
[0,33; 0,43)	Dissonance (D)
[0,43; 0,57)	Strong Dissonance (SD)
[0,57; 0,67)	Dissonance (D)
[0,67; 0,75)	Weak Dissonance (WD)
[0,75; 0,85)	Weak Positive Consonance (WPC)
[0,85; 0,95)	Positive Consonance (PC)
[0,95; 1]	Strong Positive Consonance (SPC)

Table 1. Correlations between the criteria

The last step of the algorithm is to determine the degrees of correlation between the criteria using the scale presented in Table 1. The correlations between the criteria are called “strong positive consonance”, “positive consonance”, “weak positive consonance”, “weak dissonance”, “dissonance”, “strong dissonance”, “weak negative consonance”, “strong negative consonance” or “negative consonance” [2].

Several extensions applications of the InterCriteria Decision Making Approach to EU Member States Competitiveness Analysis have been already published [6, 7, 8, 9, 10].

### 3 Applying ICA Approach

We have decided to apply the ICA analysis to three annual salary surveys performed with the same methodology for the same sets of positions and for the same cities [15]. In this analysis we want to understand the relationships between salaries for the same harmonized positions, with same responsibilities: Finance Director, Finance Manager and Chief Accountant, and between eight large cities in Poland. Our use of ICA analysis is to discover hidden patterns in salary level trends and relationships between cities and positions.

### 3.1 Applying ICA approach over the data for salary according to positions for discovering the relationships between the towns in Poland

The number of the pairs of criteria and the type of their consonances after applying ICA Approach over salary depending from position specific benchmarks in the finance and accountancy sectors are presented in the Table 2.

<i>Degrees of Correlation</i>		Salary, lower band	Salary, upper band
[0,33; 0,43)	D	1	
[0,43; 0,57)	SD	3	
[0,57; 0,67)	D	11	
[0,67; 0,75)	WD	3	
[0,75; 0,85)	WPC	6	8
[0,85; 0,95)	PC	4	6
[0,95; 1]	SPC		2

Table 2. Number of pairs of criteria

In the case of the ICA method we are interested in the towns that are in positive consonance. The pairs of criteria for upper band of the salary belong to the groups of weak positive consonance, positive consonance or strong positive consonance. The pairs of criteria for lower band of the salary belong to the groups of strong dissonance, dissonance, weak dissonance, weak positive consonance or positive consonance.

The pairs of criteria in weak positive consonance, positive consonance and strong positive consonance for salary lower band and salary upper bound are shown in Table 3.

<i>Degrees of Correlation</i>		<i>Salary, lower band</i>	<i>Salary, upper band</i>	
[0,75; 0,85)	WPC	Lodz - Gdansk Lodz - Katowice Lodz - Poznan Gdansk - Poznan Szczecin - Katowice Warsaw - Wroclaw	Wroclaw - Gdansk Wroclaw - Katowice Wroclaw - Poznan Gdansk - Krakow	Katowice - Krakow Krakow - Poznan Warsaw - Katowice Warsaw - Poznan
[0,85; 0,95)	PC	Lodz - Szczecin Gdansk - Szczecin Szczecin - Poznan Katowice - Poznan	Lodz - Gdansk Lodz - Katowice Lodz - Poznan Gdansk - Szczecin Szczecin - Katowice Szczecin - Poznan Warsaw - Wroclaw Warsaw - Krakow Wroclaw - Lodz	Wroclaw - Szczecin Lodz - Krakow Szczecin - Krakow Warsaw - Lodz Warsaw - Szczecin Gdansk - Katowice Gdansk - Poznan Katowice - Poznan Warsaw - Gdansk
[0,95; 1]	SPC		Wroclaw - Krakow	Lodz - Szczecin

Table 3. Pairs of criteria

### 3.2. Applying ICA approach over the data for salary in the towns for discovering the relationships between positions

The second investigation in the current research work presents an application of ICA approach to discover the relationships between the positions Finance Director, Finance Manager, Chef Accountant for years 2012, 2013, 2014. This observation can present the positions with similar salaries in the different towns in Poland (Warsaw, Wroclaw, Lodz, Gdansk, Szczecin, Kato-wice, Krakow, Poznan). The number of pairs of positions and their correlation are presented in the Table 4. The pairs of positions and their correlation are presented in the Table 5.

	<i>Degrees of Correlation</i>			
	<b>SPC, [0,95; 1]</b>	<b>WPC, [0,75; 0,85)</b>	<b>WD, [0,67; 0,75)</b>	<b>D, [0,57; 0,67)</b>
<i>Position</i>	5	15	3	6

Table 4. Number of pairs of criteria

<i>Degrees of Correlation</i>	<i>Correlation between positions over the years</i>
<b>SPC, [0,95; 1]</b>	Finance Director 2013 - Finance Manager 2013 Chef Accountant 2013 - Chef Accountant 2012 Chef Accountant 2014 - Chef Accountant 2013 Chef Accountant 2014 - Chef Accountant 2012
<b>WPC, [0,75; 0,85)</b>	Finance Director 2013 - Chef Accountant 2013 Finance Director 2013 - Chef Accountant 2012 Finance Manager 2013 - Chef Accountant 2013 Finance Manager 2013 - Chef Accountant 2012 Finance Director 2014 - Finance Director 2013 Finance Director 2014 - Finance Manager 2013 Finance Director 2014 - Chef Accountant 2013 Finance Director 2014 - Chef Accountant 2012 Finance Director 2014 - Chef Accountant 2014 Finance Director 2013 - Chef Accountant 2014 Finance Manager 2013 - Chef Accountant 2014 Finance Director 2012 - Chef Accountant 2014 Finance Director 2012 - Chef Accountant 2013 Finance Director 2012 - Chef Accountant 2012 Finance Director 2014 - Finance Director 2012
<b>WD, [0,67; 0,75)</b>	Finance Director 2013 - Finance Director 2012 Finance Director 2012 - Finance Manager 2013 Finance Director 2012 - Finance Manager 2014
<b>D, [0,57; 0,67)</b>	Finance Manager 2014 - Chef Accountant 2014 Finance Director 2013 - Finance Manager 2014 Finance Manager 2014 - Finance Manager 2013 Finance Manager 2014 - Chef Accountant 2013 Finance Manager 2014 - Chef Accountant 2012 Finance Director 2014 - Finance Manager 2014

Table 5. Pairs of criteria

## **4 Analysis of the results for the period of research (2012-2014)**

Via the comparison of the results from the first application of ICA approach during the period of research (2012–2014) the following outcomes are obtained:

- 1) From the obtained results it is seen that there is high level of dependences between the criteria for upper bound of the salary in the towns of the observation - the correlations between them are in “weak positive consonance”, “positive consonance” or “strong positive consonance”;
- 2) There is no strong dependences between the criteria for lower bound of the salary in the towns of the observation - the correlations between them are in “strong dissonance”, “dissonance”, “weak dissonance”, “weak positive consonance” or “positive consonance”;
- 3) The pairs of criteria “Gdansk–Szczecin”, “Szczecin–Poznan” and “Katowice–Poznan” do not change their behavior in time. They are in positive consonance during the period of research (2012–2014);
- 4) The dependence between pair of criteria “Lodz–Szczecin” increases from positive consonance (for lower bound of the salary) to strong positive consonance (for upper bound of the salary);
- 5) The dependences between pairs of criteria “Lodz–Gdansk”, “Lodz–Katowice”, “Lodz–Poznan”, “Gdansk–Poznan”, “Szczecin–Katowice” and “Warsaw–Wroclaw” increase from weak positive consonance (for lower bound of the salary) to positive consonance (for upper bound of the salary).

Via the comparison of the results from the second application of ICA method during the period of research (2012–2014) the following outcomes are obtained:

- 1) There is strong dependences between criteria “Chef Accountant 2012”–“Chef Accountant 2013” –“Chef Accountant 2014” (they are in strong positive consonance);
- 2) The correlations between position “Finance Director” and “Chef Accountant” over the period of the investigation is constant. They are in positive consonance;
- 3) The criterion “Finance Director 2012” is in wake dissonance with “Finance Manager” over the year.

## **5 Conclusion**

In the current research the ICA method for discovering some hidden patterns in the data using salary benchmarks and constraints for compensation model was used. Via the ICA approach the best correlations between the groups of criteria and dependent and independent group of criteria and the relationships between them were identified.

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