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A Company Improvement Analysis using the AHP/ANP Methods and the Modern Technology

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ABSTRACT

This paper has as a goal the application of the modern technology (the "SuperDecisions" software) for the analysis of the factors that determine a company improvement and the determination of the priorities of the methods that the company management might consider in order to improve the company activity. Having as a point of start the analysis obtained using the AHP ("Analytic Hierarchy Process") and the ANP ("Analytic Network Process") methods through numerical methods, this work underlines the equality of the results provided by these two different ways of solving the problem and the way in which the modern technology changes the working environment for the AHP/ANP applications.

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1. Introduction

The modern technology and the commercial software available nowadays are offering to the user a way of solving the problems that is very close to an environment that is familiar to the young students, researchers, et al. SuperDecisions is one of this software programs. It translates the AHP ("Analytical Hierarchy Process") and the ANP ("Analytic Network Process") methods (Neagu, 2016, 2017) into a modern environment.

A great number of research works that are using the SuperDecisions software are encountered in the scientific literature, while their domains of study vary as follows:

- education (Aragoné-Beltrán, 2017; Gibney, 2007);
- industry (Hasan et al, 2012; Akyildiz et al., 2014; Milani et al, 2013; Aljurais et al., 2016; Mu et al., 2016; Önüt et al., 2008);
- energy sector (Aragonés-Beltrán et al, 2014; Xu and Chan, 2013; Canemmit et al, 2014; Atmaca and Basar, 2012);
- transportation (Ivanovíc, 2013);
- decision-making process (De Ambroggi and Trucco, 2011; Hallikainen et a;, 2009; Keramati and Salehi, 2013; Burnaz and Topcu, 2011).

This paper uses the analysis of Istrate et al. (2018) regarding a company activity improvement and translates it into the SuperDecisions environment. The results obtained show not only the equivalence of the two methods of solving the problem, but also the modern application of the AHP/ANP methods.

2. The problem formulation

2.1. The problem decomposition

An analysis realized by the leaders of a company (a company considered here as an example) underlines the objective of the study ("Company activity improvement"), the criteria ("Management", "Human Resources", "Acquisitions" and "IT") and the subcriteria as they are revealed by Table 1: "Acquisitions plan" and "Tenders", "Employment criteria" and "Personnel training", "Software" and "Software Usage", "Decisions" and "Tasks". Table 1 presents, also, the improvement methods that the analysis team considers as being appropriate for the company activity improvement: "Competence", "Economy", "Education", "Efficiency", "Evaluation", "Finance" and "Training".

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Table 1. The criteria, the subcriteria and the methods of a company activity improvement.

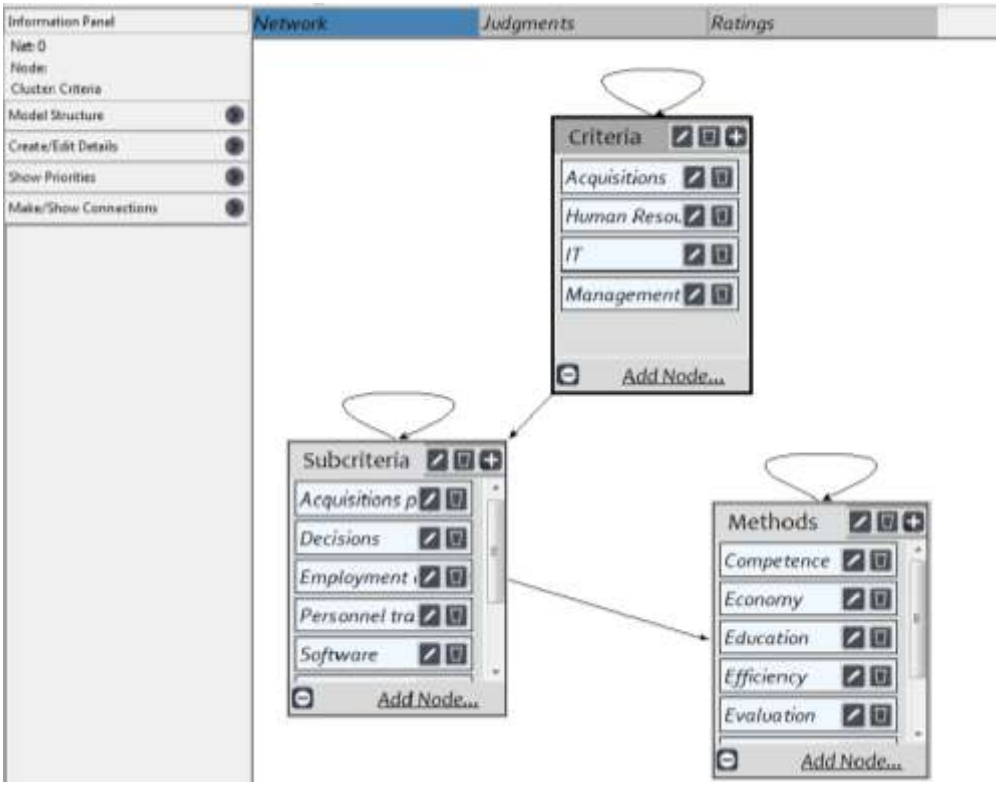
Objective	Company activity improvement						
Criteria	Acquisitions		Human resources		IT		Management
Subcriteria	Acquisitions plan		Employment criteria		Software		Decisions
	Tenders		Personel training		Software usage		Tasks
Methods	Competence	Economy	Education	Efficiency	Evaluation	Finance	Training

If the "Objective"→"Criteria"→"Subcriteria" part of the analysis requires the application of the AHP method, the "Subcriteria"→"Methods" part requires the ANP method application due to the inner dependencies of the "Subcriteria" and the "Methods" components. The simultaneous application of the AHP and the ANP methods conducts us to an original application of the steps that these methods require (Neagu, 2016, 2017).

2.2. The clusters and the nodes definition

Figure 1 presents the clusters and the nodes of the SuperDecisions program that is developed here in order to solve the problem. There are three clusters: "Criteria", "Subcriteria" and "Methods". The cluster "Criteria" contains four nodes (a node for each criterion), the cluster "Subcriteria" contains eight nodes (a node for each subcriterion), while the cluster "Methods" contains seven nodes (a node for each method).

Figure 1. The clusters and the nodes of the SuperDecisions program for a company activity improvement

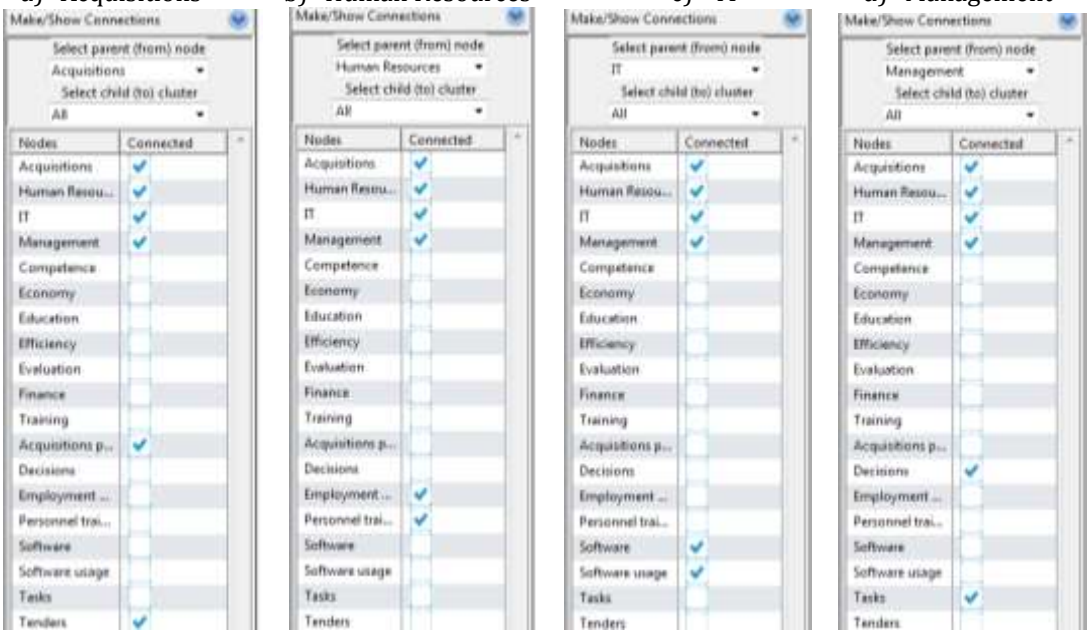


2.3. The connections definitions

Figure 2 shows the connections of the "Criteria" nodes: "Acquisition" (Figure 2a), "Human Resources" (Figure 2b), "IT" (Figure 2c) and "Management" (Figure 2d).

Figure 2. The connections of the "Criteria" cluster nodes

a) "Acquisitions" b) "Human Resources" c) " IT" d) "Management"

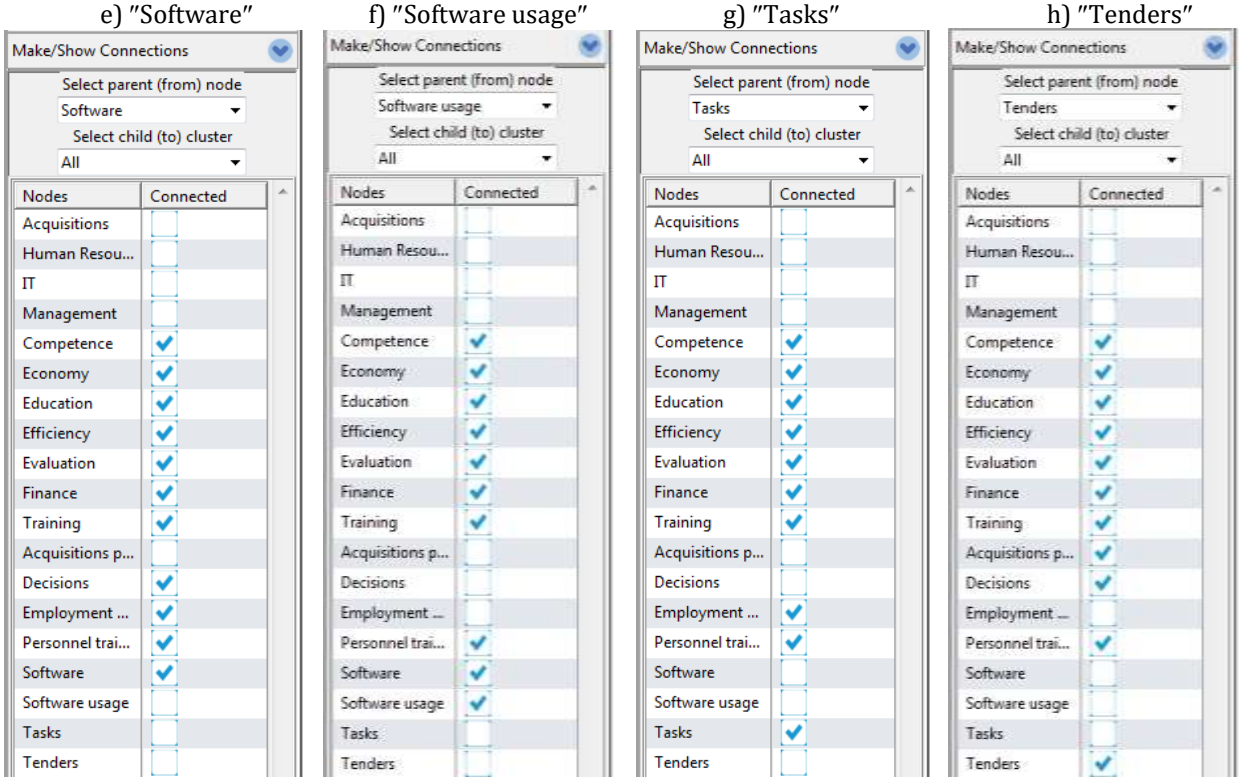


Successively, the connections in the "Subcriteria" cluster are defined by Figure 3 for the nodes: "Acquisitions plan" (Figure 3a), "Decisions" (Figure 3b), "Employment criteria" (Figure 3c), "Personnel training" (Figure 3d), "Software" (Figure 3e), "Software usage" (Figure 3f), "Task" (Figure 3g) and "Tenders" (Figure 3h).

Figure 3. The connections of the nodes in the "Subcriteria" cluster

a) "Acquisitions plan" b) "Decisions" c) "Employment criteria" d) "Personnel training"

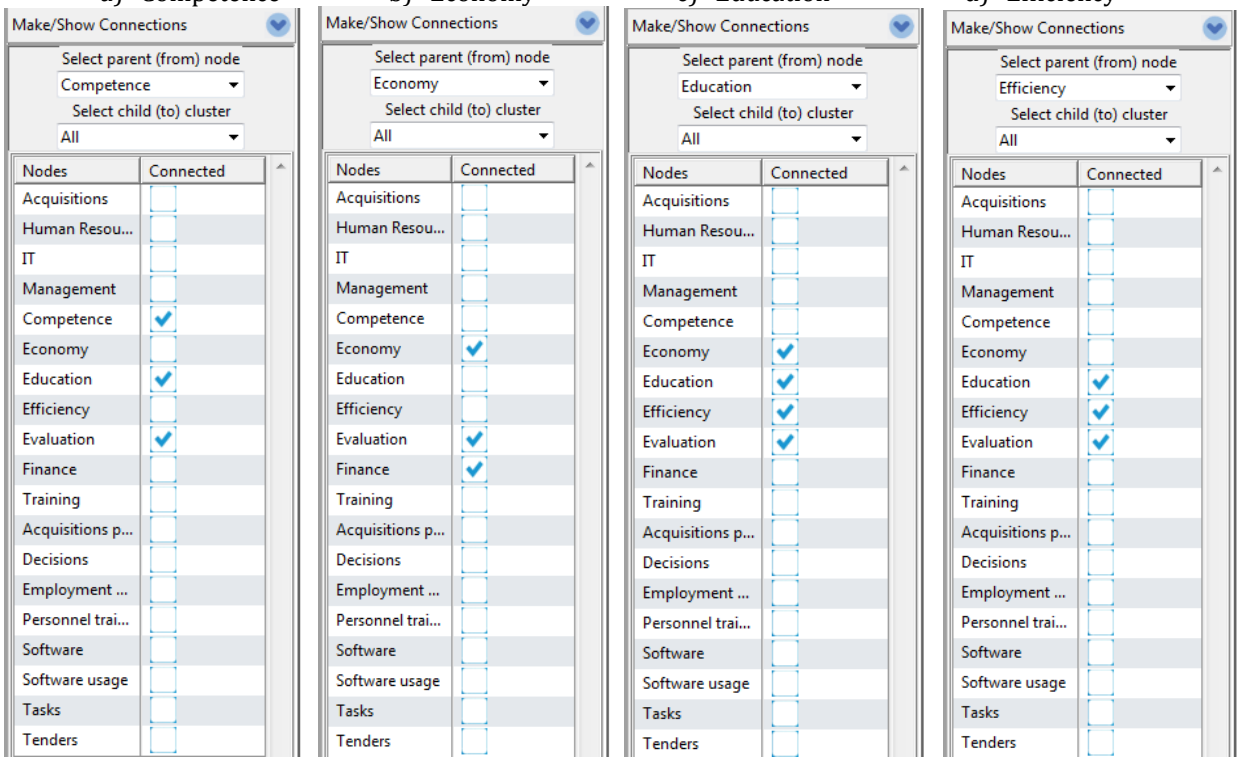
e) "Software" f) "Software usage" g) "Tasks" h) "Tenders"



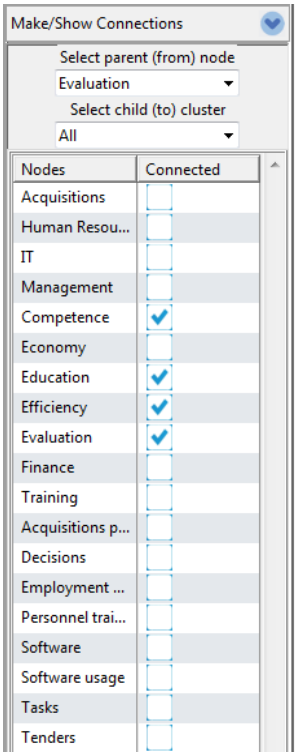
The nodes of the "Methods" cluster are inter-connected as Figure 4 reveals for the nodes "Competence" (Figure 4a), "Economy" (Figure 4b), "Education" (Figure 4c), "Efficiency" (Figure 4d), "Evaluation" (Figure 4e), "Finance" (Figure 4f) and "Training" (Figure 4g).

Figure 4. The connections of the nodes in the "Methods" cluster

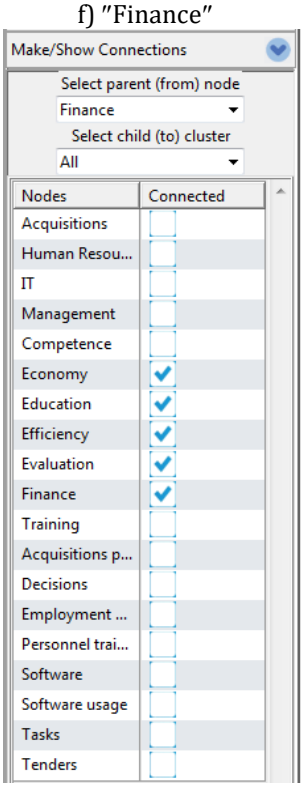
a) "Competence" b) "Economy" c) "Education" d) "Efficiency"



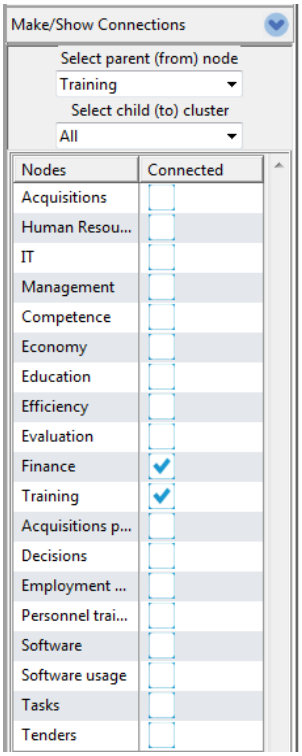
e) "Evaluation"



f) "Finance"



g) "Training"



3. The matrices of comparison constructions

After the connections are defined, we build the matrices of comparison, in the "Judgments" section of the software window, by choosing carefully in the left side (the "1. Choose" section) the node and the cluster.

Having in view the particularities of this problem, the six steps of the ANP method (Neagu, 2017) will guide further the process.

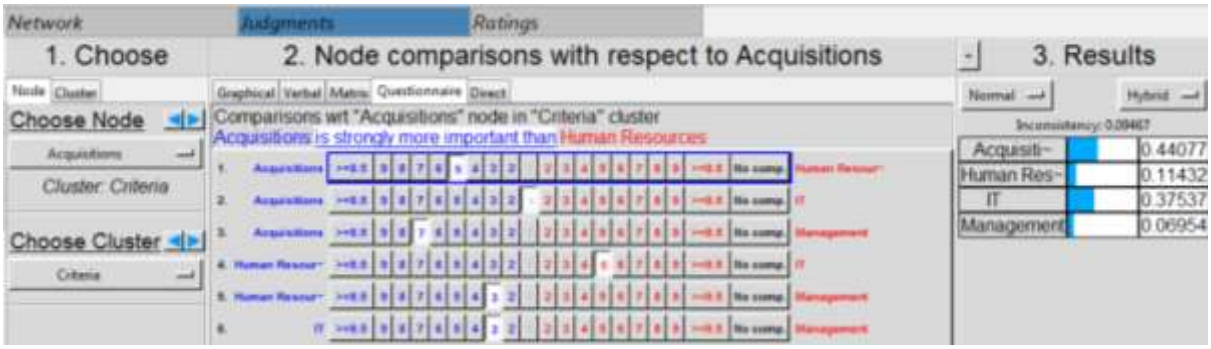
Step 1. The identification of the subcriteria and the methods. They have already been presented.

Step 2. The weights of the subcriteria. Here, we choose the node "Acquisitions" and the cluster "Criteria" and we answer the questionnaire in the central section of the window (see Figure 5) according to Table 2.

Table 2. The matrix of comparison and the weights of the criteria (Istrate et al., 2018)

	Acquisitions	Human resources	IT	Management	Weight
Acquisitions	1	5	1	7	0.4407
Human resources	1/5	1	1/5	3	0.1167
IT	1	5	1	3	0.3693
Management	1/7	1/3	1/3	1	0.0733

Figure 5. The numerical comparison of the criteria



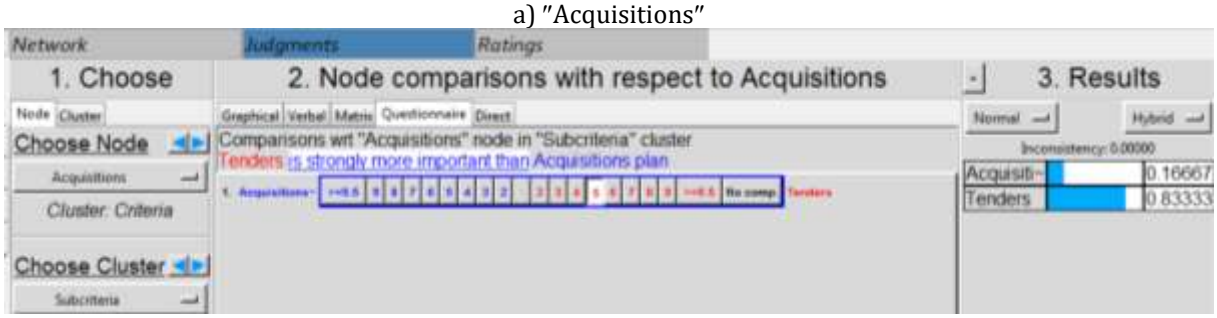
In the "3. Results" section, in the right side of the window, we notice that the criteria weights are the same as the values obtained in the Table 2 Similarly, keeping the same cluster, but changing successively the node: "Human resources", "IT" and "Management", we establish the inner dependence of all the nodes in the "Criteria" cluster.

The inconsistency of the answers is mentioned above the weights table allowing us to see instantly its value and to check that it is smaller than 10% as the AHP/ANP methods require.

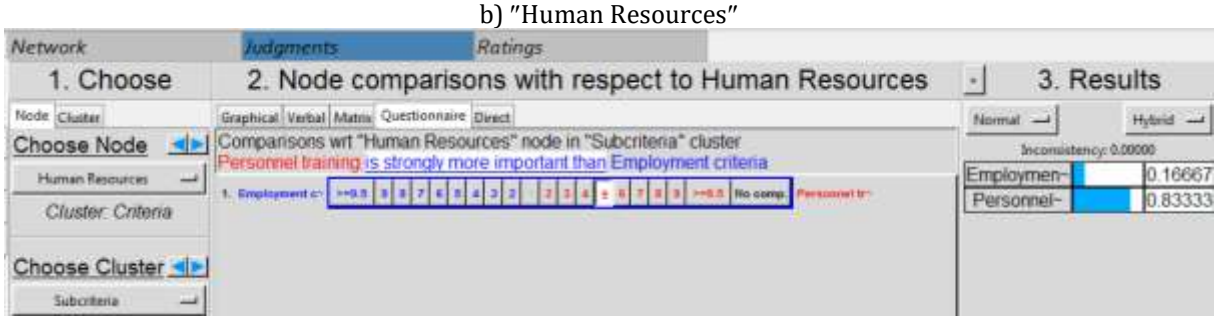
The inner dependencies of the subcriteria are determined by choosing successively the nodes "Acquisitions" (Figure 6a), "Human resources" (Figure 6b), "IT" (Figure 6c) and "Management" (Figure 6d) and the cluster "Subcriteria". In the right window, the local weights reproduce the results of Tables 4÷8 of Istrate et al. (2018).

Figure 6. The numerical comparison of the subcriteria for the criteria nodes.

a) "Acquisitions"



b) "Human Resources"



c) "IT"

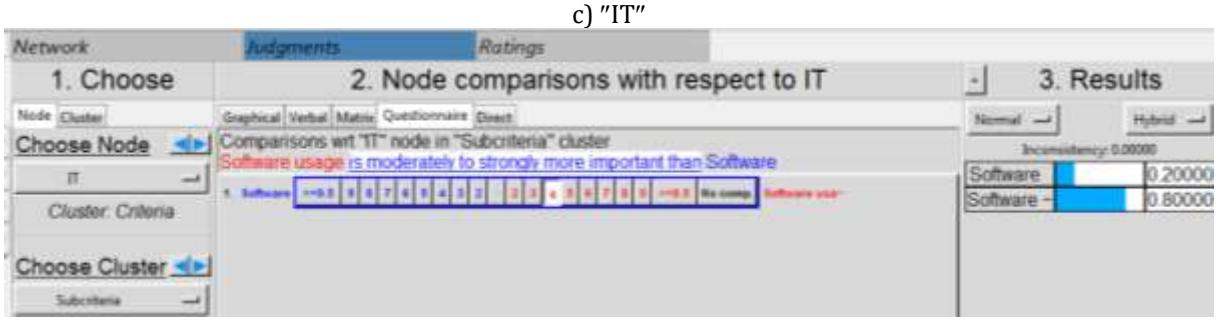


Figure 6. The numerical comparison of the subcriteria for the criteria nodes. d) "Management"

Step 3. The weights of the methods for each subcriterion

For each subcriterion, Figure 7 presents the questionnaire that compares the methods. For the nodes "Acquisitions plan" (Figure 7a), "Decisions" (Figure 7b), "Employment criteria" (Figure 7c), "Personnel

training" (Figure 7d), "Software" (Figure 7e), "Software usage" (Figure 7f), "Tasks" (Figure 7g) and "Tenders" (Figure 7h), the methods priorities are determined using the Tables 12÷19 of Istrate et al. (2018). As an example, Table 3 is translated using the SuperDecision software and it takes the form of Figure 7a.

Table 3. The measures comparison matrix for the "Acquisitions plan" subcriterion (Istrate et al., 2018)

Measures	Competence	Economy	Education	Efficiency	Evaluation	Finance	Training	Weight
Competence	1	3	1/2	3	5	1/2	1	0.1737
Economy	1/3	1	1/3	1/2	1/3	1/3	1	0.0633
Education	2	3	1	3	2	1/2	2	0.1953
Efficiency	1/3	2	1/6	1	1/2	1/6	1	0.0708
Evaluation	1/5	3	1/5	2	1	1/5	1	0.0965
Finance	2	3	2	6	5	1	2	0.3002
Training	1	1	1/2	1	1	1/2	1	0.1000

Figure 7. The numerical comparison of the methods for each subcriterion.

a) "Acquisition plan"

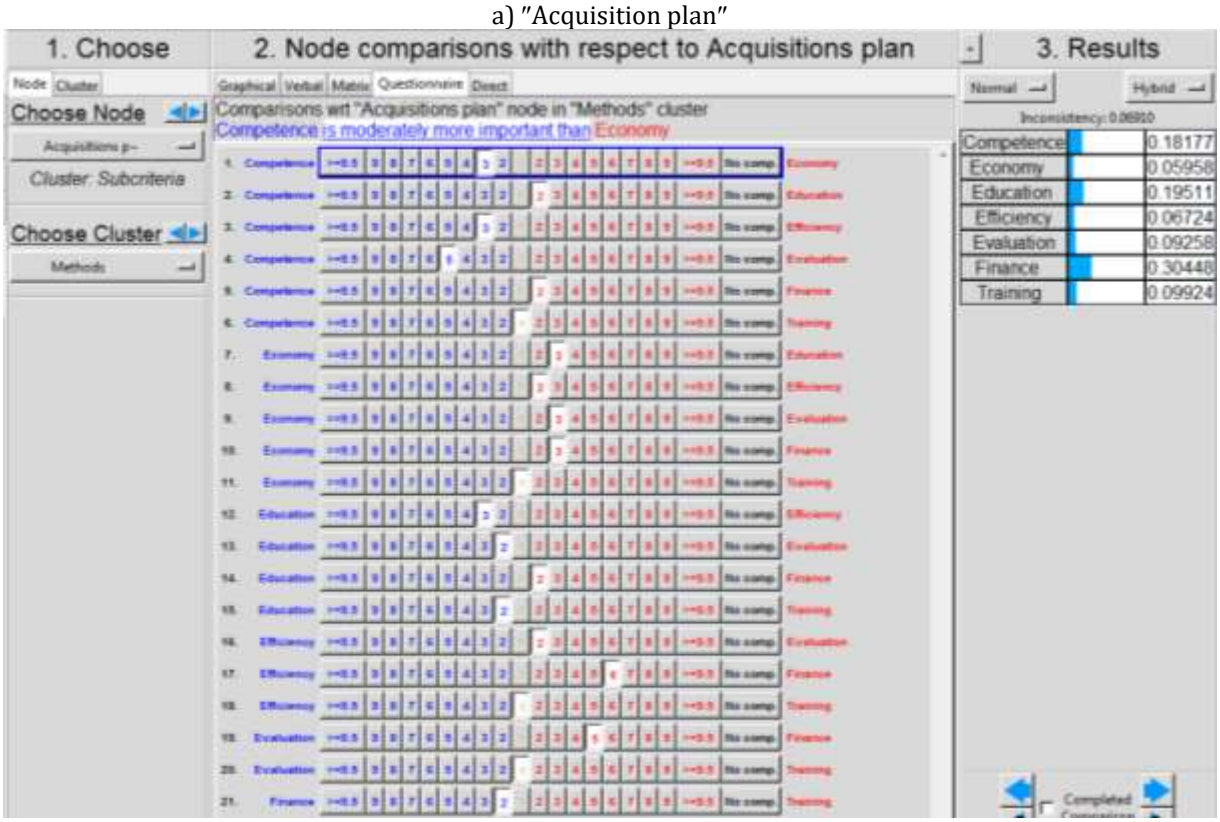
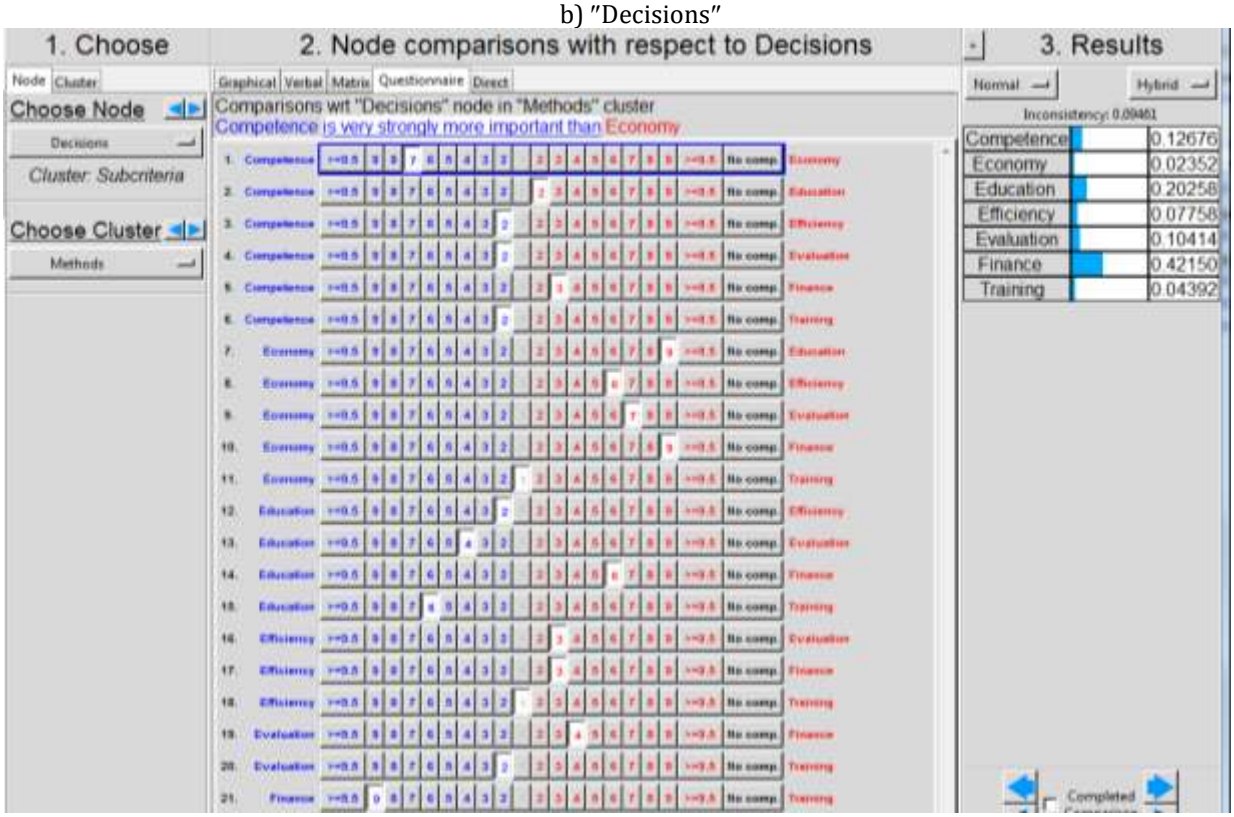


Figure 7. The numerical comparison of the methods for each subcriterion. (continued)

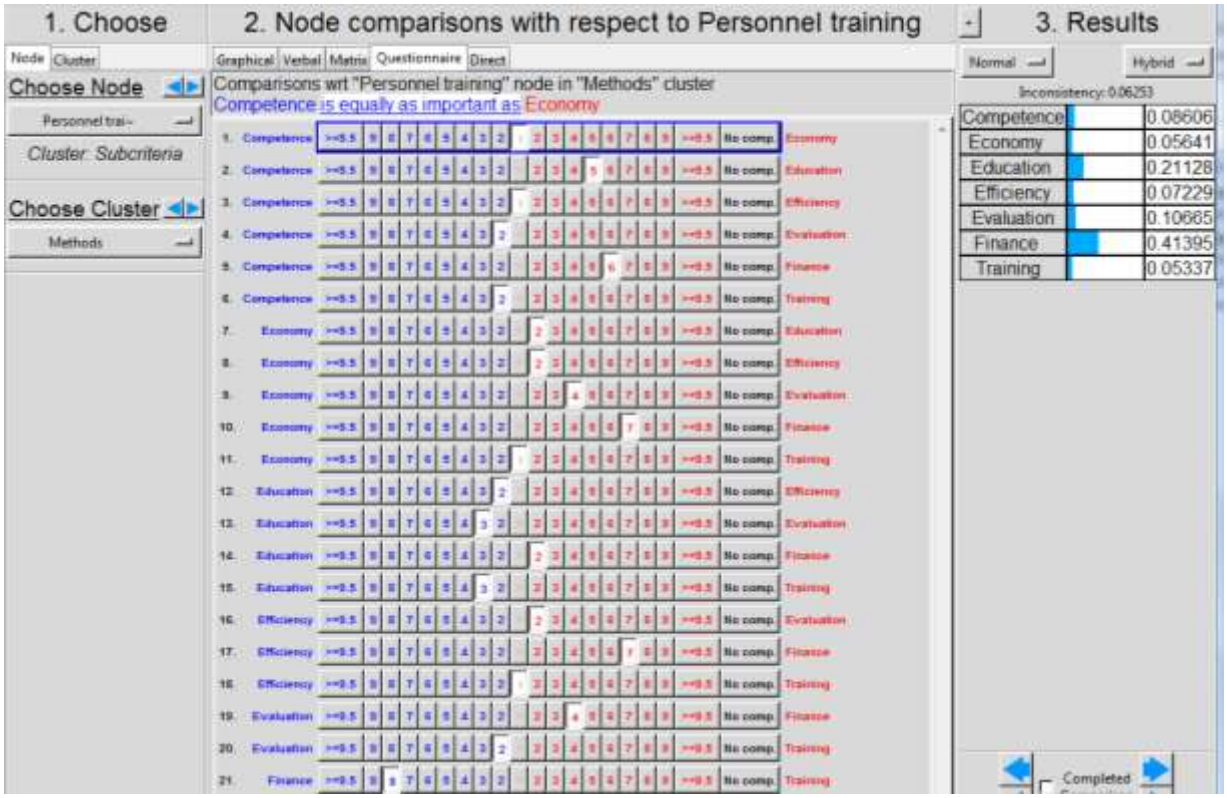
b) "Decisions"



c) "Employment criteria"

Figure 7. The numerical comparison of the methods for each subcriterion. (continued)

d) "Personnel training"



e) "Software"

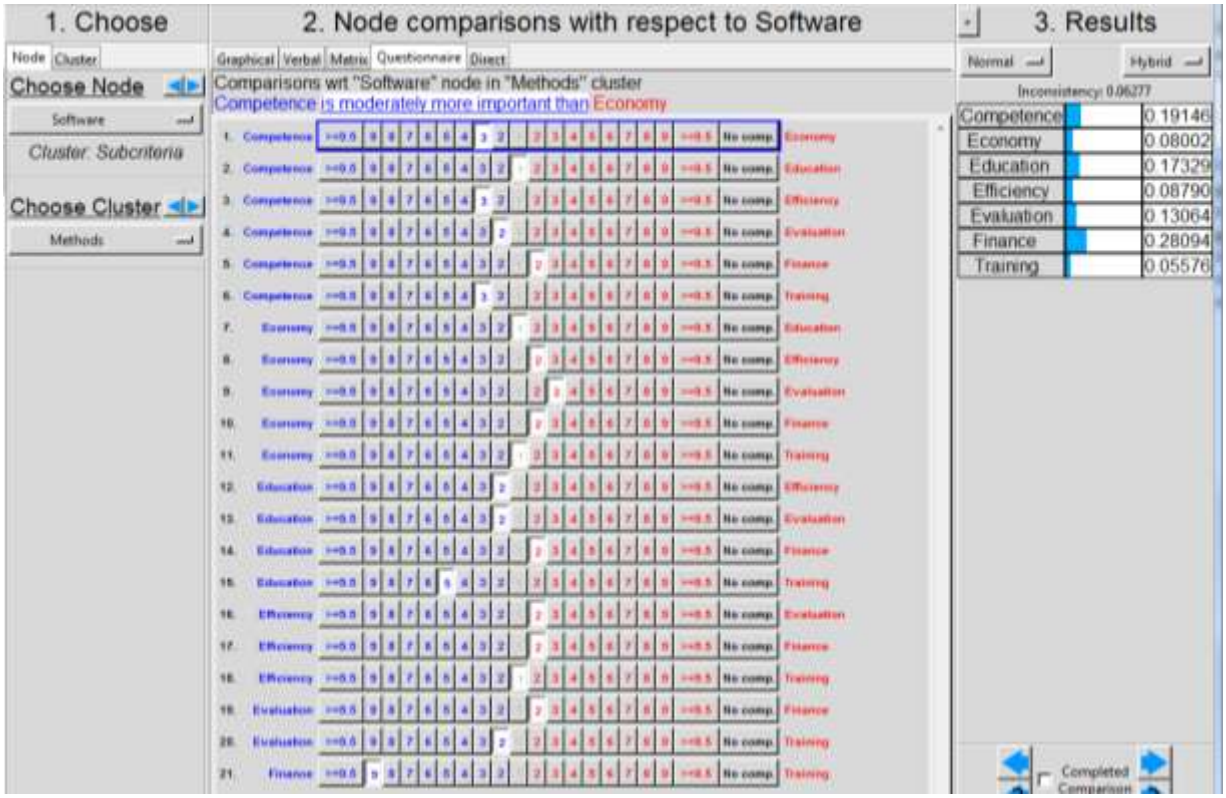
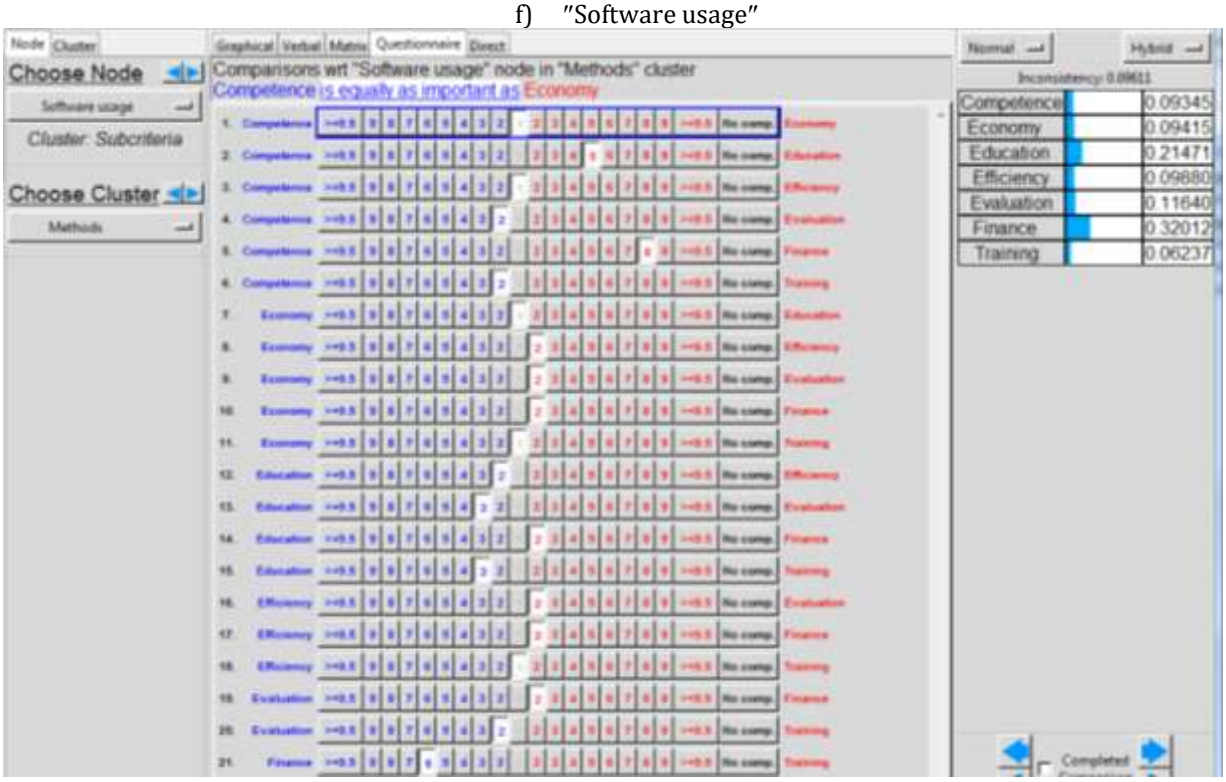


Figure 7. The numerical comparison of the methods for each subcriterion. (continued)

f) "Software usage"



g) "Tasks"

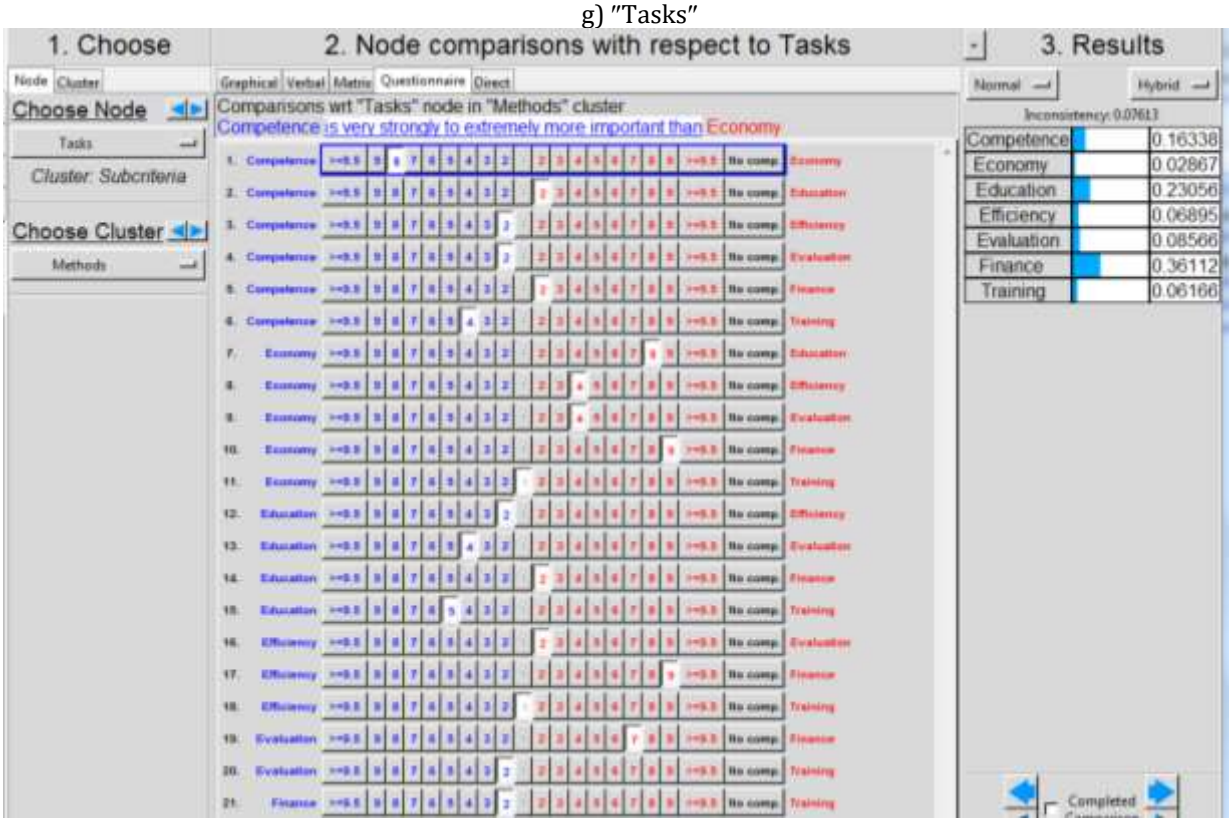
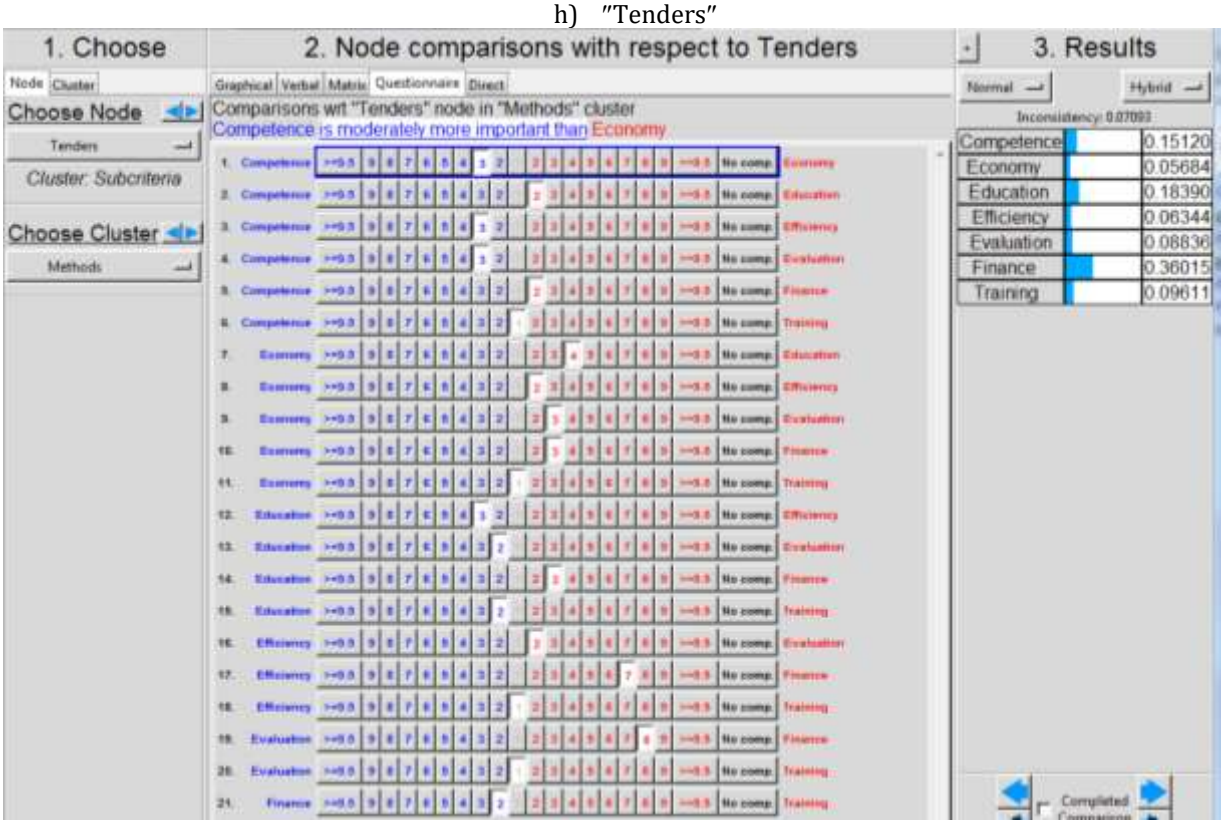


Figure 7. The numerical comparison of the methods for each subcriterion. (continued)

h) "Tenders"

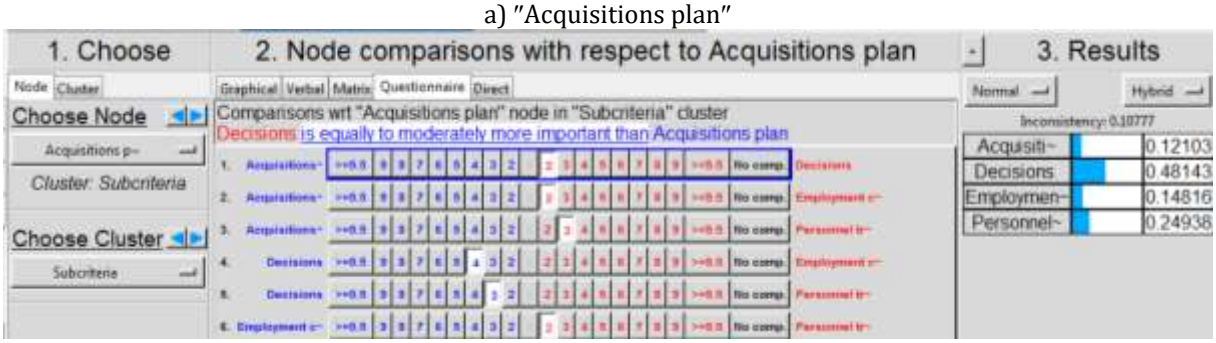


Step 4. The inner dependencies of the subcriteria

It is established by choosing successively the subcriteria and answering the questionnaires corresponding to each of them according to the tables 20÷27 (Istrate et al. 2018) and Figure 3. These procedures are presented by Figure 8 for the subcriteria: "Acquisitions plan" (Figure 8a), "Decisions" (Figure 8b), "Employment criteria" (Figure 8c), "Personnel training" (Figure 8d), "Software" (Figure 8e), "Software usage" (Figure 8f), "Tasks" (Figure 8g) and "Tenders" (Figure 8h).

Figure 8. The inner dependencies of the subcriteria.

a) "Acquisitions plan"



b) "Decisions"

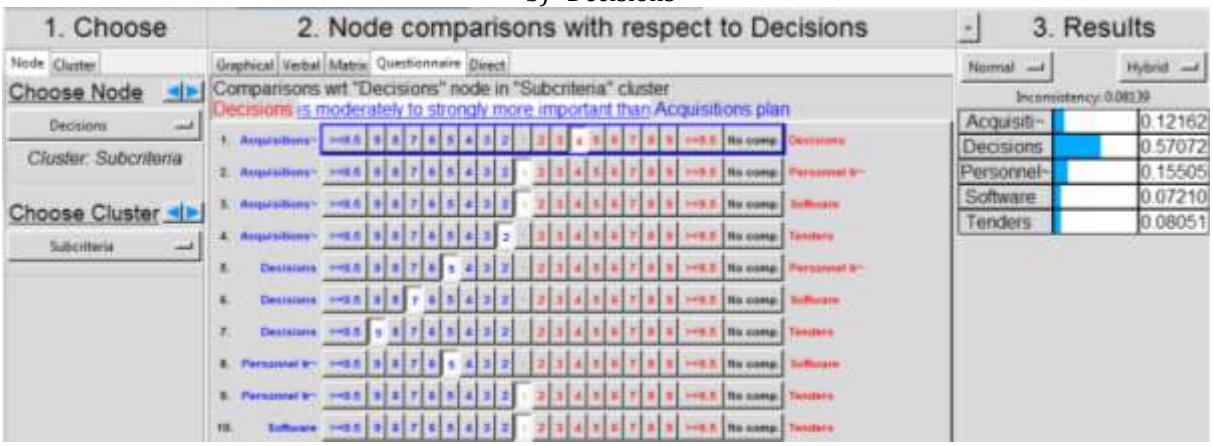
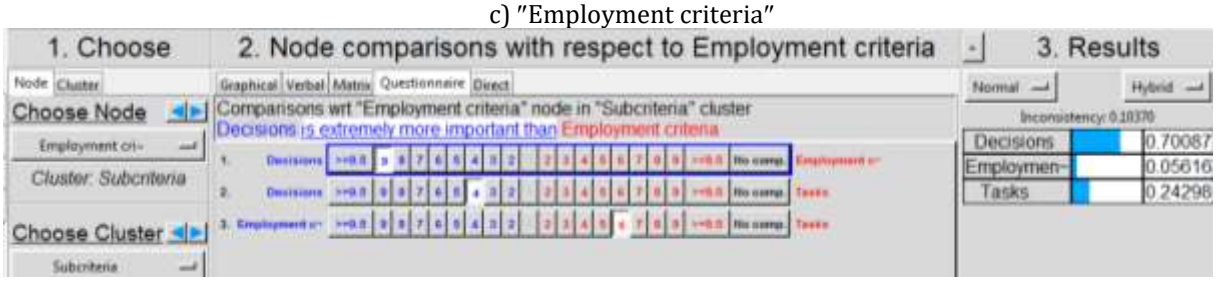
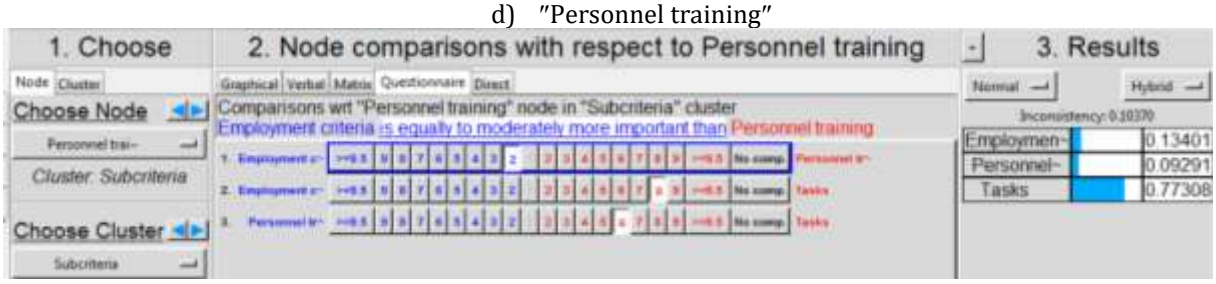


Figure 8. The inner dependencies of the subcriteria. (continued)

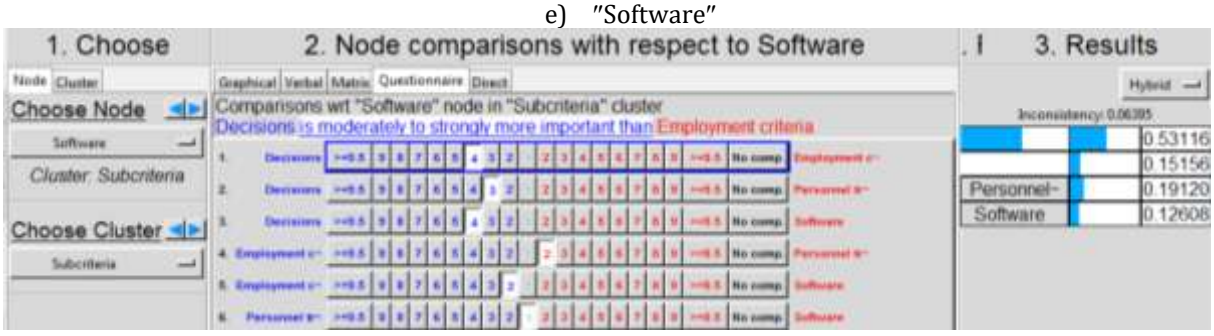
c) "Employment criteria"



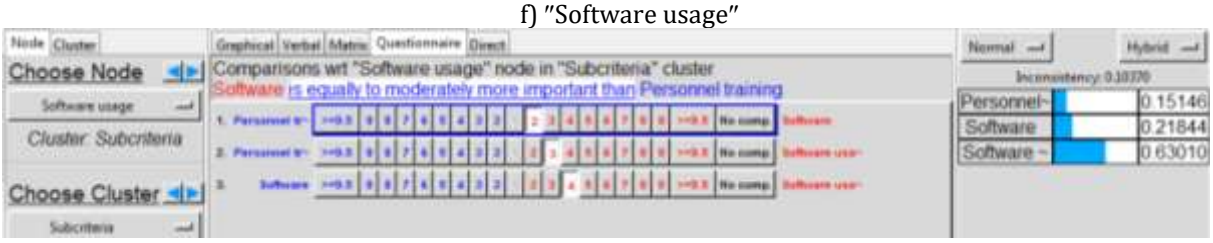
d) "Personnel training"



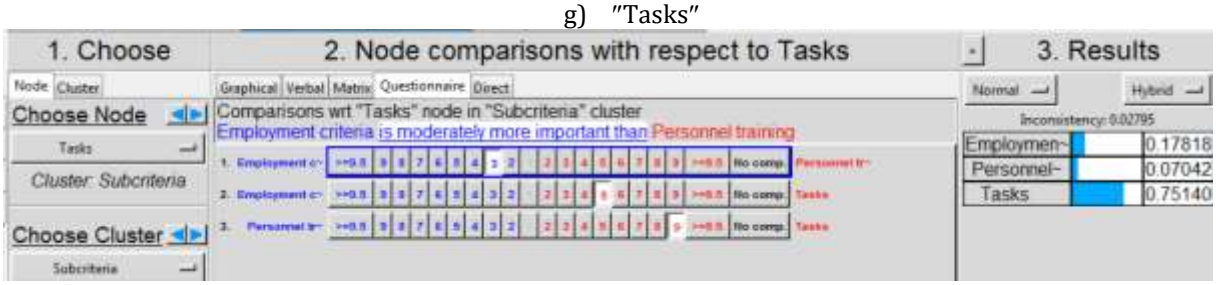
e) "Software"



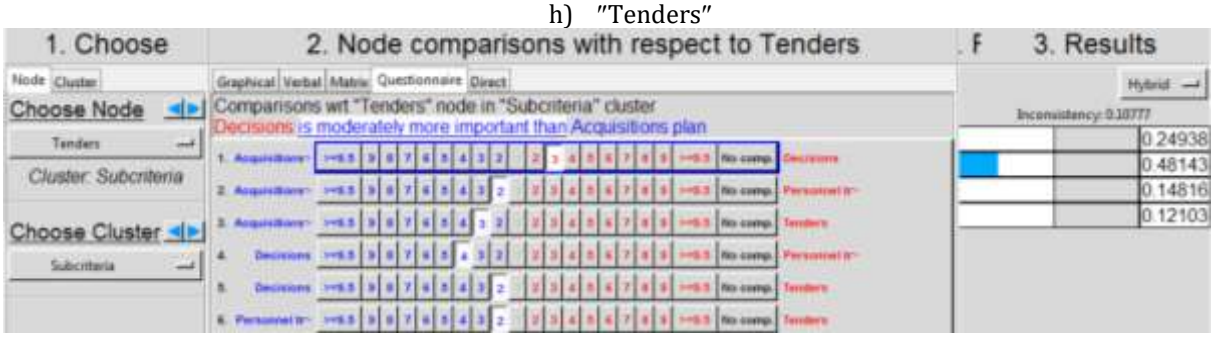
f) "Software usage"



g) "Tasks"



h) "Tenders"

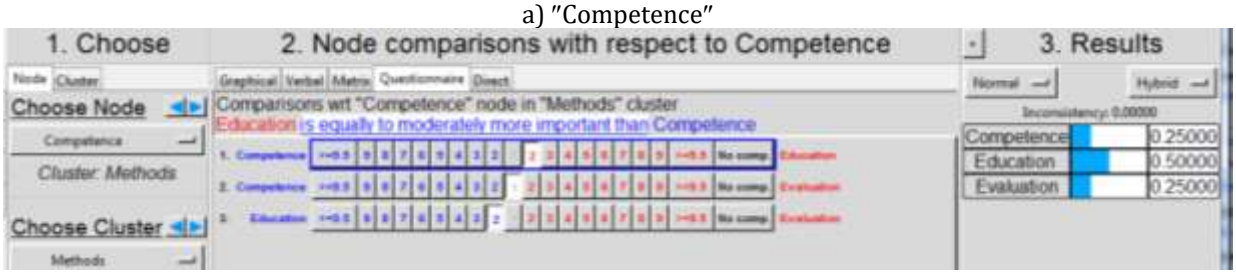


Step 5. The inner dependencies of the methods

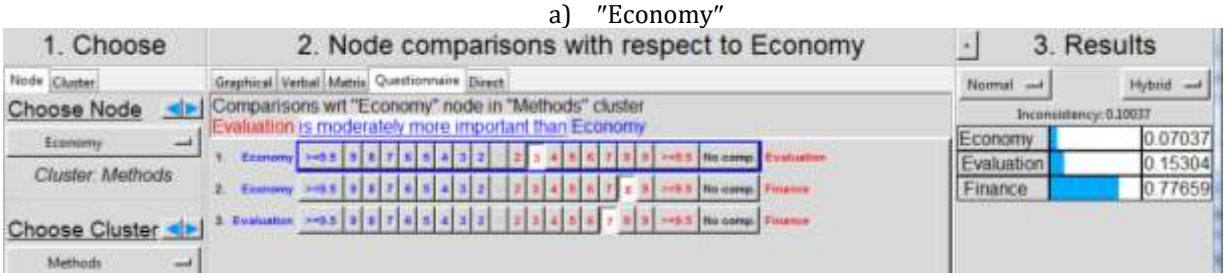
We compare the measures and construct their inner dependencies taking into account the Tables 28÷34 (Istrate et al, 2018) and Figure 4. Figure 9 presents these inner dependencies for the methods: "Competence" (Figure 9a), "Economy" (Figure 9b), "Education" (Figure 9c), "Efficiency" (Figure 9d), "Evaluation" (Figure 9e), "Finance" (Figure 9f) and "Training" (Figure 9g).

Figure 9. The inner dependencies of the methods

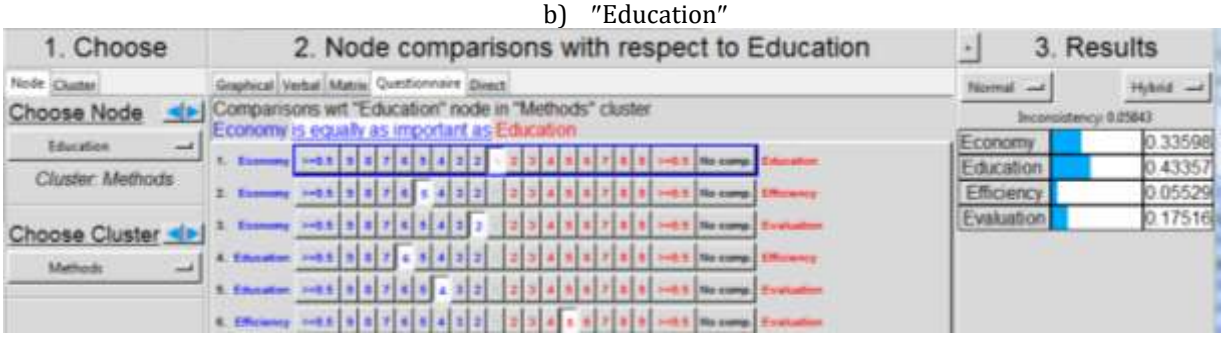
a) "Competence"



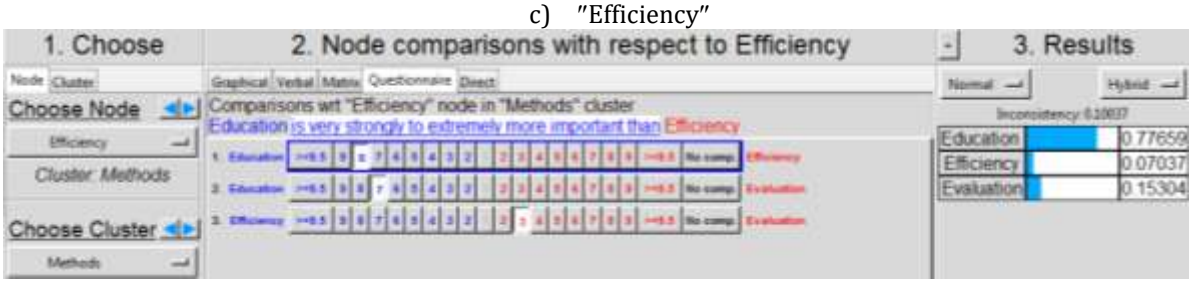
a) "Economy"



b) "Education"



c) "Efficiency"



d) "Evaluation"

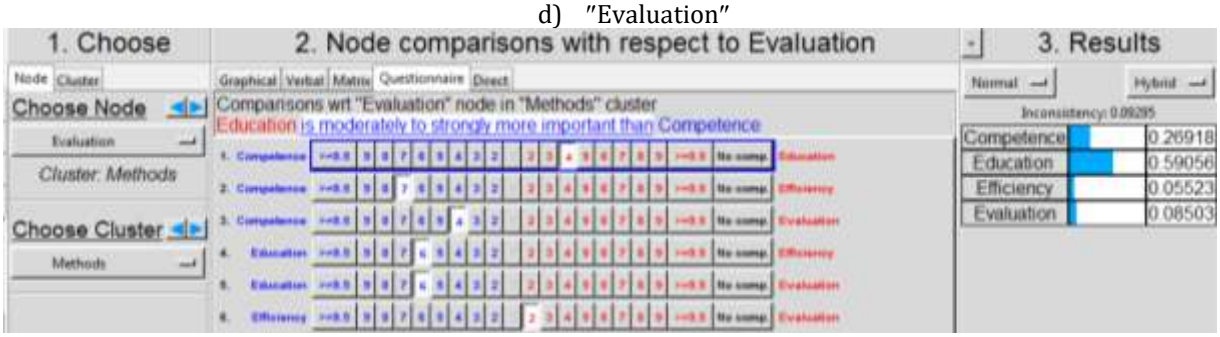
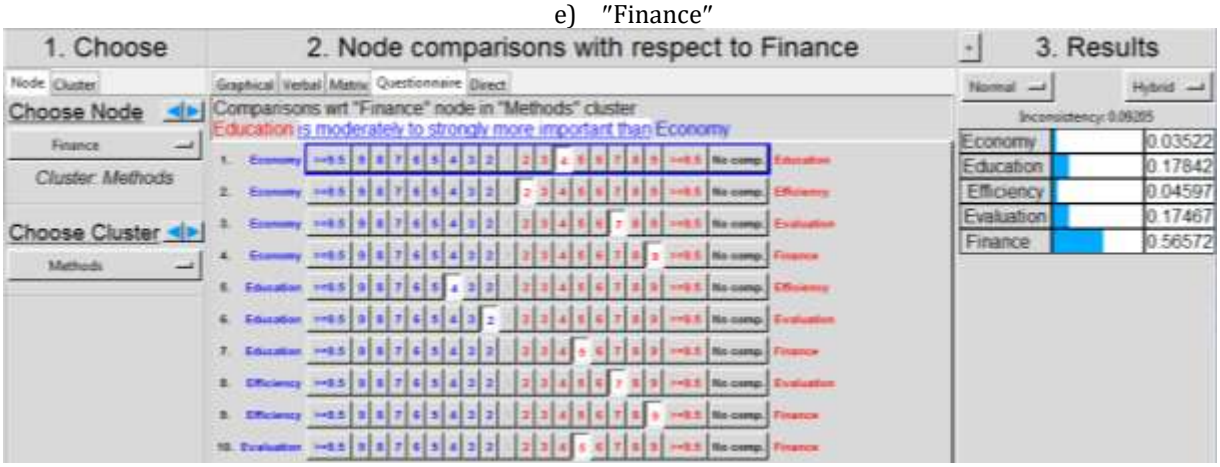
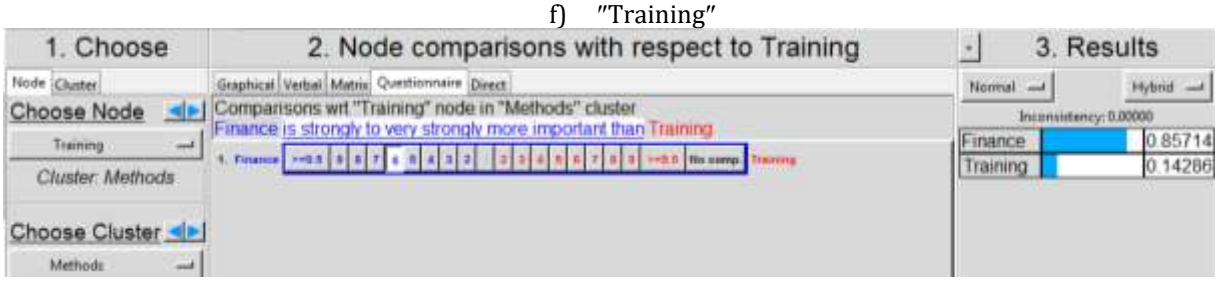


Figure 9. The inner dependencies of the methods. (continued)

e) "Finance"



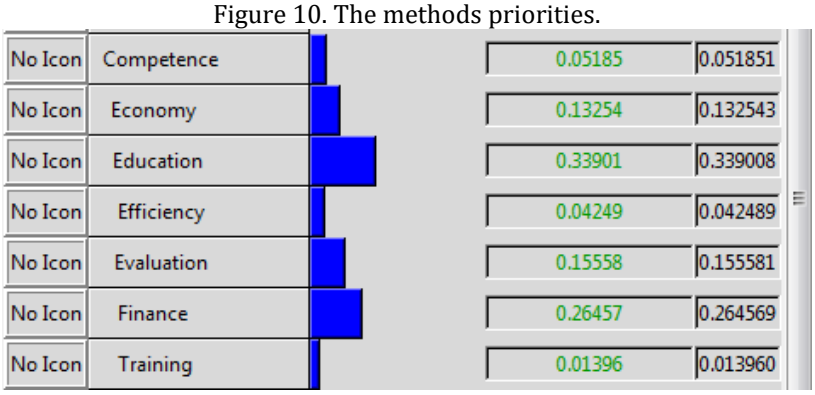
f) "Training"



Step 6. The methods priorities

Using the "Computations"→"Priorities " sequence, the software presents us the priorities of the methods considered in the analysis of the company performance. Figure 10 presents these priorities.

Figure 10. The methods priorities.



4. Results and discussions

The priorities of the measures that a company should take in order to improve its activity show that the "Education" occupies the first place (a weight value of 0.339) followed immediately by the "Finance" (a weight value of 0.2645). The third measure that the analyzed company should take into consideration is "Evaluation" (0.1555) followed immediately by "Economy" (0.339). We find here the same conclusions that were obtained previously using the classical method of solving this AHP/ANP problem (see Istrate et al., 2018).

5. Conclusions

The modern technology represents an achievement that changes the way in which the new generations of students, researchers, et al. are defining their working environment. The well established numerical, analytical and computational methods are presented to the user in a manner that becomes friendlier, easier to understand and to use. The AHP/ANP methods are not an exception. A great number of software programs are presenting these methods in an actual, modern way and the SuperDecision software is one of them.

This paper presents the general problem of a company activity improvement. Considering general factors, using both the AHP and the ANP methods and the new technology available, this work leads the reader through the process of translation of the intuitive arguments into the new environment in order to establish the priorities that should lead the analysis team.

The company considered here is an example that can be modified and adapted for other particular cases that the reader is interested of. This paper, also, constitutes an example of the way in which the modern technology can improve the analysis activity in a company.

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