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**Analysis of Internal Audit Efficiency by Using the Data Development  
Analysis (DEA) Method and Linear Regression**

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**Abstract:** Internal audit plays a particularly important role in supporting decisions within the entity in the context required by the need to overcome the difficulties arising from the occurrence of different risk factors, respectively in order to achieve the proposed objectives and **improve the performance of the entity**. In the current context, it is the task of internal audit to advise management in decision-making, **to optimize** the performance of activities, to identify some dysfunctions in the entity's processes, to inform decision-makers and **to propose solutions** to address identified deficiencies. In this respect, a key objective is to focus on identifying methods and models for quantitative analysis of the **effectiveness of the internal audit function** and its effects in providing added value, among them the method of **DEA (Data Development Analysis method and linear regression)**.

**Keywords:** internal audit function; efficiency; DEA strategy; linear regression; risk management

**JEL Classification:** M42 - Audit

## **1. Introduction**

The *analysis of the impact of improving internal audit* work on decisions in an entity shall start from determining the degree of achievement of the main objective of internal audit, namely cost reduction through the provision of effective risk management tools.

A measure of the internal audit impact on management decisions can be obtained by analyzing the link between **the level of performance of the internal audit** and the variation of financial indicators or independant measures.

The results of the internal audit activity department cannot be quantified in monetary terms of revenues, which is a cost center that uses various resources of the entity in order to offer services to internal users. The number of services can be a measure of output associated with this department and analyze the efficiency and performance can be made by analyzing the efficiency of allocated resources.

The degree of efficiency of the internal audit department has an important influence on decisions developed by the management of an entity that can exercise better cost control or identify more efficient resource use methods based on internal audit results. Furthermore, determining an indicator

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of the effectiveness of internal audit is important for further improving its work in terms of the improvement of audit plans, the allocation of resources across compartments/activities or the determination of the types of audit required to be carried out.

## **2. Literature Review**

As a result of documentation I found that the issue of internal audit varies in approach from the role of internal audit in the evaluation of internal controls (Pickett, 2004), to the role and functions of internal audit (Sawyer, 2003), coming now to emphasize the activity of advice and recommendations to the general management. (Staciokas & Rupsys, 2005 p. 169-181) and (Davies, 2009, p. 41-73).

In the international literature, approached strictly from the perspective of the internal audit, we have identified the work of some specialists as Stacey, Littleton, Brown and Caylor (Stacey, 1954), (Littleton, 1988) and (Brown & Caylor 2006, p. 904-934) which have paid particular attention to this area.

In the research of internal audit, a significant contribution was made by Matthews (Matthews, 2006) with his work '*A history of auditing; the changing audit process in Britain from the nineteenth century to the present day*'. During this, the author spoke about audit history in the United Kingdom, using several techniques to capture the progress of internal audit.

Some authors as Iain, Stuart (Gray & Manson, 2011) specified that the internal audit is a function of the management that seeks to establish recommendations for improving the real situation of the entity. Other experts believe that the internal audit is experiencing a more pronounced development after the 1980s, when the internal audit functions begins to take shape and role of internal audit is to bring value to the entity (Renard, 2002). The author talks about performance measurement criteria, being a success factor in an entity and can help management improve their business, as opposed to internal compliance audit that only checks the application procedure. E. Macre (Macre, 2010) criticizes the fact that the implementation of the internal audit was made fast, first adopting the deadline and then the process itself.

In the last years in the area of internal audit there has been a significant increase in the research interest, following the criterion of effectiveness of this work, with internal audit practitioners increasingly being consulted by the entity managers, in order to base the formulation of the most relevant decisions (Sawyer, 2003, p.21).

In Romania the internal audit first appeared in the public sector entities and was recommended to the private sector entities (Ghiță, 2004), unlike the global situation, where internal audit first occurred in the multinational entities and then it was transferred to the national ones and adopted by the administration (Renard, 2002).

In Romania, specialists support explanations of internal audit practices and procedures necessary to achieve the entity's purpose (Dobroțeanu, 2002).

Authors as Morariu and Stoian ("*Audit intern și guvernarea corporativă*", (Morariu, Suci, & Stoian, 2008)) and Sabău and Nagy ("*The necessity and role of the performance audit in ensuring enterprise's competitiveness*") (Sabău & Nagy, 2009) tried to explain the importance of the internal audit missions that contribute to the increase of the economic performance.

### 3. Research Methodology

Any research work, whether directed toward establishing new theories or aimed at verifying the practical application of theoretical aspects, can be classified into two categories, namely: (1) inductive research, from practice to theory and (2) deductive research, from theory to practice. From a theoretical point of view, these research methods mentioned co-exist in the study carried out, and from a practical point of view, we are witnessing an interrelationship between them.

The methodology applied in this study is characterized by the combination of the respective, mostly inductive, deductive research methods (method of data interpretation: Comparative and interpretative) (methods for data collection, information processing and data interpretation).

The research carried out regarding the efficiency of the internal audit activity includes specific elements both descriptive and exploratory and explanatory.

Referring to the classification of research methods developed by Septimiu Chelcea (Chelcea, 2001), cross-cutting (observation) and longitudinal (case study) methods, experimental methods and observation methods (documentation), case-related methods (entity study), qualitative methods and quantitative methods of data and information processing were used in the research carried out.

### 4. The Quantification of the Efficiency of the Internal Audit Activity on the Basis on THE DEA Method

The analysis of the impact of improving the internal audit work on the decisions of the entity shall start from determining the extent to which the main objective of the internal audit is achieved, i.e. reducing costs through the provision of effective **risk management tools**.

A measure of the impact of the internal audit on the decisions of the entity can be obtained by analyzing the link between the performance level of the internal audit and the variation of financial indicators or independent measures.

The results of the internal audit function cannot be monetised in the income term, as it is a cost center that uses different entity resources to provide services for domestic users. The number of services offered may be a measure of the output of this department and an analysis of the degree of efficiency or performance may be made on the basis of an analysis of the efficiency of the use of the resources allocated.

*The degree of efficiency of the internal audit* department has an important influence on the decisions made by the management within the entity that can exercise better control over costs or identify more efficient resource use methods based on the audit results. It is also important to determine an indicator of the effectiveness of internal audit for the future improvement of its work in terms of the improvement of audit plans, the allocation of resources across compartments or activities, or the determination of the types of audit required to be carried out.

The methods used in the present study to analyze the effectiveness of internal audit **DEA (Data Envelopment Analysis) and linear regression**, the period analyzed is from January 1st to December 31, 12 months respectively.

**Description of the method:** THE DEA model characterizes how a series of entries affect a lot of outputs of a transformation process performed by an established unit (in our case a draft audit).

**THE DEA** method is a non-parametric method for determining an efficiency indicator of an individual decision unit (DMU – decision making unit) depending on the other individual decision-making units belonging to the group.

The individual decision-making units shall be considered to be responsible for the transformation of inputs into outputs and the efficiency shall be measured on the basis of the ratio of linear combinations of inputs and outputs of those units.

Optimization of the efficiency of a DMU according to the values of the other DMUs is done using linear programming techniques, the method requiring only input and output variable values. The fundamental assumption of THE STUDIED DEA model is the homogeneity of all system variables (inputs, outputs and operational characteristics) over the analysis period.

The results offered by the DEA method differ from the results obtained by calculating efficiency rates in that it allows the use of both multiple exits and multiple inputs, providing relevant additional information about the areas that allow for efficiency improvements and the magnitude of these potential improvements.

The application of the method was aimed at determining the efficiency of the internal audit for twelve consecutive months, each month being considered a DMU.

**Main DEA model variables:** The determination of the model variables was made based on the analysis of the activity of the internal audit department of the studied entity.

Thus, for the input variables were chosen:

- the number of hours allocated to audits calculated as a product of the number of employees of the department, the number of hours allocated daily and the number of working days of the month;
- the monthly cost of the audits carried out composed of the costs related to the salaries to which were added other costs allocated to the personnel activity (travel, stationery, training, indirect costs).

The output variables of the model were identified on the basis of the final product of the internal audit department's work, i.e. the audit reports prepared. Since the objective of the internal audit department was to conduct efficient and effective audits, it was necessary to quantify the effectiveness of individual audit projects, also using THE DEA method, to quantify the achievement of this objective. Based on these individual efficiency values of the audits carried out, a monthly average of their efficiency could be calculated, which is the output of the main DEA model.

The other output variables of the model were the total number of hours allocated monthly to audits and the total number of issues identified monthly and analyzed in audits.

**Auxiliary DEA model:** As mentioned above, in order to de-identify the values of one of the output variables of the main model, it is necessary to apply the DEA model to determine the effectiveness of individual audit projects developed by the Internal Audit Department during 2019.

**Auxiliary DEA model inputs:**

- the number of employees involved in the project;
- the number of hours needed to complete the project;
- the cost of the project.

**Auxiliary DEA model outputs:**

- the total number of identified problems;

- the number of recommendations made;
- the number of accepted management recommendations;
- number of implemented management recommendations.

Addressing THE DEA model was to maximize the efficiency function  $\theta$  for each individual unit o, subject to individual unit conditions i.

$$Max\theta = \frac{u_1 y_{1o} + u_2 y_{2o} + \dots + u_r y_{ro}}{v_1 x_{1o} + v_2 x_{2o} + \dots + v_m x_{mo}} = \frac{\sum_{r=1}^s u_r y_{ro}}{\sum_{i=1}^m v_i x_{io}}$$

In accordance with the conditions:

$$\frac{\sum_{r=1}^s u_r y_{r1}}{\sum_{i=1}^m v_i x_{i1}} \leq 1 \quad \frac{\sum_{r=1}^s u_r y_{r2}}{\sum_{i=1}^m v_i x_{i2}} \leq 1$$

$$\frac{\sum_{r=1}^s u_r y_{rj}}{\sum_{i=1}^m v_i x_{ij}} \leq 1, \text{ where } u_1, \dots, u_s > 0 \text{ și } v_1, \dots, v_m \geq 0$$

Where:

j = number of DMU rated (units)

$y_{ij}$  = the output quantity r used by the unit j

$x_{ij}$  = the quantity of inputs i used by the unit j

i = number of entries used by a DMU

r = number of outputs generated by DMU

$u_r$  = the coefficient (weight) allocated to the output r

$v_i$  = the coefficient (weight) allocated to the input i

The required data to apply the method are the observable outputs  $y_{ij}$  as well as observable entries  $x_{ij}$  for the analyzed period.

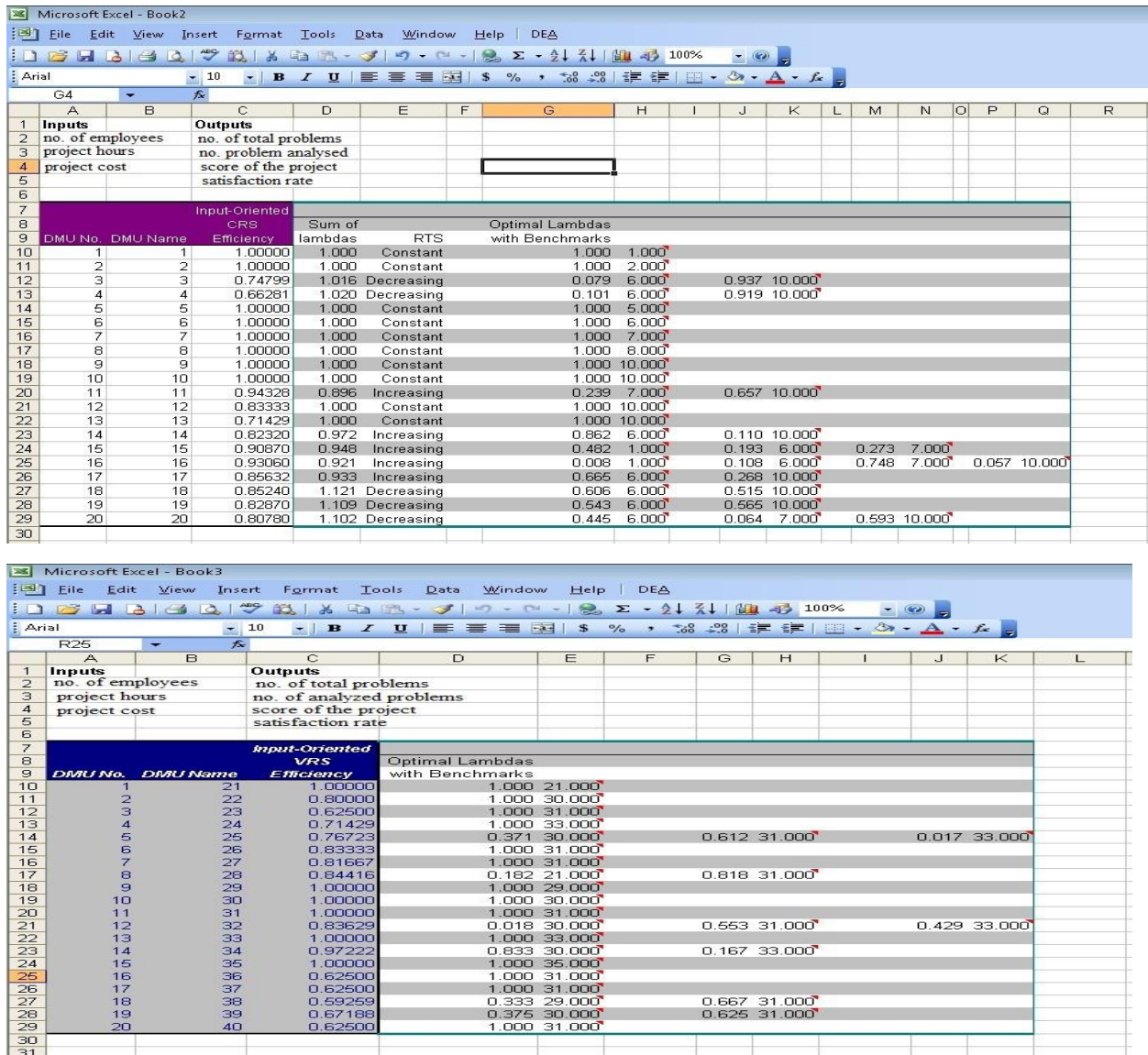


Figure 1. The Results of Applying the Auxiliary DEA Model

Source: own projection

Figure no. 1 shows the results obtained from applying the DEA model to a number of 40 internal audit missions carried out during the year 2019. The results obtained in this stage were the values of the input variables of the main DEA model.

The results of the main DEA model (Determining the efficiency of the audit function) are presented as follows:

**Table 1. Main DEA Model Results for 2019**

Inputs		Outputs								
Available hours		Project efficiency								
Costs		Audit hours								
		No. recommendations								
DMU No.	DMU Name	Input-Oriented								
		CRS	Sum of	Optimal						
		Efficiency	lambdas	RTS	with Benchmarks					
1	January	0.98010	0.940	Increasing	0.358	February 2	0.58	May		
2	February	1.00000	1.000	Constant	1.000	February				
3	March	0.99960	1.075	Decreasing	0.487	May 8	0.58	September		
4	April	0.96504	0.942	Increasing	0.451	May 1	0.49	September		
5	May	1.00000	1.000	Constant	1.000	May				
6	June	0.84834	0.893	Increasing	0.185	May 7	0.08	September	0.62	October
7	July	0.86842	0.868	Increasing	0.868	October				
8	August	0.98936	0.989	Increasing	0.021	May 8	0.96	October		
9	September	1.00000	1.000	Constant	1.000	September				
10	October	1.00000	1.000	Constant	1.000	October				
11	November	0.95455	1.000	Constant	1.000	October				
12	December	0.87258	0.789	Increasing	0.789	October				

Source: own projection

In the table no. 1 are presented the results of applying the main DEA model, which quantifies the monthly efficiency of the activity of the internal public audit department. Based on these values, it was possible to calculate the average annual efficiency of the studied entity, which stood at the value of 0.946988, which represents a high efficiency.

The value of this size allows us to affirm that the improvement of the activity of internal public audit leads to an increased efficiency of the activity, which in turn is quantified in the offering of surplus-value.

## 5. Conclusions

The results provided by the study presented allow us to state that one of the important ways of improving the internal audit is to quantify its effectiveness and demonstrate its contribution to the creation of added value. The existence of concrete ways to measure the effectiveness of the internal audit and the relationship of those results to the entity's overall performance provides a concrete measure of its importance as well as the effective contribution of the internal audit to the creation of added value. Ensuring a high level of efficiency and effectiveness of internal audit depends crucially on the definition of the expected performance level, which is the prerequisite for identifying strategies to improve internal audit.

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