UTILIZATION OF CASE-BASED REASONING IN AUDITING
Determining the Audit Fee

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Abstract: Case-based reasoning represents a method for solving problems and decision making support which is based on the previous business experience. It uses cases from the past to solve new problems. Case can be defined as conceptualized piece of knowledge representing the experience that teaches a lesson fundamental to achieving the goals of the decision maker and it usually incorporate input (situation part of the case) and output features (solution part of the case). Many studies tried to explain types and impact of different factors that determine audit fees. Mostly all authors concentrate their research on the impact of following determinants: auditee size, auditee complexity, auditee profitability, ownership control, timing variables, auditor location and auditor size. In paper all mentioned factors are described except auditor size and location since these factors are not significant in Croatian audit service market. All significant audit fee determinants will be appropriately quantified in order to build a case-based reasoning model for determining audit fee for smaller and mid sized auditing firms in Croatia but also for the same firms in the other, particularly transition, countries too.

1 INTRODUCTION

The transitional period in Croatia started at the beginning of nineties. In that time social ownership left its place to private owned companies what meant that the financial statement auditing will become obliged very soon. Couple of years later, precisely in 1993., The Accounting and Auditing Acts were brought. According to The Accounting Act all big companies, and medium companies[1] if they are organized as joint stock companies, have to audit their financial statements once a year. Once in a tree years small companies, if they are organized as a joint stock companies, have to make the review of financial statements. Other companies don't have a legal obligation to audit financial statements but they sometimes do that because of creditors requesting. Considering the fact that Croatia is still transitional economy, Croatian companies are looking on auditing mainly as a legal obligation which has to be fulfilled. According to mentioned they are looking for auditing firms which will offer the lowest price for performing financial statement audit.

Today, in Croatian audit market operate about 200 audit firms. During the past 11 years the competition on audit service market was strong mainly because many of small auditing firms were founded. Like in other countries most of banks and biggest companies are audited by "Big four"[2] auditing firms. Other companies are audited by smaller auditing firms and the competition is particularly strong in this segment of audit market. This "non big four" auditing firms are faced with problem of determining the audit fee when competing for new client. During informal interviews with audit partners in smaller and medium size auditing firms it was found that problem of determining the audit fee when bidding for new clients often occurs. The motivation of this article is to develop a model based on case-base reasoning which can be useful for smaller and medium size auditing firms when biding for a new client. Article is structured in the following way: at the start the characteristics of case-based reasoning are explained after what determinants of audit fee are described. Application of case-base reasoning

[1] Company size is measured by their assets, revenues and number of employees according to the Accounting Act.

[2] Deloitte & Touche, Ernst & Young, KPMG and PriceWaterhouseCoopers

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model in auditing when determining the audit fee is explained at the end.

2 CASE-BASED REASONING

During the last decade different methods of transforming data into business intelligence have emerged. Information systems like OLAP systems, rule based systems, case-based reasoning, neural networks, fuzzy logic has found different applications in management, auditing, finance and many other areas as a very helpful management tools. Case-based reasoning represents a method for solving problems and decision making support which is based on the previous business experience. It uses cases from the past to solve new problems. These types of decision making systems are based on the fact that in many cases a new problem is partly known to decision maker because it often reflects situations experienced in the past. Therefore, if problem was successfully solved in the past the same experience can be used to solve the current problem. Otherwise, if solution of an old problem was inappropriate than that kind of solution should be avoided in the current problem. As the main advantages of case-based reasoning systems following could be pointed out:

1. it solves problem quickly by retrieving similar cases, rather than generate solutions from the scratch,
2. it can solve problems in domains that are not understood completely
3. it can remember past mistakes and warn users not to repeat these mistakes
4. it can use past cases to determine which parts of a problem to focus on
5. it can create justification for proposed solution by comparing and contrasting new problem with the old problem (Morris, 2002., p. 1).

First step in case-based reasoning process is introduction of a new problem which has to be solved. The problem is represented as a target case which consists of features that describes the situation decision maker is interested in matching. When solving a new problem case-based reasoning system firstly finds similar case from the past. After that system adjust old solution and for any difference between old and new case, and provide solution for the new problem. At the end system stores the new case and its solution into data base, from which it can be retrieved and used in solving the future problems.

Central point in the system represents cases. Case is conceptualized piece of knowledge representing the experience that teaches a lesson fundamental to achieving the goals of the decision maker. Cases have to be represented in a way which enables effective usage by the reasoner. They usually incorporate input feature and output feature. Input feature represent important attributes of cases that effect decision making. Some authors point out that input features form so called situation part of the case (Dhar, Stein, 1997., p. 151). Before entering cases into case base it is important that input features names and values are defined. Input features value can take different forms, like numeric value, yes or no value, text value, etc. On the other hand output features describe solution part of the problem.

Once, when target case is inputted in the system with its input features, case-based reasoning system has to retrieve the most similar cases from the case base. Retrieving case from the case base represents a very important step in the case-based reasoning working cycle. Retrieval of relevant cases depends on indexing of cases. The easiest way to do indexing is to a priori set important features for the problem solution. That set of selected features represents a probe that is sent in the case base in order to find similar cases, cases which have selected features.

In order to do match and retrieval of the similar cases from the case base there must be used some similarity assessment method because decision maker should not expect perfect match (in most situation values of the selected features for old and new case will not be the same). Therefore, it is necessary to define some similarity metrics. An example of such metrics is nearest neighbor method which works well in situations where features have numerical value. After the most similar case is retrieved from the case base it can be used for finding interesting information and after that reasoner can adjust and send a new probe with different features for retrieving of new case. On the other hand case-based reasoning system can be designed to make automatic adjustments in solution part of the case on the base of differences in situation part of the cases, providing the solution for the new case.

Case-based reasoning process is illustrated in Figure 1 where case-based reasoning steps are shown (Hwang, Shin, Han, 2004., p. 25.).

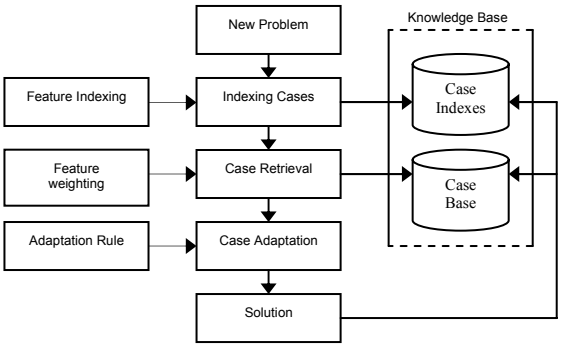

Figure 1: Case-based reasoning process.

Case-based reasoning systems have different areas of business applications. According to some authors until 1997 there was developed more than 100 CBR systems (Lopez de Mantaras, Plaza, 1997., p. 21). As an example of using case-based reasoning in auditing, system called SCAN is developed in order to provide audit recommendations (Morris, 2002., p. 10 - 11).

3 DETERMINANTS OF AUDIT FEES

Many authors tried to explain types and impact of different factors that determine audit fees. They found that the same factors have different impact depending on the size of audit service market and the impact of some of them is not precisely known. But mostly all of them concentrate on researching the impact of following audit fee determinants: auditee size, auditee complexity, auditee profitability, ownership control, timing variables, auditor location and auditor size. Each determinant is explained except auditor size considering the fact that the article is focused on developing the case-based reasoning model for determining audit fee for non big four firms so the size of auditor is not important. Auditor location is not considered too according to fact that it is the determinant which depends on characteristics of each audit services market. For example, in United Kingdom auditor location is important variable because audit staff costs are higher in Southeast than in other region while in Croatia, and in most transitional countries, there is no significant difference between regions. This determinant can be used in other countries depending on the characteristics of their audit services market.

3.1 Auditee Size

Researches have found that auditee size is the most significant explanatory variable in determining audit fee. Auditee size can be measured by total assets and by total revenues. Most of researches used total assets as measure of auditee size and it is suitable particularly when audit approach is balance sheet based. Factors like the age profile of assets and chosen accounting policy can make the total assets measure different between similar companies. Auditee size measured by total revenues is better approach when auditor has a transaction based approach to the audit. For building the model total revenues will be used as the measure of auditee size. When considering the relationship between auditee size and auditor fee it must be noticed that it is not linear. The studies have shown that proportionate increase in audit fee is decreasing function of auditee size what can be explained by presumption that the bigger the auditee is the strongest internal control procedures it will have. This relationship is represented in the Figure 2.

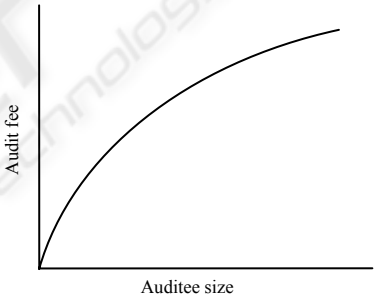

Figure 2: Relationship between audit fee and auditee size.

3.2 Auditee Complexity

When auditing complex companies auditors are faced with much more work to be done. Complex companies are considered those with many subsidiaries, dislocated business units, companies with big numbers of unusual transactions, and different internal controls, companies with particular balance sheet composition and companies that have subsidiaries which are operating in different branches. They deserve much more attention and request much more time when auditing what usually result in higher audit fee. When auditing companies with many subsidiaries auditor has to charge higher fee because he or she has to audit separate financial statements and if the subsidiaries are situated in foreign country costs became even higher. Auditor has to pay attention on intra-group transactions,

taxation and pricing policies. If the subsidiaries are operating in different branches (the business is diversified) auditor has to get specific knowledge about business and the costs became higher again. Diversification can be measured by Herfindahl index

$$H = \sum_{i=1}^{n} S_i^2 \quad (1)$$

where S_i represent turnover of the i-th segment as a proportion of total revenue of the auditee. Dislocated business units have influence on price too. Auditor has to visit all those locations what usually make audit more expensive. Big numbers of unusual transactions and complex system of internal controls takes more time for testing and put the pressure on costs too. Companies with particular balance sheet composition include companies which have big proportion of inventory and debtors in total assets. Mentioned items are more difficult to audit then for example cash or fixed assets and it can result in higher fee. For building model the complexity will be represented by scale from 0 to 10 where 0 means low complexity of auditee and 10 very complex companies. Auditor usually makes estimation on complexity considering the factors like: number of subsidiaries, location of subsidiaries and business units, Herfindahl index which measure diversification, number of different branches in which company is operating, and two ratios: inventory/total assets and debtors/total assets.

3.3 Auditee Profitability

The impact of auditee profitability on audit fee is more important when auditee is facing financial problems than when it is generating profit. Auditee profitability may cause changes in audit fee in two ways. When auditee has financial problems it is trying to control all overhead costs which might result in lower fee. But on the other hand, financial distresses put in front of auditor need to focus more directly on valuation of assets, the status of a auditee as a going concern, possible breaches of loan covenants etc. what may rise the audit fee. In building the model return on equity (ROE) will be used as a ratio which represents auditee profitability.

3.4 Ownership Control

Development of financial statements audit is the result of divorcement between ownership and control (management) of the company. Diverse ownership structure requires more extensive and higher quality audit than in the case of auditee owned by only couple of shareholders with relatively high shareholdings so it is logical to expect that the extent of audit services demanded will be a function of ownership control which will be measured by the number of shareholders.

3.5 Timing Variables

Auditing is a quite seasonable activity with busy season which start at January and lasts till June. Auditors often charge a premium for performing audit in this period of year what can be a result of shifting the audit emphasis to pre year end testing with higher audit costs or auditor has to engage new human resources. Another timing variable is auditee request for audit report i.e. time which past from the end of accounting year to the date of audit report. Shorter the period is the audit fee is expected to be higher as it is possible that auditor has to engage new work force to audit financial statements. For building a model it will be used the period from the end of accounting year to the issuance date of audit report measured by number of weeks.

4 DESIGNING THE CBR MODEL FOR DETERMINING THE AUDIT FEE

In order to design case-based reasoning model it is necessary to define feature names and values at the start. In order to keep model simple and easy for understanding six features shown in Table 1 are used. It should be pointed out that first five features represent input features or situation part of the case and the last feature (audit fee) represents output feature or solution part of the case. On the basis of the previous experience and business data it is necessary to build data base that will contain cases from the past. The easiest way to build such data base is to find records on all the clients from the past. After that for each client feature values must be determined and inputted into the data base (case base). On the basis of such approach in building data base it will be assumed that the data shown in Table 2 is included into data base of auditing firm.

Table 1: Features and their characteristics.

Feature	Type	Measurement unit	Feature value span
Auditee size - Revenue	Numerical	Money units (MU)	0 - 100.000.000
Auditee complexity	Numerical	Number	0 - 10
Auditee profitability - ROE	Numerical	Number	-0,5 - 0,5
Number of owners	Numerical	Number	1 - 500
Timing variable - Weeks	Numerical	Number	5 - 25
Audit fee	Numerical	Money units (MU)	10.000 - 100.000

Table 2: Model of case-based reasoning data base.

Case	Size (MU)	Complexity	Profitability	Ownership	Time	Fee (MU)
A	18.000.000	2	0,47	8	23	2.890
B	28.000.000	3	0,21	2	14	4.475
C	31.500.000	3	0,19	9	25	6.000
D	37.900.000	2	0,31	5	8	18.700
E	56.700.000	4	-0,02	35	7	19.870
F	69.900.000	7	-0,05	78	17	53.290

Table 3: Probe input features for the clients X, Y and Z.

Probe case -new client	Features				
	Size (MU)	Complexity	Profitability	Owners	Time
x	21.900.000	3	0,17	3	7
y	42.970.000	5	0,21	13	18
z	62.700.000	7	0,35	29	9

In the situation when a new client is analyzed in order to determine auditing fee, case-based reasoning model requires setting up a probe that is send to data base. It should contain values of relevant input features in order to find the most similar case in the data base. It can be assumed that potentially new clients have the features presented in Table 3.

On the basis of the send probe into the data base the case-based reasoning system will find the most similar case using similarity metrics. For the simplicity of the model nearest neighbor method is used. It calculates the geometric distance between probe and the all cases from the base. Geometric distance (GD) for each feature can be defined by the following formula:

$$\mathbf{GD} = \sqrt[2]{(\mathbf{old\ case} - \mathbf{probe})^2} \qquad (2)$$

After geometrical distance is calculated for each feature *j* case-based reasoning system must calculate total geometrical distance (TGD) for each old case *i* and each feature *j*. Total geometrical distance can be calculated, by using the following formula (Babić, 1997., p. 42):

$$\mathbf{TGD_i} = \sqrt[2]{\sum_{j=1}^{n} \mathbf{w_j}\left[(\mathbf{old\ case_i} - \mathbf{probe})\right]^2} \qquad (3)$$

Where *j* represents feature (j= 1…n) and *i* old case (i=1...m).

For the simplicity of this paper it will be assumed that all features have the same importance and weights *(w)* of features can be excluded from the calculations. But if reasoner is not valuing all features by the same importance than a priori features weights have to be defined. Research of importance of each audit fee determinant is opened and some results can be potentially useful in improving this model. Since calculation of total geometrical distance requires adding geometrical distances of each feature arises the problem of different measurement scales of features. In order to deal with that problem all values in data base must be normalized. Among different approaches of normalization so called vector normalization will be used. Vector normalization procedure requires that each feature value must be divided by the feature norm. Normalized values r_{ij} are calculated from original values x_{ij} by using the following formula (Babić, 1997., p. 24):

$$\mathbf{r_{ij}} = \frac{\mathbf{x_{ij}}}{\sqrt[2]{\sum \mathbf{X_{ij}^2}}} \qquad (4)$$

Normalized data calculated on the basis of the previous formula and original data from the Table 2. are presented in the Table 4.

Table 4: Model of normalized case-based reasoning data base.

Case	Size	Complexity	Profitability	Ownership	Time
A	0,170370	0,179605	0,504183	0,162255	0,564003
B	0,265020	0,269408	0,225273	0,040564	0,343306
C	0,298147	0,269408	0,203819	0,182537	0,613047
D	0,358723	0,179605	0,332546	0,101409	0,196175
E	0,536665	0,359211	-0,021455	0,709865	0,171653
F	0,661603	0,628619	-0,053636	1,581984	0,416872
x	0,207283	0,269408	0,182364	0,060846	0,171653
y	0,406711	0,449013	0,225273	0,263664	0,441394
z	0,593455	0,628619	0,375455	0,588174	0,220697

In the case of clients *X*, *Y* and *Z* case-based reasoning system would calculate the total geometrical distance scores for each old case which are presented in Table 5.

Table 5: Total geometrical distance scores.

Case	TGD for *x*	TGD for *y*	TGD for *z*
A	0,526514	0,481191	0,834537
B	0,187219	0,334259	0,757870
C	0,467284	0,283815	0,751118
D	0,236220	0,415752	0,704340
E	0,761134	0,598065	0,500557
F	1,662868	1,383325	1,102228

On the basis of all previous calculations and usage of nearest neighbor method based on the geometrical distances case-based reasoning system would finish matching procedure finding that the most similar case in comparison to client X is old case B. Namely, old case B has the smallest total geometrical distance score (0,187219). On the basis of such finding reasoner would check data base and find that auditing fee for old client B is 4.475 MU. Therefore, amount of 4.475 MU represents starting point in establishing the final fee for the new client X. In the same way one can notice that the most similar cases to clients Y and Z are cases C and E. According to audit fee charged for cases C and E reasoner is able to conclude that the starting point for making decision on audit fee for client Y is 6.000 MU, and for client Z 19.870 MU. In the more advanced mode of working, case-based reasoning system for determining audit fee might take into consideration

differences among cases B and X input features in order to make adjustments to the solution part of the problem, i.e. audit fee amount, or the auditor can adjust audit fee according to his previous experience.

5 CONCLUDING REMARKS

Case base reasoning, as a method for solving problems and decision making support based on the previous business experience, can be useful instrument in making decision about audit fee. New problems often are not completely new but consist of situations which are partly known to decision makers and in that sense case-based reasoning can be very helpful tool. The advantages of case-based reasoning, like velocity in solving problems by retrieving similar cases, simplicity, solving problems in domains that are not understood completely and remembering past mistakes and warning users not to repeat these mistakes, resulted in use of case base reasoning systems in different area of business applications like bank lending, employee tax status, audit recommendations etc. In order to be accurate and flexible this method, which transform data into business intelligence, depends on the number and diversity of cases stored in the case base. The probability that the new problem will be appropriately solved would be higher if the case-based reasoning model has more cases.

In this paper case base reasoning model was built using the most important audit fee determinants - auditee size, auditee complexity, auditee profitability, ownership control and timing variable. All these determinants (input features) combined with appropriate audit fee which has been charged in the past (output feature) represent a case stored in a case base. Problem of determining audit fee to the potentially new client case-based reasoning model is able to solve by finding a similar case with similar input features and suggesting the audit fee that can be charged. In order to find adequate case in case base, model use similarity assessment method called nearest neighbor method. Considering the fact that all input features have the same weights the future work can be focused on estimating the weights for each feature and finding new features i.e. audit fee

determinants. Perfect matching of old cases and new problem usually does not occur so there can be used different methods for making adjustments to audit fee considering the differences among input features of old and new case what can be used for improving the model in the future work. On the other hand, the auditor can decide to make adjustments to audit fee according to his previous experience. The key accuracy factor of this model is appropriate case base. More cases it has, more accurate the solution i.e. audit fee will be. This model can be useful for small and medium size auditing firms in competing for new clients as a guideline for making decision on audit fee. Its implementation and theoretical development will probably result in different improvements which will be helpful for auditors in making more precise decisions.

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