Requirements for Corporate Governance Assessment Based on Ontologies

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The paper tackles the issue of determining proper requirements for corporate governance assessment by employing ontologies as the tool of choice. Properties and specifics of corporate governance are defined. Its hierarchical structure is highlighted and its compatibility with ontology is submitted for debate. Corporate governance codes are briefly defined and their role within organisations is emphasized. It is argued that corporate governance's constant flow of documents makes it an ideal candidate for using ontologies. Basic elements of ontologies are defined with an emphasis on the semantic web. Several research papers that tackle the issue of approaching different fields through ontologies are mentioned. The need to assess corporate governance processes using ontologies is underlined. The elements that need to be identified when analysing a source text of low complexity, using an ontology, are listed. The outputs of a product that performs analysis based on source text are enunciated. The elements of corporate governance are reiterated in the context of ontologies. The elements that characterise the analysis process of corporate governance are defined. Sets of rules, ways to assess the consistency of rules and behaviour within the organization are defined. A metric is built for determining the consistency between the requirements of corporate governance, expressed by rules, and the actual behaviour within the organization. Using ontologies, qualifications are determined that help assess corporate governance organization. Conclusions are formulated and future research topics are submitted for debate.

Keywords*: Corporate Governance, Ontologies, Quality Assessment, Procedures*

1 Corporate Governance

Governance is defined by the functions of leadership, guidance and administration while involving activities that are proprietary to management and execution. Corporate governance entails the overall management of the entire organization. Thus, it covers a wide range of areas and fields such as economics, law, accounting, finance, psychology, sociology and politics. According to [1] corporate governance is the system by which companies are managed and controlled. Corporate governance consists in identifying and implementing procedures to ensure that decisions, at company level, are taken effectively. Corporate governance is shaped based on internal balances of power in society [2] and it represents a key element in the debate surrounding competitiveness, sustainability, and accountability [3].

Corporate governance involves interaction between people with different skills and specializations. Every filed has well-established protocols and evaluation criteria which highlighting the extent to which each participant follows procedures and achieves results in line with the organisation's objectives.

Corporate governance is based on a hierarchical structure that fits perfectly an ontology structure. At the organizational level a well-defined hierarchy, comprised of multiple specialized components, is defined. Each individual component is associated a priority function and dependencies are established with other components on the same k level, respectively, on a superior level, $k-1$ and on the inferior level, $k+1$, as depicted in Figure 1.

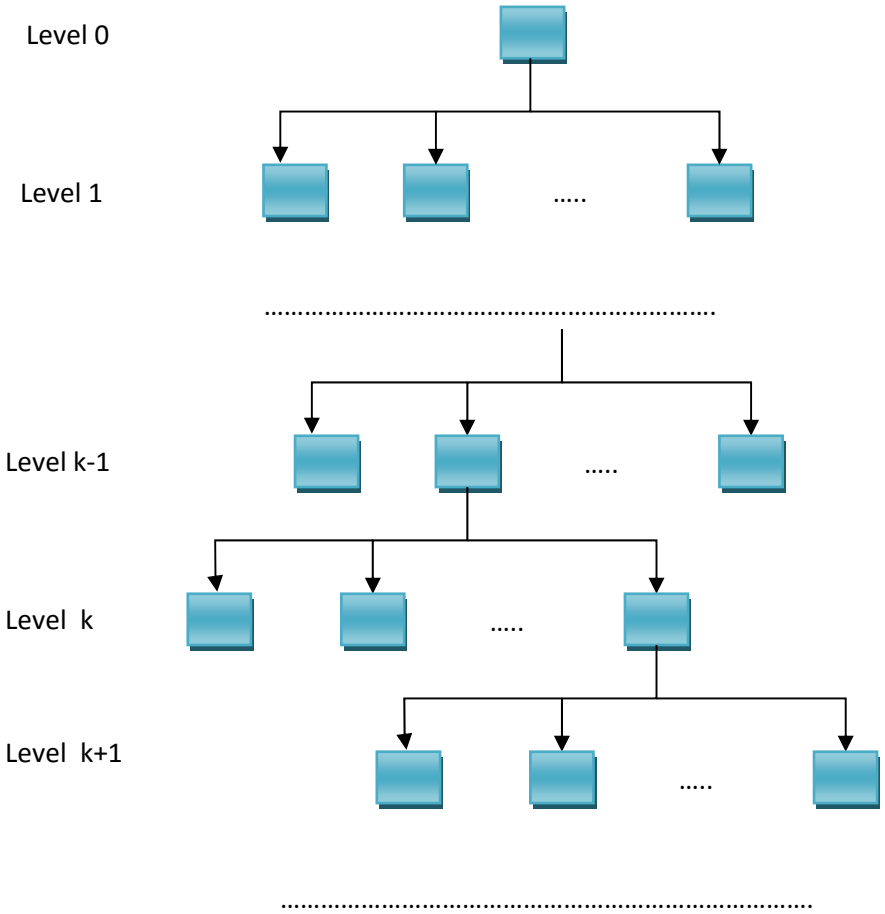

Fig. 1. Organization levels employed in corporate governance

Practice shows that in interdisciplinary teams the complementarity principle applies, each team member having specific tasks, orthogonal relative to the tasks of others, thus avoiding duplication, redundancy and the appearance conflicting decisions. The idea of corporate governance is founded on the need to cover all aspects regarding an organization, both in terms of the management by control, evaluation, coordination, audit, correction, execution and in terms of evaluation of all involved entities.

For implementing smooth running processes in an organization where corporate governance is operational, informational flows are defined in such a manner as to be consistent with the self-imposed discipline, compliance with the rules and implementation of procedures for all activities, pursuing both quantitative and qualitative aspects.

The collaborative side specific to corporate governance requires a high level of transparency for decision-making processes and for the execution stage reporting processes, so that at any given moment it is easy to find out exactly what are the resources that are being used and who are the people that participate and have responsibilities both in terms of execution and in terms of management.

Corporate governance involves document flows for all stages establish in a very detailed way parameters for resources, timelines, deliverables, executors, responsibilities and ways of processing and measuring the value level of what was executed. This constant and rigours flow of documents makes corporate governance an ideal candidate for implementing ontologies.

According to [4] corporate governance covers issues related to social responsibility and ethical practices in business.

Corporate governance codes aim to define how, on each level of the organization's structure, processes must be run so that

information on top organisation levels, in conjunction with the current level, define decisions, procedures, activities within each component but also tasks to be executed by those on lower levels.

For each specialists' category there are corporate governance codes that defines:

- types of activities to be performed;
- self-imposed rules to be followed;
- list of activities that should never be executed;
- ways to increase individual performance;
- procedures for ensuring transparency;
- ways of substantiating scenarios based on which decisions are made;
- attitudes towards the working environment within the company.

Code must include a commitment whereby each team member participating in corporate governance processes agrees to comply with all the requirements set out and contribute to the spread of the codes in practice.

When building a code for members of the management team, both ethics elements and compliance procedures related elements, which generate messages, are considered so that messages target specific people and have a rigorous structure showing exactly what needs to be executed, by whom, using which means, which is the allotted timeframe and showing exactly what the final result is. Thus corporate governance codes can be easily translated into ontologies.

The code is designed so that the person entrusted with management privileges assumes responsibility for messages that have been sent, without acting as a simple a simple transmission channel. Corporate governance codes are equally addressed to those who execute, including proper understanding of the message they received, the capacity of selecting adequate resources, applying procedures for ongoing activities, pursuing quantitative and qualitative indicators and information, obtaining the final output and reporting on how execution unfolded. Corporate governance codes also define ethic elements for executants, elements for increasing skill levels, introducing innovative elements and implementation of high-level collaborative activities.

Corporate governance codes do not contain elements of maximum generality but precise indications including as many specific aspects of each structural level, discarding both elements containing subjective assessment and ditching accountability at both managerial and execution level.

There is a big difference between corporate governance codes and internal regulations of the organization, namely, individual job requirements and responsibility documents signed by each employee.

Corporate governance codes are meant to raise onto a higher level of activities and work within the organization in that it defines a very high level of exigency by enforcing ethical requirements, accountability, control, assessment from a quantitative and a qualitative perspective, differentiating the governance participants by contributions they made, measured using widely accepted indicators.

Corporate governance involves defining a system of assessment indicators, known to all participants, indicators which through a fair self-assessment process lead to collecting indicator levels comparable to the levels assessed by independent evaluators.

A support system for good corporate governance has the following dimensions:

- complies with corporate governance codes;
- ensures risk monitoring and control;
- ensures monitoring and control of financial performance indicators;
- ensures monitoring and control of indicators and processes specific to Corporate Social Responsibility – CSR; figure 2 displays CSR components;
- ensure information transparency by publishing data and provided unrestricted access;
- minimizes informational asymmetry and optimizes the principal - agent – stakeholder relationship;
- ensures monitoring and decisions' optimization.

Fig. 2. Corporate Social Responsibility [5]

Corporate Social Responsibility processes dictate that, for undergoing any activity, the following aspects must be considered:

- environmental protection with regards to vegetation and fauna;
- using technologies that do not degrade the environment;
- preserve historical heritage;
- upholding human rights;
- contributing to eliminating all forms of forced labour.

It is of the utmost importance that in corporate governance all aspects are clearly defined. In this context the rules of corporate governance are constructed by using a minimalistic vocabulary, where keywords form a completely defined subset. Keywords also play an important role in ontologies so they facilitate translating corporate governance rules into ontology entities. Rules are orthogonal to each other. Such an approach creates the conditions required for text analysis and for determining the meaning of the text.

2 Using Ontologies in Managing Corporate Governance

It is important to consider several concepts that underlie management evaluation processes specific to governance based on ontologies.

Syntax studies the functions of different elements within the vocabulary that has previously been defined and sets the rules by which these elements combine. For any organization and its activities, resources and workflows a specialized sub-vocabulary is identify, which is made-up of keywords included in the vocabulary used by the people within the organization. For words belonging to the sub-vocabulary a, set of syntactic rules, derived from the natural language, is built. The syntactic rules are refined and processed so that implementing them into a software program would be feasible.

Semantics analyses the meaning of vocabulary elements and interprets those elements when grouped in the vocabulary. In order to achieve this goal words within the sub-vocabulary are correlated with classes

and thus the initial text is translated at a level of abstraction that enables the synthesis to a contextual level that allows an exact match with a keyword list. If the semantic analysis converges the entire list is reduced to only one word.

Semantic web is tantamount to organize sites so that the information displayed in its pages it's easier to process by software programs such as Internet search engines. Programing languages used for building webpages contain commands that allow for building lists of words in which the author can summarize digital content.

The subjective side of building the words list by the author leads to scenarios where the intersection between the page's text and the words list is an empty set. The authors know the most common words used in the search engine processes and therefore include in their lists such words with maximum frequency of occurrence.

It is important that search engines contain lists of websites and distinguish between existing sites and new sites that are published. The set comprised of new sites is subject to analysis and the search engine will generate keywords for each page and in this way will building its own search graph of each site.

Ontology is building concepts and establishing relationships between them and a vocabulary. The vocabulary consists of words specific to a given industry or field. The concepts are embodied levels of abstraction associated with a tree structure. At the base of the tree structure lay the words of the vocabulary.

There are numerous research papers that tackle the issue of approaching different fields through ontologies.

According to [6] ontologies represents the endeavour of building a common vocabulary to be used in a particular field and the relations between components of that particular vocabulary.

According to [7] ontologies are the basis for the semantic web because it offers some reusable knowledge in a particular field.

Ontologies allow the expansion of processed information thus generating new categories that allow for the development opportunities to automate processes. Ontologies are descriptions of established concepts and relations that allow the analysis of a single or multiple programs.

There are several levels of ontology approaches starting with the complexity of the objectives that are being pursued. The ontology based analysis is performed in a certain way for a source text written in a programming language and it's done in a totally different way when managing the process of highlighting the quality of governance processes that were developed over a corporate structure. In the particular case of analysing source text written in a programming language, elements specific to the programing language are considered and any sequence is analysed in order to conclude that it is part of an aggregated mechanism intended to solve a class of problems.

If T1 text is considered for analysis and it represents the algorithm for calculating the sum of items in an array of 10 elements. At semantic level, as in any source text of low complexity, using an ontology, one must automatically identify:

- a variable defining sequence;
- a variable initialization sequence;
- a result displaying sequence.

Assuming that interchangeability between homogeneous sequences is limited, the hypothesis that interchangeability is absent does not contradict the general approach to the problem of ontological analysis in terms of source texts.

A product that performs analysis based on the source text ontologies builds:

- list of defined variables;
- list of used variables;
- list of initialized variables;
- list of variables used in calculations;
- list of displayed variables.

It is important that the aggregation of the variables lists that were used to be identical to the list of defined variables, the dynamic allocation restriction being operational.

Further, the research proceeds to sequence analyse to determine if:

- defined variables are initialized;
- there are variables that come into processing as entities in the left side of an assigning operation;
- there are variables that are displayed.

The source texts that do not hold true to the above mentioned analysis are either incorrect or incomplete.

The keyword *sum* requires using the + operator when expressing addition in computation.

The plural for the words *element* and *component* leads to using a repetitive structure in a software program.

A source text parser for syntax is based on syntax language names and takes every statement and determines to which extent it complies to the rules defined by the designers of the source code.

A strong semantic analysis component of a source text aims:

- highlight correlations between instructions;
- to suggest what changes should be made in the software program;
- to highlight the shortages in the source code;
- suggest equivalent instruction sequences.

There must be an option allowing the creation of a customized version of the source text while including changes that will impact the quality of the software running process. If the option is not activated, ontology-based analysis results are purely for guidance purposes.

Corporate governance is defined by a multitude of:

- types of individuals who perform tasks according to a job description sheet that includes responsibilities, deadlines, restrictions and quality standards;
- the matrix of all states the organization, for which analysis of corporate governance is performed, is going through as a progressive dynamic cybernetic system.
- activities that are characterized by duration, necessary resources, risks, outcomes and simple actions, replicable, executed in a well-defined succession;
- resources that are specific ongoing processes and which consist of raw materials, equipment, finished products, subassemblies, parts, energy resources, data and documents;
- flows that are defined differently if it's material flows, energy flows, information flows, flows of individuals, every time with regard to a start point and an end point, and crossing from the starting point to the end point is achieved by passing the organization system through a multitude of finite states;
- rules specific to corporate governance constituted as sets of unprocessed texts;
- pairs containing a subinterval and quality level.

For each set of resources, individuals, states, flows, activities finite and stable lists are built. Lists items associated to every set are described using a unique template of each sets. A vocabulary keyword is built using as a starting point from the texts included in the corporate governance rules. The keywords within the vocabulary are associated to resources, activities, people, streams, states, rules and conditions that must be met in order to achieve the aggregate indicators and required assessment levels belonging to subintervals to be put in correspondence with qualitative levels.

Is considered that a corporate governance ontology was defined if all elements of all the considered sets are fully defined and if a subset of indicators ranked by the levels of aggregation was built thus allowing for to associate without ambiguity the levels calculated using the indicators belonging to a subinterval put in correspondence with a quality level.

Analysis of corporate governance entails:

- building of a set of primary documents aimed at resources used, activities performed, people who participated;
- extraction of grades by comparing consumption, duration and quality analysis with planned levels;
- running aggregation processes using

simple indicators like:

$$IS = \frac{\sum_{k=1}^{n} \alpha(I_k, J_k)}{n}$$

where:

I_k - actual level;

J_k - planned level;

$$\alpha(I_k, J_k) = \begin{cases} 1, & I_k \geq J_k \\ 0, & I_k < J_k \end{cases}$$

- associating a value of data obtained using IS indicator with appropriate quality level of the sub-interval to which the IS value belongs to.
- the assessment process is performed according to the rules analysing governance for each individual resource and for the entire lot of resources, for each individual and for the entire staff, for each activity and total activities, for each state and aggregate states, for each rule and for all the rules.

Assuming that governance rules and components have different levels of importance, indicators are built with consideration of specific weights obtained by experimental means. It should be mentioned that the differences between the importance scores are obtained on the basis of data provided by specialists and weights must be monitored to ensure that they are of a stable nature over a longer period of time.

In this context the simple aggregate indicator becomes:

$$IS = \sum_{k=1}^{n} p_k * \alpha(I_k, J_k), \quad \sum_{k=1}^{n} p_k = 1$$

where:

I_k - actual level;

J_k - planned level;

$$\alpha(I_k, J_k) = \begin{cases} 1, & I_k \geq J_k \\ 0, & I_k < J_k \end{cases}$$

The analysis mechanisms of corporate governance oriented on ontology start from analysing a representative time sample of synthetized texts and from them, through reverse steps, analysis progresses until reaching the primary documents and the database to make complete and accurate definition of all orthogonal sets included in the data aggregation processes and putting in correspondence with the appropriate qualitative levels.

3 Procedures for Assessing Corporate Governance Based on Ontologies

To carry out the study on ontology based corporate governance, it is necessary to design a tool which includes a lot of procedures that are activated in predetermined succession and which ultimately leads to a conclusion on corporate governance in the organization.

The procedures are classified into three categories:

- procedures designed to prepare the informational basis on which processing is performed, in view of calculating aggregated indicators; data extracted from the database targets elements from the set of individuals; elements from the set of activities, elements from the set of states, elements from the set of raw materials, elements from the set of end products, elements from the set of flows, elements from the set of documents and any other set elements that need to be analysed in order to obtain a complete assessment of corporate governance in the organization; if this set of procedures is built so that the sets are obtained based on text analysis, in an automated way, analysis will increase in terms of the coverage;
- procedures for mapping the elements from the sets that were generated with full characterization using predefined templates; for the elements belonging to the individuals, as depicted in their job description, certain elements defining planned levels to be achieve are extracted; for the elements belonging to the activities set, as depicted in technology sheets, certain elements that concern planned raw material consumption, planned timeframe of activities, succession of simple actions, result of each activity and its

characterization; for all the sets required for a comprehensive analysis templates are defined and filled in automatically;

- procedures for calculating aggregated indicators which entail scanning databases containing the evolution of the organization over a given period while extracting the actual levels for the elements within the templates associated to the sets being considered; values of aggregated indicators at different levels according to organization structure are obtained; it is important to ensure the homogeneity of the aggregation processes working only with indicators in which resources, people, activities, states and resources have the same importance, respectively, working only with indicators in which associated weights are derived from data sets; if structure of the organization is a tree type structure than at the maximum level of aggregation, corresponding to the tree root level, results the aggregate indicator that has a certain value which belongs to a certain subinterval and the sub-interval is put in correspondence with an appropriate quality level.

Building the list of resources, people, states and rules is based on a tailored approach to the BNF – *Bachus Naur Form* description used in describing programming languages.
Procedures within an organization are grouped as follows:

<procedure>::=<resources list><activities list><results list>

where:

< resources list >::= represents all resources used by the organization in its effort for obtaining profit;
< activities list >::= represents all the activities performed by the organization;
< results list >::= represents results based on which organization obtains a profit.

All coordination efforts that resulted in getting the end products delivered, starting from the primary resource state, are called procedures and belong to the category defined above.

Fig. 3. Simple format for constructing procedures

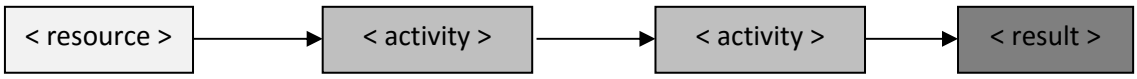

Fig. 4. Format for constructing procedures

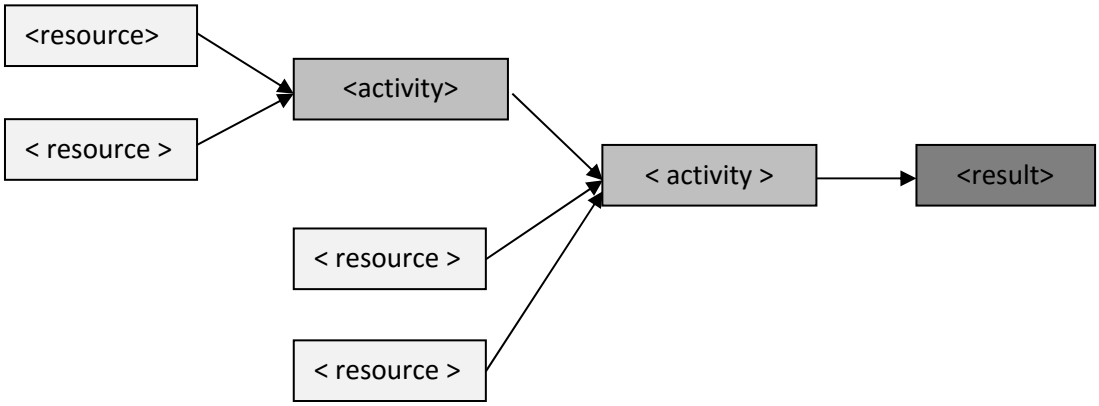

Fig. 5. Complex format for constructing procedures [8]

In addition to the formats presented above there are countless other formats of constructing procedures depending on the interaction between resources, activities and results. Best practice means to have a list of raw materials and an actual results list. There planned results and achieved results. Differences between planned results and achieved results are analysed thus resulting the difference between *planed* and *achieved*. In reality, in an organization are a *np* number of procedures are constructed {P_1, P_2, P_3, …P_{np}}. The hypothesis assumes that all procedures are equally important. Going further:

$$J(p_i)=\begin{cases}1, if\ \ the\ \ procedure\ \ is\ \ completly\ \ \text{accomplished}\\ 0, if\ \ the\ \ procedure\ \ is\ \ NOT\ \ completly\ \ \text{accomplished}\end{cases}$$

The IG indicator is calculated as:

$$IG=\frac{\sum_{i=1}^{np}J(P_i)}{np}$$

The value of IG indicator shows whether or not there is a good corporate governance within the organization. So if: very good corporate governance

$$IG\in\begin{cases}[0;0,78]-\text{bad corporate governance}\\ [0,78;0,92]-\text{good corporate governance}\\ [0,92;1]-\text{very good corporate governance}\end{cases}$$

In this hypothesis good governance means:

- establish procedures list *P*;
- establishing a precedence graph so the order in which the procedures are performed is known, Figure 6.

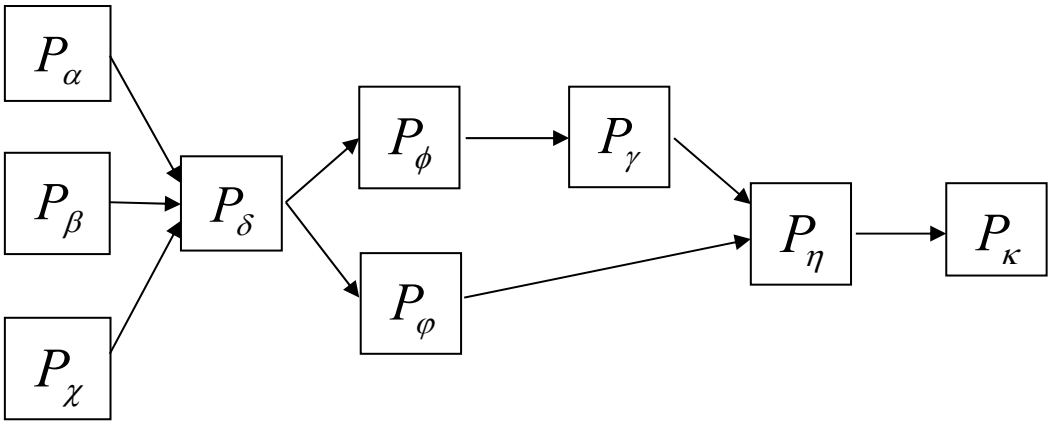

Fig. 6 - Precedence graph [8]

- procedures are analysed;
- *IG* indicator is calculated;
- governance level is determined.

IG indicator is calculated for each procedure in list *P*. Then governance is determined by averaging the values calculated for the IG indicator when it comes to all the procedures within the organization.

The software tool for the analysis of corporate governance routinely uses sub-programs for:

- reading a set of representative texts and calculating the of words' occurrence frequency;
- ranking by frequency the words within the vocabulary;
- extraction of a sub-vocabulary in relation to a coefficient of representativeness;
- separation within the sub-vocabulary for the set of individuals, set of activities, set of states, the set of rules and the set of flows;

- defining templates for planned levels by parsing the databases where there are specific consumptions, planned duration, minimum duration and precedents;
- location events that took place in the organization within a given timeframe and extracting them;
- comparing planned levels with achieved levels;
- calculation of indicators aggregated at the level of each element within the collectivity, and calculation on indicators at collectivity level;
- summing up aggregate indicators in order to obtain a calculated level for all the components that define corporate governance, individuals, activities, states, flows, rules and resources;
- establishing the assignment of calculated values to subintervals and the sub-interval's to a quality level.

The level of automation of the entire process of analysing the corporate governance oriented ontology depends on:

- lists' coverage associated with each set;
- templates complexity associated to set elements;
- accuracy and stability for planned levels;
- sub-intervals representativeness associated to qualitative levels.

Such a software product is highly complex and requires the organization's software infrastructure to be of an open nature so that the primary information will be the basis for building all the sets. In addition to this, it is of paramount importance that the software infrastructure is designed so that updating data is performed by adding information while identifying the individual, the place and the time specific to the event that's being registered.

4 Conclusions

Assessing the requirements of corporate governance based on ontologies entails a new way of designing the organization's IT system, because all the processes used in the assessment process are based on data obtained by parsing databases. The digital content from all the databases of the IT system, where update means adding information, constitutes the foundation on which the vocabulary is built, collections and relations between them, everything being based on the actual reality within the organization.

Implementing a software product designed to evaluate corporate governance based on ontologies is done gradually starting with a set of data characterised by a high level of uniformity, whose elements are described using a low complexity template and for which, on a predefined time interval, representative aggregate indicators are calculated without significant effort. The value obtained from the calculation is framed in a subinterval and it is put in correspondence with a certain quality level. Likewise, components are implemented by adding software features that allow the same steps to be performed on another subset that characterizes corporate governance. The process continues and the software product grows in complexity in an extensive manner. After all the procedures concerning the whole assembly defining a corporate governance based on ontologies were implemented, occurs the aggregation of all previously calculated indicators thus generating an aggregate value, which is put in correspondence with a subinterval, which in turn is placed in correspondence with a quality level.

The process is lengthy because the rules of good corporate governance need to be successively refined, so that they become directly usable in an evaluation process based on ontologies.

If indicators structures, mechanisms of constructing sets of components, template structures are carried out so that they are accepted without reserve by the auditors of corporate governance processes, it creates real premises for the software to become a useful tool to assist auditors, without replacing them but by rather to helping them to draw conclusions based on comprehensive analysis of primary data on individuals, activity, products, flows, materials,

information and rules circulated within the organization.

The report on corporate governance is based on the results of the implementation of ontology oriented algorithms which lay in correspondence quantitative levels with qualitative levels.

The role of specialists is to define the specific context of successive integration of outputs by calculations of aggregated indicators. The human factor has the task to move to assessment based on context while taking into account factors that are not included in the analyzed subsets and in the templates built for the elements' subsets. Analysts of corporate governance processes include in their reports risk elements that are found within the organization and elements that reflect the interaction between the organization and the business environment.

As a future research topic one might build a software product based on the IG indicator and implement it to be used in assessing corporate governance quality levels.

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