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SPECIFICATION OF FINANCIAL KNOWLEDGE – THE CASE OF AN INTELLIGENT DASHBOARD FOR MANAGERS[1]

Abstract: The article presents the approach to the definition the financial knowledge used for an Intelligent Dashboard for Managers. The content of the knowledge is focused on essential concepts related to the management of micro, small and medium enterprises. Knowledge-based functions, not previously available in commercial systems, increase the quality, effectiveness, and efficiency of the decision-making process. The Intelligent Dashboard for Managers contains six ontologies describing areas of Cash Flow at Risk, Comprehensive Risk Measurement, Early Warning Models, Credit Scoring, Financial Market, and General Financial Knowledge. In the article we presented the process, used in the InKoM project, of creating ontology, particularly the stage of encoding ontology in a formal way in Ontopia. This description was illustrated with the example of creating ontology of Credit Scoring.

Keywords: financial knowledge, ontology, topic maps, dashboard for managers.

1. Introduction

Decision makers of small and medium enterprises (SMEs), using Business Intelligence systems, frequently need appropriate knowledge about the economic situation of the enterprise and its environment. Knowledge about key dependences between various financial ratios is essential because they can indicate important trends and alert one to anomalies and dangers [Olszak 2011, p. 85]. Decision makers in SMEs, in contrast to managers of big companies, may have no access to much essential strategic information. SMEs operate in a definitely more uncertain and risky environment than big enterprises because of the complex and dynamic market that has a much more important impact on SMEs' financial situation than on big companies. Tolerance of mistakes is narrower (see among others [Gibcus,

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Vermeulen, Jong 2009, p. 74-91]). In these conditions, SME's decision makers often act intuitively and as a result, the rationality of their decisions is decidedly lesser. Moreover, the survey of SME managers shows that they often do not have a solid knowledge of economics and finance.

In general, most existing Business Intelligence (BI) and Executive Information Systems (EIS) provide the functionality of data aggregation and visualization. Many reports and papers in this domain underline the fact that decision makers expect new ICT solutions to interactively provide not only relevant and up-to-date information on the financial situation of their companies, but also explanations taking into account the contextual relationships.

The aim of this article is to present the approach to the specification of financial knowledge used in the Intelligent Dashboard for Managers further referred to as InKoM). The InKoM system has been developed by a consortium consisting of the Wroclaw University of Economics (WUE), which is the leader, and the company UNIT4 TETA BI Center Ltd. (TETA BIC). Credit Agricole Bank Polska S.A. is also participating in this project.

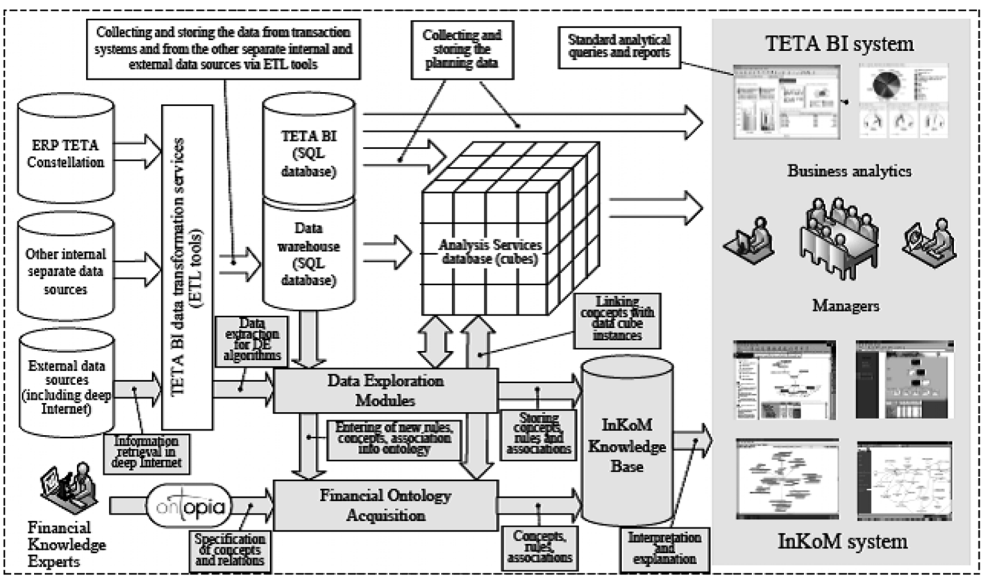

Figure 1. Components of the Intelligent Dashboard for Managers and their location in the TETA BI system (The InKoM components are shaded in grey)

Source: own elaboration.

Figure 1 presents the main components of the InKoM: a comprehensive description of the TETA BI system with examples of its application is available on the website: [*TETA Business Intelligence*] (see also [*Architektura system*... 2011;

We change... 2011]). It can be seen that the InKoM uses TETA BI mechanisms for extracting source data from transactional systems (ETL), its data warehouse and an analytical database. However, the available solutions – in particular the standard analyses, reports and analytical statements generated by the system – are complemented by economic and financial knowledge – most importantly ontologies and topic maps – and financial data mining algorithms, including mechanisms for extracting business knowledge from the deep Web. This enables a dynamic, on-line, interactive analysis of key economic and financial indicators.

The transactional data obtained from external sources, supplemented with planning data, e.g. budgets, form multidimensional data structures, or cubes, which are stored in a TETA BI Analysis Services database and provide the basis for the on-line, interactive creation of standard analytical queries and/or reports. The InKoM system complements and extends these processes[2]. By providing economic and financial knowledge stored in ontologies and presented in the form of topic maps to facilitate the perception of concepts, InKoM can make the analysis more comprehensive and simpler. This is particularly important for users who are not specialists in the analysis and interpretation of economics and finance.

Over a dozen methods of building ontologies have been developed. Among the methods listed in literature, the following are worth noting (more widely characterized inter alia in [Dudycz 2013; Gomez-Perez, Corcho, Fernandez-Lopez 2004; Pimentel, Suárez, Caparrini 2009]):

- METHONTOLOGY (based on the standard IEEE 1074-1995) – is used to build ontology from scratch. This method is based on the main operations defined by the process of software development and by the methodology of knowledge engineering.
- Noy and McGuinness' method – was proposed by its authors as a textbook for developing ontologies. This approach is based on creating examples, followed by the iterative process of evaluating and improving them.
- On-To-Knowledge – allows building ontology for knowledge management systems. It was developed during the project of the same name financed by the European Union, whose aim was to apply ontology to information accessible electronically in order to easily manage knowledge in big scattered organizations. In this method the created ontology depends largely on the applications in which it will be used.
- SENSUS – proposes connecting topics specific for a given field (or domain) in order to created bigger ontologies and limiting those topics that are not essential for new ontology. The basic assumption of this method is to share knowledge, as it assumes the same base ontology for all newly created ontologies concerning the given field.

[2] The InKoM architecture and functionalities were presented in [Korczak, Dudycz, Dyczkowski 2012a; 2012b].

- UPON (Unified Process for ONtology building) – is marked by *use-case driven* and iterative, and incremental character. Therefore it is also described as an incremental method of ontology building.
- Ushold and King's method – was developed basing on experiences gained by its authors during project Enterprise Ontology, which consisted in creating ontology for modeling enterprise processes. This approach was used inter alia to create KADS and IDEF systems, and was also developed by IBM as BSDM.

Noy and McGuinness emphasized that the best model of ontology is the one that best cooperates with the existing information system, accomplishes a set of goals and is intuitive and easy to maintain [Nelson 2010]. So far there is no single standard of design because creating an ontology is dependent on its application and the needs of specific users (see [Noy, McGuinness 2005]). However during recent years the standardization activities in terms of information have been undertaken at European level; an example is the SMEST project (see http://www.cencenelec.eu/sme/SMEST/).

The structure of the paper is the following: in the next section the ontological approach to knowledge design is described. The third section presents the ontology structure. The fourth section characterizes the ontology design process in the InKoM. In the next section encoding of ontology in the InKoM is described. The last section summarizes the work already carried out and points out the further research and development tasks.

2. Ontological approach to knowledge definition

The main goal of any BI system is to provide simple, personal analytical tools which support the exploration of data sources, the retrieval of information based on predefined economic and financial relations, and do not require a priori knowledge about data structures and methods of data accessing (see among others [Dudycz 2013; Nelson 2010; Raden 2007; Sell et al. 2008]).

Today the development of new BI systems is oriented towards BI 2.0 (using semantic search) and 3.0, Service Oriented Architecture (SOA) and Software as a Service (SaaS) (see [Nelson 2010; Raden 2007; Sell et al. 2008]). The typical features of the systems include: proactive alerts and notifications, event driven (real time) access to information, advanced and predictive analytics, mobile and ubiquitous access, improved visualization, and semantic search information (see also [Nelson 2010]).

One of the main parts of modern BI systems is the ontology (see [Nelson 2010]). In general, the ontology is used to create the necessary knowledge models for defining functionalities in analytical tools. In the development of InKoM, many new features are integrated such as domain ontology covering the key concepts of corporate finance and economics, knowledge discovery algorithms, semantic search mechanisms, explanation facilities, and tools for visual navigation in financial knowledge.

In the InKoM project, six ontologies were built covering economic and financial areas: Cash Flow at Risk, Comprehensive Risk Measurement, Early Warning Models, Credit Scoring, the Financial Market, and General Financial Knowledge. The ontologies will be detailed in the next section.

The integration of these ontologies into the BI systems assures:

- support for the definition of business rules in order to get proactive information and advice in decision-making;
- a semantic layer describing relationships between the concepts and indicators;
- relevant information according to the different kinds of users that can be found in an organization;
- effective usage of existing data sources and data warehouse structure.

The knowledge representation layer is the most critical aspect of a BI system since it broadly shapes the core understanding of the information displayed on their screen [Wise 2008]. In the InKoM design, the basic assumption of navigation was that managers should be able to view focus and context areas and, at the same time, to present the relevant knowledge structure [Smolnik, Erdmann 2003].

3. Ontology structure

Analysis of SMEs decision makers' needs defined the required fields of economic and financial knowledge. Creating one ontology for this whole knowledge is neither a good nor a practical solution, because of the number of topics and relations. That required determining the areas of created ontologies and their scope. With the participation of experts it was decided that the InKoM systems' knowledge would consist of six selected areas: Cash Flow at Risk, Comprehensive Risk Measurement, Early Warning Models, Credit Scoring, Financial Market, and General Financial Knowledge (Figure 2). Between these fields there are intersections, and some topics belong to two or three ontologies.

CFaR is considered to be one of the best adjusted ratios for the needs of complex risk measurement in enterprises. According to the newest trends in enterprise management and on companies' economic practice, it was determined that the appropriate ratio for complex risk management in enterprises is *Cash Flow at Risk* (CFaR) using the *RiskMetrics Group* rules. The choice of *Cash Flow at Risk* meets managers' needs in the scope of creating single risk ratio, illustrating the risk level connected with an enterprise's operating activity. Of course, the prerequisite for the manager being able to use this information is the appropriate knowledge level on CFaR ratio.

The ontology of *Comprehensive Risk Measurement* involves various variants of the model used to estimate the *Cash Flow at Risk* ratio. The developed ontology concerns the way of understanding and defining inter alia: risk variables, risk models and the risk management process.

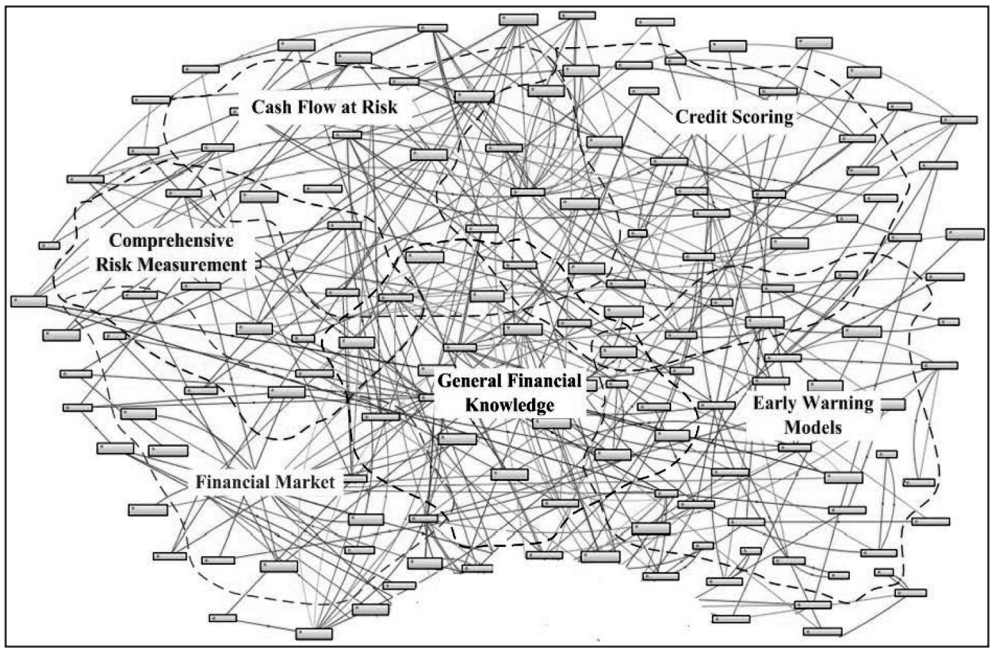

Figure 2. Ontology domains in the InKoM

Source: own elaboration.

The ontology of the Early Warning System contains models of cautionary forecasting in supporting a manager's decision. The developed concept uses a group of tools for early warning model creation, in which mainly data from financial reports are used. By using this data an objective view of a company's situation can be quickly and easily obtained, which is essential for a manager's efficient and accurate decision making.

The ontology of *Credit Scoring* describes the model of the credit procedure carried out by a bank. Credit scoring evaluation is an integral part of bank credit procedures (credit processes) and it is an essential stage in conditioning the granting of credit. This is realized by a bank's organizational units and supporting infrastructural-system solutions, and the company trying to get credit (potential borrower) is the subject of analysis (quantitative and qualitative). The internal logic and details of credit procedures in a specific bank is its unique know-how and is not usually made public.

In literature, many approaches to credit scoring can be found, such as stochastic models (e.g. Bayesian models, regression, Markov chain), artificial intelligence techniques (e.g. expert systems, neural network models, genetic algorithms) and data mining methods [Desai et al. 1997; Fishelson-Holstine 1998; Fung et al. 1997; Hand, Henley 1997; Yobas, Crook, Ross 1997]. The approach implemented in the InKoM

system is based on the rule of thumb generally accepted in the practice of financial institutions. Of course there are still open questions which might be considered: which methodology to choose? What models might work? Should one look at the profit on each product in isolation or the total profit over all possible products? In general there is no overall best method of credit scoring. The InKoM system is open to include more advanced models and rules, specific to the particular type of company or financial institution.

The Financial Market ontology involves information about the financial market and financial instruments. Knowledge on this topic is an essential element capable of aiding a manager in making investment decisions and securing from market risk. The financial market may be used by managers to regulate liquidity by using money market instruments.

The ontology of *General Financial Knowledge* concerns essential economic and financial knowledge which is required to analyze issues of listed ontologies. This ontology includes a set of supplementary topics to other ontologies and will be used in calculating the value of Cash Flow at Risk (the ontology of Cash Flow at Risk), basic economic ratios (the ontology of Early Warning System) and indicators used by banks in the process of credit scoring (the ontology of Credit Scoring).

To sum up, the domain knowledge about the relations between economic and financial ratios will make the analysis and interpretation of contextual connections easier. This is very important in the case of SMEs, where a company does not employ experts in economic-financial analysis and using outer consultants is too costly.

4. Ontology design process

In the design of the InKoM system, five basic stages of creating the ontology were defined. These are:

1. Definition of the goals, scope and constraints of the created ontology. While creating an ontology, assumptions about the created model of knowledge that will apply during its building have to be provided. That requires an answer to the question: *what will the created ontology be used for?*

2. Conceptualization of the ontology. This is the most important stage in the procedure of ontology development[3]. It includes the identification of all notions, definition of classes and their hierarchic structures (*Superclass – Subclass*), modeling relations, identification of instances, specification of axioms, and rules of inference.

3. Verification of the ontology's correctness by experts. In this stage the constructed ontology is verified by experts who did not participate in the process of creating it.

[3] Independently of the field that is to be modeled by using an ontological approach, this is the most important stage in creating a model based on ontology (see inter alia [Almeida, Barbarosa 2009, p. 2036]).

4. Encoding the ontology in a format compatible with the knowledge representation standard. During this stage the developed ontology is described in the formal language or chosen software. The result of this stage should be the encoded ontology.

5. Validation and evaluation of the built ontology. This is the stage during which the evaluation of the created ontology meets the needs of the managers.

An important stage in the described procedure of creating an ontology is the conceptualization of the ontology. The process of conceptualization of an ontology is an intellectual activity organizing knowledge from a given field carried out by the person, either an expert or collaborating with an expert, responsible for creating the model of knowledge without the support of automated tools (see inter alia [Almeida, Barbarosa 2009, p. 2036]). In this scope, there are few concepts of identification of topics and relations between them within the process of conceptualization. These are the following approaches to carrying out an analysis: top-down, bottom-up and middle-out. We used middle-out, because it enables us best to maintain the level of detail control of the created ontology and reduce imprecision, which translates into reducing iterative work (see [Uschold, Gruninger 1996, p. 21]; see also [Almeida, Barbarosa 2009, p. 2036]). Based on literature studies (inter alia [Gomez-Perez, Corcho, Fernandez-Lopez 2004; Noy, McGuinness 2005]), as well as research carried out, the following procedure in the conceptualization of the ontology of economic knowledge was used:

1. Identification and definition of all topics. A topic, representing any concept, is "a syntactic construct that corresponds to the expression of a real-world in a computer system" [Grant, Soto 2010, p. 60]. In the InKoM project, the topics' list was determined by experts creating ontologies for the given field of economic knowledge. These topics include, beside their names, their synonyms and descriptions (Table 1).

Table 1. The example of topics' list

Name	Synonym	Description
Return on Assets	ROA	ROA indicator is a synthetic measure that determines company's assets capability to create profit. It shows the percentage net profit per unit of capital invested in the company.
Profitability evaluation indicators	–	Evaluation using indicators of profitability

Source: own elaboration.

2. Creating a taxonomy of topics. Specification of taxonomic relations between distinguished topics and defining classes and subclasses. In Figure 3, the taxonomy for the topic *Indicators* and the topic *Profitability evaluation indicators* are shown[4].

[4] The description of taxonomy can be presented in a graphic or tabular form. An example of the description as a table was shown in: [Korczak, Dudycz, Dyczkowski 2013].

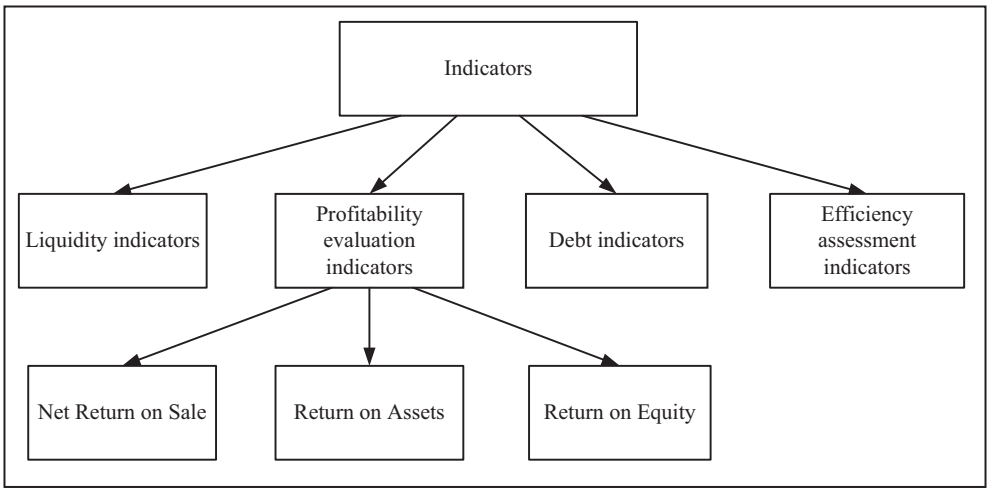

Figure 3. The example of the taxonomy for the topic *Indicators* and the topic *Profitability evaluation indicators*

Source: own elaboration.

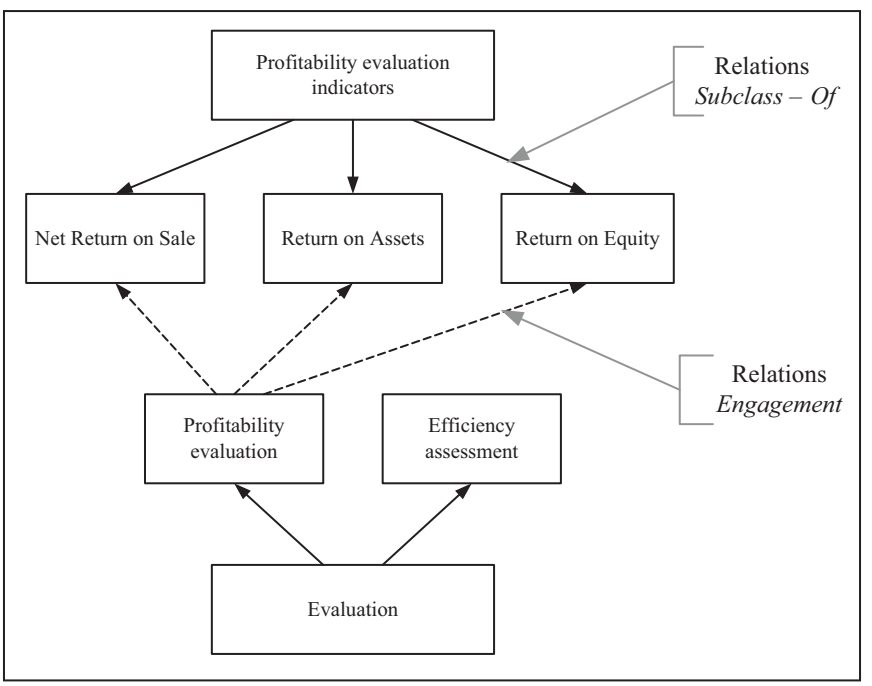

Figure 4. The example of illustrated of relationships *Engagement*

Source: own elaboration.

This relationship describes the topics' generalization. This approach to creating a taxonomy is proposed in METHAONTOLOGIA (see [Gomez-Perez, Corcho, Fernandez-Lopez 2004]).

3. Definition of all other types of relations between topics. In the InKoM project, the basic relationship *aggregate of* (*Aggregate – Member*) occurring in all six created ontologies was defined. Moreover, within each ontology additional relations were defined, for example: *engagement* (*Engaging – Accession*).

4. The list of all the user defined relationships existing in the ontology. The list includes the name of the relationship, source topic, and target topic. The description of taxonomy can be presented in a graphic or tabular[5] form. In Figure 4, the relations existing between topics in the class *Profitability evaluation indicators* and the topic *Profitability evaluation* (in the class *Evaluation*) are shown. The solid lines denote taxonomic relations (relation *Subclass – Of*), whereas the broken lines denote basic relations (relation *Engagement*).

5. Description of functions and rules. The definition of the knowledge of how to interpret their values and explain financial ratios is essential. In the InKoM this description contains: name, input, output, initial and final conditions, and a definition of a formula. The following description specifies the example of the indicator Return on Assets (ROA), implemented in the InKoM system:

Name:
Indicator Return on Assets (ROA)
Input:
– *Result of Net profit (NP)*
type: number, value with balance sheet
– *Total Assets (TA)*
type: number, value with balance sheet
Output:
– *Return on Assets*
Initial conditions:
– *available data from balance sheet*
Final conditions:
– *Message 1: "Value of indicator ROA"*
– *If ROA<5%,*
Then to Message 2: "Low value of ROA";
– *If 5% < ROA < 10%,*
Then to Message 3: "Average value of ROA";
– *If ROA > 10%,*
Then to Message 4: "High value of ROA";
Description/formula:
ROA = NP/TA

[5] An example of description as a table was shown in: [Korczak, Dudycz, Dyczkowski 2013].

6. Description of usage scenarios. Usage scenarios, also called use case view, describe the demonstration analyses of economic topics occurring in this ontology. For example, if a manager is interested in the opportunity of applying for a bank loan:

- The manager analyzes the semantic network, from which it follows that the credit score assessment is based on the analysis of indicators belonging to four groups: debt indicators, liquidity indicators, profitability evaluation, and efficiency assessment.
- From the TETA BI system the manager receives the values of financial indicators that make up the credit score assessment. According to them, the company has bad parameters concerning profitability evaluation, especially the value of the ROA indicator.
- The manager analyzes the semantic network connected to the data from the TETA BI system on account of the semantic connections of the ROA indicator with other indicators. The aim of the action undertaken by the manager is to identify causes of unfavorable values from the ROA indicator.
- Based on conclusions from the analysis conducted of economic indicators, the manager can undertake corrective actions which may potentially result in improving the company's condition. An improvement of the company's parameter essentials in the score assessment can allow actions to be undertaken concerned with receiving the bank loan.

That work has required multi-domain expert knowledge, both theoretical and practical, in economics, finance, and informatics.

After its realization, the stage of conceptualization of the ontology is started with the verification of the ontology's correctness by experts. This is the third stage of creating the ontology as defined in the project InKoM. The constructed ontology is verified by experts who did not participate in the process of creating it. The experts are economic and financial researchers and managers of SME (including users of the TETA Business Intelligence System).

5. Encoding of ontology

Encoding is the fourth stage of ontology development, in which the ontology is described in the formal language or chosen software. The result should be the encoded ontology. In the InKoM, the format compatible with the topic map standard has been applied. The developed ontology was entered using the programs Ontopia and Protégé 4.2. Ultimately it will be performed with the use of software for topic maps developed by the company UNIT 4 TETA BI Center.

In the paper, the specification of ontology is presented by the ontology for Credit Scoring following the procedure of the encoding of the ontology as below:

1. Entering all topics and creating taxonomy of these topics. In this step all topics defined in the procedure of conceptualization of the ontology are specified.

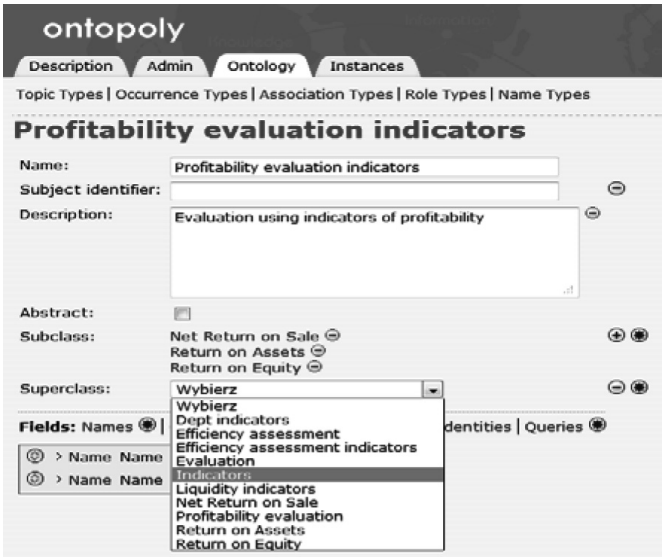

Figure 5. The exampleillustrates the description of topic of *Profitability evaluation indicators* in Ontopia

Source: own elaboration.

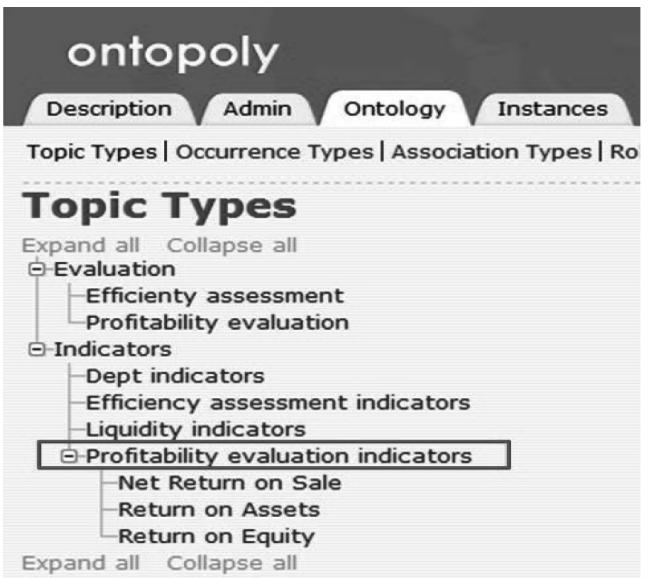

Figure 6. The example illustrates the topic *Profitability evaluation indicators* in the structure of taxonomy of Credit Scoring in Ontopia

Source: own elaboration.

In Figure 5, entering and description of topic *Profitability evaluation indicators* is shown[6]. Each topic is detailed by name, description, subclass and superclass. In Figure 6 a part of the taxonomy of Credit Scoring is shown. The user can see the result of entering and he/she can verify this topic in the structure of taxonomy of this ontology.

2. Entering all other types of relations between topics. In this step all relations defined in the procedure of conceptualization of the ontology are entered. In the InKoM project, first, in order to quickly test the developed ontology, it was entered in the program Ontopia. As opposed to other ontology editors, there are no arrows, i.e. it is not possible to define the direction of relation. In order to do this, from the Ontopoly tab we choose *Role Types* and create a new role type (Figure 7). They indicate the relation's direction, that is one topic's dependence on another topic (except for the relation *Subclass – Of*). In Figure 8 there is the example of defining the relation *Engagement* between the topic *Profitability evaluation* (role type: *Engaging*) and the topic *Return on Equity*.

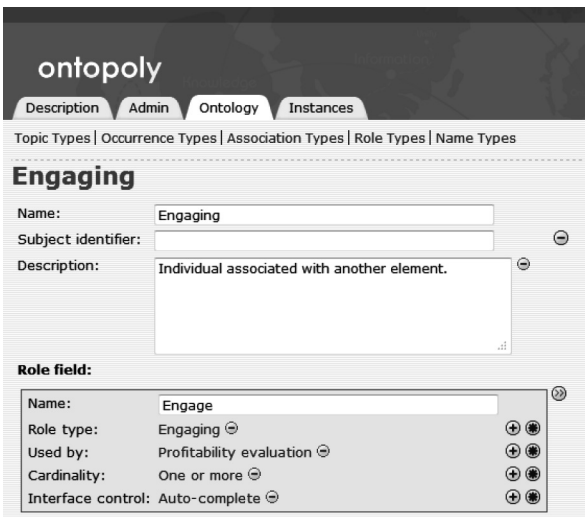

Figure 7. The example illustrates the definition of the role type *Engaging* of Credit Scoring in Ontopia

Source: own elaboration.

Ontopia allows saving the created ontology according to the topic map standard[7]. This is essential because the visual exploration in InKoM is based on a standard Topic Map. TM enables the representation of complex structures of knowledge bases [Arndt,

[6] In the example, part of ontology of Credit Scoring is presented in English. In the InKoM ontologies are created in Polish.

[7] The standard of Topic Map (TM – ISO/IEC 13250:2003) was defined in an XML syntax XTM. The format XTM can be converted to a notation topic map (LTM).

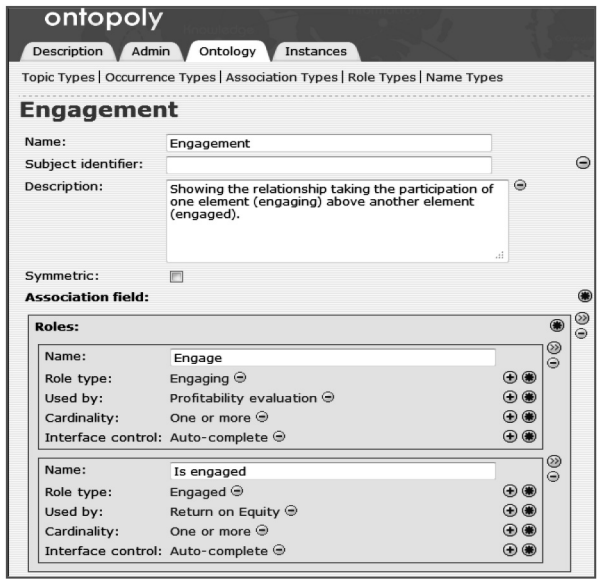

Figure 8. The example illustrates the fragment of definition the relation *Engagement* of Credit Scoring in Ontopia

Source: own elaboration.

Graubitz, Jacob 2008] and the delivery of a useful model of knowledge representation (see [Librelotto et al. 2009, p. 174]), where multiple contextual indexing can be used. TM is a relatively new form of the presentation of knowledge, which puts an emphasis on data semantics and the ease of finding the desired information (see also [Ahmed, Moore 2006; Pimentel, Suárez, Caparrini 2009, p. 30]). The application of topic maps permitted us to separate the data of the enterprise's information system from operational business activities (see among others [Korczak, Dudycz 2009]). The developed topic maps for the analysis of economic indicators (see among others [Dudycz 2011b; 2011a; Korczak , Dudycz 2009]) have demonstrated that the system [Dudycz 2012]:

– can be easily used for the representation of economic knowledge about economic and financial measures,
– can express the organizational structure,
– can be adapted to new applications and managers' needs,
– can be supportive of the managerial staff by facilitating access to a wide range of relevant data resources,
– can assure a semantic information search and interpretation for non-technically-minded users,
– can visualize different connections between indicators that make possible the discovery of new relations between economic ratios constituting knowledge still unknown in this area,

– can improve the process of data analysis and reporting by facilitating the obtaining of data from different databases in an enterprise, and finally
– can be easily extended by users who are not IT specialists, e.g. by experts in economic analysis (using tools for creating a topic map application).

The preliminary evaluation of ontologies is very encouraging. Knowledge of corporate finance is very useful in the interpretation and explanation of data presented in the financial reports of BI systems.

A part of the visualization of the entered ontology is presented in Figure 9. The screenshot shows the expansion of the selected topic: *Total Assets*. In the diagram it is the area encircled by the dashed line, with new topics being a subclass of the topic *Total Assets*. In InKoM, a semantic search is provided to avoid difficulties related to the decision makers' interpretation of economic and financial information. This gives the opportunity to search data sources taking into account not only structural dependences, but also the semantic context. In this figure there are two types of lines between topics, (1) the solid line represents a relation *Subclass – Of* and (2) the dashed line represents the user defined relations.

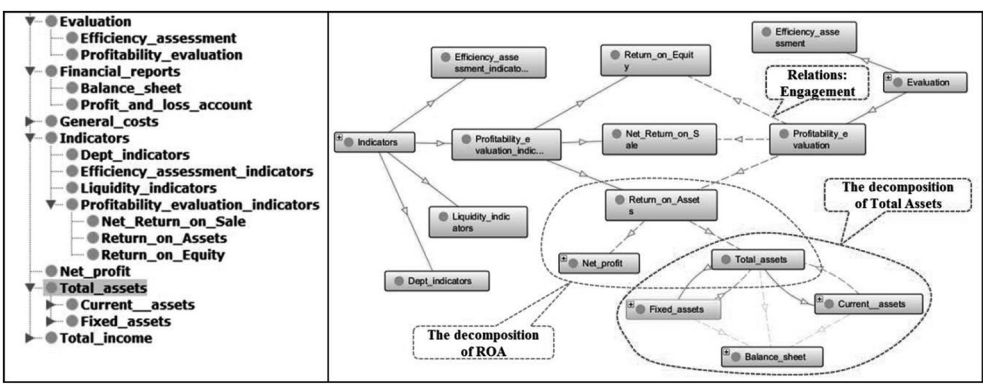

Figure 9. Example of topic map including *Total Assets*

Source: own elaboration.

After the stage of encoding the ontology in a format compatible with the knowledge representation standard, the stage of the validation of ontology begins. This is a very important stage of the project development because the created ontology should meet the needs of the managers.

In the InKoM system, the manager can use the topic map application which allows the visualization of relationships between the analyzed topics. Visualizing the relationships explicitly not only makes the interpretation of indicators easier, but also contributes to finding the explanations of the current values of indicators. The topic map provides a user-friendly interface which allows managers to navigate easily from

topic to topic in an interactive manner. Therefore various types of associations are visualized in different ways. To interpret financial reports correctly, many measures and ratios need to be examined that either directly or indirectly influence the final economic performance of the enterprise. For example, the lines which have the same relation have the same color. This enables an easy overview of the concepts, visualisations and navigation of hierarchical structures, whilst also providing short definitions on each topic. The visualization is highly interactive – interesting nodes can be put in the foreground with zooms, translations, and rotations. Managers can delete non-relevant branches of the graph or expand the interesting ones.

5. Summary and future work

In this paper, the approach to the ontology specification of InKoM was presented. We concentrated mostly on the fourth stage of ontology development - the encoding of ontology, which is a key stage of creating ontology. In the InKoM development the editors Ontopia and Protégé 4.2 and a XTM parser developed by TETA were used to encode and implement the InKoM ontology.

Based on the design experiences, the following main conclusions can be formulated:

1. The quality of specification of economic and financial knowledge depends on the correctness of the conceptualization of ontology.

2. The process of encoding ontology should be supported by tools dedicated to knowledge specification and programs allowing formal and rigorous specification. The editors used, Ontopia and Protégé, assure the standard representation of ontology and topic maps.

3. In terms of the editors' functionalities, the visualization facilities of Protégé seems to us more effective and efficient than Ontopia. However, the editor in Ontopia is relatively easier to use by allowing corrections, e.g. entered topics or relations in case of formal and conceptual mistakes.

4. Encoding of ontology using editors' facilitates the domain experts' verification of completeness, consistency and the formal correctness of domain ontology.

In the next step of the project, further studies will be conducted on the above issues, notably navigation in topic maps, reasoning engine and explanation mechanism.

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PODEJŚCIE DO REPREZENTACJI WIEDZY FINANSOWEJ NA PRZYKŁADZIE INTELIGENTNEGO KOKPITU DLA MENEDŻERÓW

Streszczenie: W artykule przedstawiono podejście do reprezentacji wiedzy finansowej zastosowane w tworzonym inteligentnym kokpicie dla menedżerów w projekcie InKoM. Dobór obszarów wiedzy koncentruje się na podstawowych pojęciach związanych z zarządzaniem przedsiębiorstwami mikro, małymi i średnimi. W tym celu opracowano sześć ontologii opisujących obszary: system wczesnego ostrzegania, kompleksowy pomiar ryzyka, szacowanie *Cash Flow at Risk*, ocenę zdolności kredytowej przedsiębiorstwa, rynków finansowych i ogólną wiedzę ekonomiczno-finansową. W artykule przedstawiono zastosowany w projekcie InKoM proces tworzenia ontologii, szczególnie koncentrując się na etapie zapisania jej w sposób formalny w edytorze Ontopia. Opis ten zilustrowano na przykładzie tworzenia ontologii Credit Scoring.

Słowa kluczowe: wiedza finansowa, ontologia, mapy pojęć, kokpit dla menedżerów.

Annex


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