Satellite Meeting - Knowledge Management Section
New Directions in Knowledge Management

Design of financial assessment scenarios of small and medium enterprises

Helena Dudycz
Faculty of Management, Computer Science and Finance, Wroclaw University of Economics, Wroclaw, Poland.
E-mail address: helena.dudycz@ue.wroc.pl

Jerzy Korczak
Faculty of Management, Computer Science and Finance, Wroclaw University of Economics, Wroclaw, Poland.
E-mail address: jerzy.korczak@ue.wroc.pl

Bartłomiej Nita
Faculty of Management, Computer Science and Finance, Wroclaw University of Economics, Wroclaw, Poland.
 E-mail address: bartlomiej.nita@ue.wroc.pl

Piotr Oleksyk
Faculty of Management, Computer Science and Finance, Wroclaw University of Economics, Wroclaw, Poland.
 E-mail address: piotr.oleksyk@ue.wroc.pl

Abstract:

Our research focuses on finding a solution to extend the functionality and knowledge of Business Intelligence systems to answer the information requirements of managers of small and medium-sized enterprises (SMEs). It concerns two major aspects of the system, i.e. the interface that takes into account the level of knowledge of the manager, and interpretation of economic and financial information using the built-in domain ontologies. The project is related to the design of smart decision support systems based on financial ontology and on the model of manager knowledge created by eye tracking analysis. The described approach is a continuation of the development of the intelligent cockpit for managers (InKoM project), whose main objective was to facilitate financial analysis and the evaluation of the economic status of the company in a competitive market. The current project is concentrated on the financial assessment scenarios supported by static (structural) and procedural knowledge. The knowledge contains the essential financial concepts and relationships related to the management of SMEs.

Keywords: ontology, assessment scenarios, financial analysis, Business Intelligence system.

1. Introduction

Small and medium-sized enterprises (SMEs) management is a process of continuous decision-making, whereas accuracy of this process determines the effectiveness and efficiency of economic activities. In practice it is very often emphasized that decisions are worth as much as information that serves a as a basis for taking these decisions. Each decision should be preceded by a financial projection and an appropriate assessment of its potential effects. The support of decision-making is based on the generation of ready-made paths, together with projections of the effects of planned decisions. These reports and patterns of decision-making should take into account inter alia the support for operational and financial planning, and risk analysis (in particular, the risk of bankruptcy). In addition, they may include support in investment decisions and measuring the effectiveness of the company as a whole and its individual organizational units. It requires taken into account three important issues:
•   number of KPIs (key measures of achievement),
•   methods of forecasting and simulation to facilitate taking corrective actions,
•   standard indicators for SMEs needed for benchmarking.

Financial assessment of enterprise functioning requires analysis of a variety of economic and financial indicators. Between these indicators there are various hierarchic and semantic connections. The quality of the analysis of semantic relations often has essential impact on accurate assessment of the enterprise operation [Bragg, 2002]. To make optimal decisions, managers need very informative data, indicators that occur at different points in time. Data and information to these analyses come from different sources among others from Business Intelligence (BI) systems. Current BI systems provide large spectrum of reports presenting economic and financial information in various structures and contexts.

Today the development of new BI systems is oriented towards BI 2.0 [Nelson, 2010; Roebuck 2012]. One of the main part of modern BI systems is the ontology and semantic retrieval of information [Nelson, 2010]. Information systems used in small and medium-sized entities are obviously much simpler in comparison to large companies, especially with respect to the information flow, the way of gathering data, and communication of information. This may mainly due to the simple organizational structure of small businesses, direct contacts between employees and decision-makers (supervisors, owners), limited financial resources (the cost of acquiring information), and scope of activities. Therefore decision-makers in these enterprises, in comparison to managers of big companies, may not have   access to all essential strategic information. Usually financial expertise is either not available or too expensive [Korczak 2012]. Big companies have at their disposal strategic consultation and possess standard procedures to solve problems in the case of essential changes in business environment. For financial and personnel reasons most SMEs cannot afford these types of facilities. It should be noted that SMEs operate in a definitely more uncertain and risky environment than big enterprises, because of a complex and dynamic market that has much more important impact on SMEs' financial situation than on big companies'. Tolerance of mistakes is narrower [Gibcus, Vermeulen, Jong, 2009, pp. 74-91]. In these conditions, SME's decision makers often act intuitively and as a result, the rationality of their decisions is decidedly smaller.

Managerial staff of SMEs expects information systems to not only provide aggregate values in the form of economic and financial indicators but also to show financial assessment scenarios. The aim of this paper is to present a proposal of the financial assessment scenarios supported by static and procedural knowledge.

The paper is structured as follows. The second section focuses the financial assessment scenarios, particularly in relation to SMEs. Section 3 describes the ontology of financial assessment. In Section 4 the use case is detailed using real life financial assessment scenarios. Finally, in the last section, some conclusions are drawn.

2. Financial assessment scenarios

SME's management is a process of continuous decision-making, whereas accuracy of this process determines the effectiveness and efficiency of economic activities. In practice it is very often emphasized that decisions are worth as much as information that serves a as a basis for taking these decisions. Each decision should be preceded by a financial projection and an appropriate assessment of its potential effects. The support of decision-making is based on the generation of ready-made paths, together with projections of the effects of planned decisions. These reports and patterns of decision-making should take into account inter alia the support for operational and financial planning, and risk analysis (in particular, the risk of bankruptcy). In addition, they may include support in investment decisions and measuring the effectiveness of the company as a whole and its individual organizational units. It requires considering three important issues:
- • number of KPIs (key measures of achievement),
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Decision projection is the preparation of a sequence of assessment scenarios. Scenarios should take into account various situations depending on external market conditions and internal performance. Although there are various constraints in small and medium-sized companies, they should build their own information systems in order to enable ongoing financial analysis, allowing to strengthen their competitive position in the market and maintain financial credibility.

Financial analysis allows the interpretation of the information necessary for the ongoing management of an enterprise [Revsine, Collins, Johnson, Mittelstaedt, 2012]. It should be emphasized that the selection of appropriate methods of analysis of the financial requirements of SME managers is necessary to determine the company's ability to continue its operations, and to define financial needs, budgets and capital resources of financing assets, signs of danger and risk of changes in the competitive position and trends in various business areas. Managers of SMEs are expected to find support in the following areas:
- • assessment of the project's effectiveness - the answer to the question whether the achieved profits are adequate to the funds involved, and how to compare the results with other companies with similar operations;
- • assessment of cash flows - whether it is possible to repeat a generated surplus in the following periods or whether it will no longer occur in the future.

These two areas, in which mangers expect support, are crucial for company functioning. Manager carry in on assessment gathers information from the external and the internal source of information. Examples of assessment scenarios dependent on available information are presented in table 1. Considering the above, scenarios in SME can be assessed on the basis of the following measures:
- • Profitability on sales, equity, and invested capital;
- • Liquidity ratios;

- Debt ratios;
- Financial performance across business segments;
- The amount of the estimated cash surplus in the future;
- Demand for free cash in the next 12 months.

Table 1. Examples of scenarios

External source of information on:	Internal source of information on:				
	Cash flow and liquidity	Product profitability	Customer profitability	Costs of organizational units	Plans and budgets execution
New products and new technologies	**D1**	**D2**		**D3**	
Changes in legal requirements			**D4**	**D5**	
Changes in suppliers and sub-contractors' market	**D6**	**D7**		**D8**	**D9**

Explanations:
D1 – Decision on starting a new investment provided that the source of the funding is available
D2 – Decision on starting a new investment provided the increase in product profitability
D3 – Decision on starting a new investment based on expected cost reduction in selected organizational units
D4 – Decision to change prices due to the change in the amount of public burdens
D5 – Decision on the need to hire new employees necessary for implementation new reporting requirements
D6 – Decision to change a supplier that offers higher quality, but demands shorter payment periods
D7 – Decision to change a supplier that offers a lower price
D8 – Decision to eliminate internal organizational unit as a result of outsourcing selected processes to external entities
D9 – Decision to change a subcontractor or supplier due to delay in the completion of the construction process

Developed scenarios should be implemented on the basis of concrete performance achieved by the company. It is therefore necessary to establish the minimum and maximum targets for selected internal measures that should trigger off the decisions associated with specified scenarios. Appropriate automation of the discussed process will allow to develop a model of system supporting managerial decisions in small and medium enterprises.

3. Ontology of financial assessment

Acquisition of information from information systems to support decisions of decision makers in SMEs is possible mainly through the use of patterns of financial assessment developed by experts in financial management. . One way to represent knowledge of experts in information systems is an ontology. In the literature, you can find many definitions of ontology. However, most often the term refers to the definition given by T. Gruber, who describes it as "an explicit specification of a conceptualization" [Gruber, 1993, p. 907]. So ontology is a model that defines formally the concepts of a specific area and the semantic relations between them. Constructing ontology always denotes analysis and organizing knowledge concerning specific field noted in formalized structure. The ontology can be used to create the necessary knowledge (especially financial knowledge) models in analytical tools.

The usability of financial analysis, which is important in financial assessment, depends on, among other things, the manager's exact understanding of the existing structural semantic links, and relations between indicators and economic terms. The created financial ontologies, which contain experts' knowledge, may serve as a strong support for decision makers in SMEs. In literature many research projects show that creating an ontology of economic and financial indicators is advantageous in decision making [Aruldoss, Maladhy, Prasanna, 2011; Cheng, Lu, , Sheu, 2011; Korczak, Dudycz, Dyczkowski, 2013; Korczak, Dudycz, Nita, Oleksyk, Kaźmierczak 2017; Neumayr, Schrefl, Linner, 2011].

The design of ontology has to provide not only a concise, comprehensive description of business processes but also express the semantics of processes in a formal way to be understood both by humans and the computer. In our study the ontology was construed using the approach presented in [Dudycz, Korczak, 2016]. This study of the created ontology has been carried out in the five stages:

1. Definition of the goals, scope, and constraints of the created ontology. For our purpose, an ontological framework was designed to represent the area of knowledge of financial indicators analysis. We analysed created ontologies of business knowledge which can be used partially or in entirety. In our research on financial analysis in SMEs we created the ontology of the part of financial analysis, which contains basic financial indicators [Dudycz, Korczak, Nita, Oleksyk, Kaźmierczak 2016].The result of this stage are: (1) identification of possible fragments of the created ontology to be used in the our study and (2) a definition of the extent of developed ontology and its required level of detail.

2. Conceptualization of the ontology. It includes the identification of all concepts, definition of classes and their hierarchic structures, modelling relations, identification of instances, specification of axioms, and rules of reasoning. In our study for identified scenarios it involved the following: the identification of all concepts, definition of classes and their hierarchic structures, modelling relations, and identification of instances. The result of this stage is built ontology's model of the defined field of business knowledge of financial assessment scenarios.

3. Verification of the ontology's correctness by experts. The created ontology was verified in the following way: (1) a formal verification of the specified ontology (e.g. incorrect relations were indicated) and (2) a content verification (e.g. correctness of taxonomic topics, and correctness of relational dependencies between topics).

4. Encoding the ontology is described in the formal language or editor of ontology. We encoded our created ontology using the Protégé, which is a free, open source platform (http://protege.stanford.edu/), which can be extended with many plugins for ontology visualization (http://protegewiki.stanford.edu/wiki/Visualization). (open source ontology editor).

5. Validation and evaluation of the built ontology. We prepared use cases of financial assessment scenarios and have validated the created ontology. In our study, evaluation of semantic network visualization as they pertained to contextual dependencies was conducted using the OntoGraf module in the Protégé 4.1 program.

The presented process of our study is characterized by iterative design. The iterative design of ontology is important in our approach to creating scenarios, because the created ontology should be useful to the managers.

Ontologies in a friendly manner should support the assessment of proposed scenarios to analyze the potential impact of planned actions on company performance. Decision paths should be based on the following decision-making contexts:
- financial and operational planning support,
- business risk analysis, investment decision support,
- performance measurement for the as a whole,
- performance analysis across various segments of the company.

The use of ontologies within analytical tools can help you solve the following problem: support in defining business rules in order to get proactive information and advice in the decision-making process.

4. Use case

Managers in SMEs usually base their decisions on intuition. They are often aware of the work to be done and the processes to be carried out. However, they cannot fully assess the financial implications of managerial actions. It is even more difficult to assess the overall financial impact of a planned project to be taken into consideration. To clarify the need to implement a context-based decision support system, we will use the following example.

Example assumptions:
- Example refers to a development project scenario for automotive company.
- Based publicly available macroeconomic information, the manager acquires the knowledge on increased demand for car parts and components. This information is related to the national strategy for the development of electromobility.
- Additional signal coming from the company's environment is the intensified recruitment of competitors.
- There is a significant risk of losing key personnel, because competitors are aware of the potential for increased production and actively looking for experienced employees. Some employees in the analyzed company choose to accept the competitive offers.
- If a manager is predominantly engaged in technological problems may be able to recognize the described signals too late for an ad hoc decision.

The above situation is not favorable and should not happen in practice. By using an intelligent analytical system, the manager does not need to track market symptoms alone. The warning signal will be generated by the system. An effective system should propose various solutions tailored to managerial problem. Examples of potential scenarios:
1. Proposal to change the salary conditions offered to current employees.
2. Carrying out professional trainings for new employees.
3. Implementing technological innovations to reduce the labor hours needed.
4. Establishing co-operation with research centers to find out how to use aid funds.
5. Changing the business profile (e. g. shifting production to trade).

The assessment of each above scenarios should be carried out using all available internal and external information.

Scenario no. 1 (changing the salary conditions offered to current employees) requires the following information:

- Sales profitability ratios;
- Forecast of operating income;
- Break-Even-Point forecasts including increased wage costs;
- Macroeconomic forecasts (e.g. inflation pressure on wage growth, unemployment rate projections).

Scenario no. 2 (carrying out professional trainings for new employees) requires the following information:
- Forecast of operating income;
- Break-Even Point forecasts including increased training costs;
- Sensitivity analysis related to warranty costs due to the adjustment of new employees to quality standards;
- Macroeconomic forecasts (e.g. inflation pressures on wage growth, unemployment rate projections).

Scenario no. 3 (implementing technological innovations to reduce the labor hours) needed requires the following information:
- Investment appraisal analysis (NPV, IRR);
- Analysis of company creditworthiness (liquidity, profitability, debt);
- Sensitivity analysis related to warranty costs due to the adjustment of new employees to quality standards;
- Macroeconomic forecasts (e.g. inflation pressures on wage growth, unemployment rate projections);
- Availability of aid funds to increase the innovation level.

Scenario no. 4 (establishing co-operation with research centers to find out how to use aid funds) requires the following information:
- list of available support programs at governmental and local level;
- forecast of financial statements.

Scenario no. 5 (changing the business profile) requires the following information:
- Investment appraisal analysis (NPV, IRR);
- Analysis of company creditworthiness (liquidity, profitability, debt);
- Sensitivity analysis related to warranty costs due to the adjustment of new employees to quality standards;
- Macroeconomic forecasts (e.g. inflation pressures on wage growth, unemployment rate projections);
- Availability of aid funds to increase the innovation level.

The optimal solution is the one for which the estimations and forecasts will prove:
- the highest profit or surplus of cash,
- increased production capacity,
- minimization of losses,
- maintain corporate ability to continue its operations,
- other goals intended by the manager.

To illustrate a practical application of the created ontology for financial analysis, let us examine the scenario no.1. Figure 1 presents a sample visualization of a semantic network search in the

OntoGraf module in the program Protégé. On this figure there are two types of lines, each of which represents a type of topical relationship. The solid lines represent a relationship of "subclass-of", whereas the dashed lines represent user-defined (expert) relationships. The ontology shows that the quantitative financial analysis consists of indicators: *Payroll*, *Revenues_from_sales*, *Other_operating_revenues* and *Return_on_sales*.
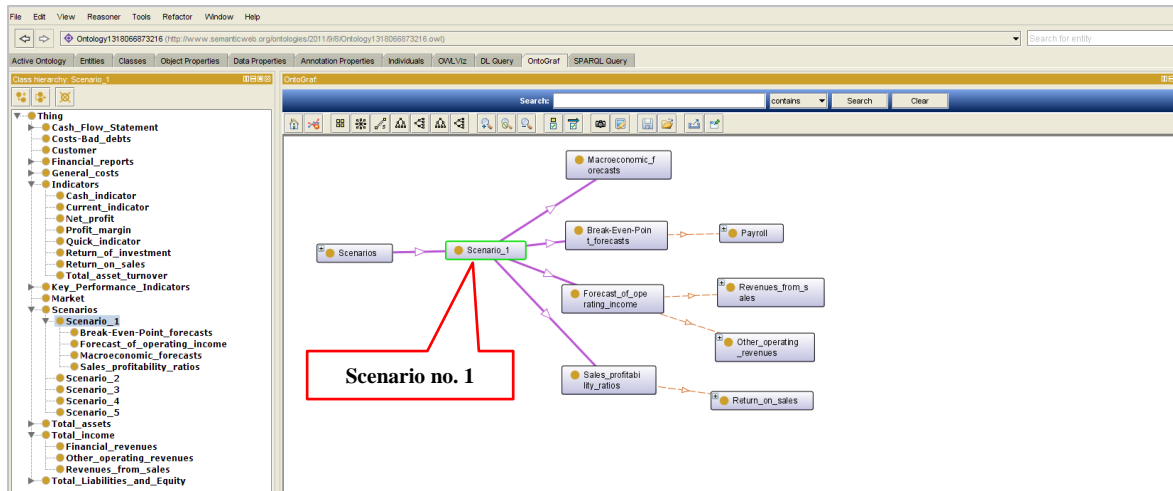

Figure 1. An example of visualization of a semantic network of the Scenario no.1
Source: an application that was built for this study, based on Protégé.

By expanding the *Return_on_sales* branch of the semantic network, the manager learns that the *Return_on_sales* value is determined by *Net_profit* and *Revenues_from_sales* (Figure 2).
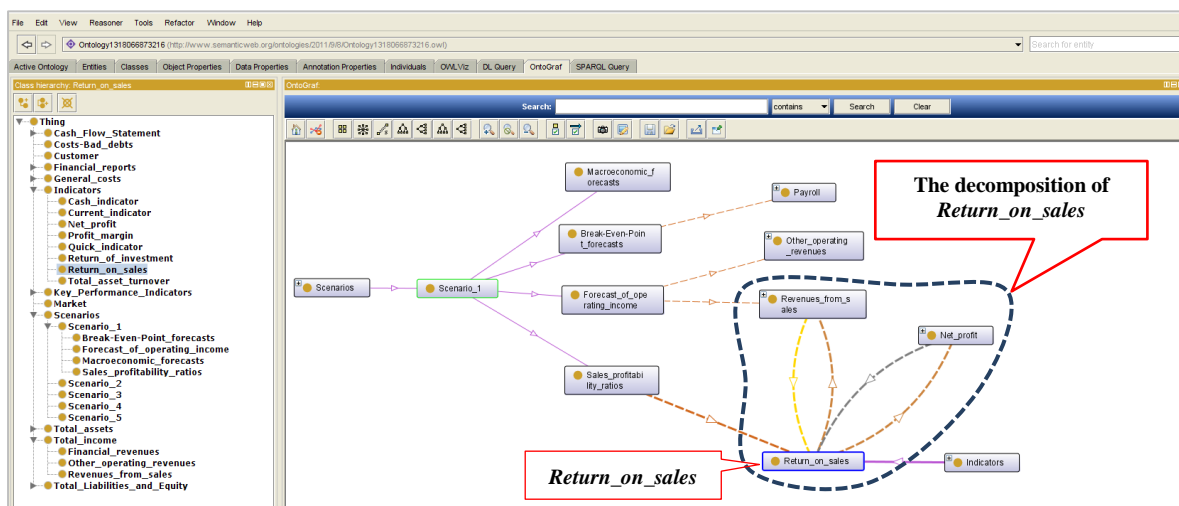

Figure 2. An example of visualization of a semantic network of the *Return_on_sales* indicator
Source: an application that was built for this study, based on Protégé.

The next logical step in this scenario is the identification of the reasons for *Revenues_from_sales* indicator. The manager expands the *Revenues_from_sales* branch of the semantic network (Figure 3) and he can see indicators, which he should analyse the value. A semantic search is provided to avoid difficulties related to manager's interpretation of business information.
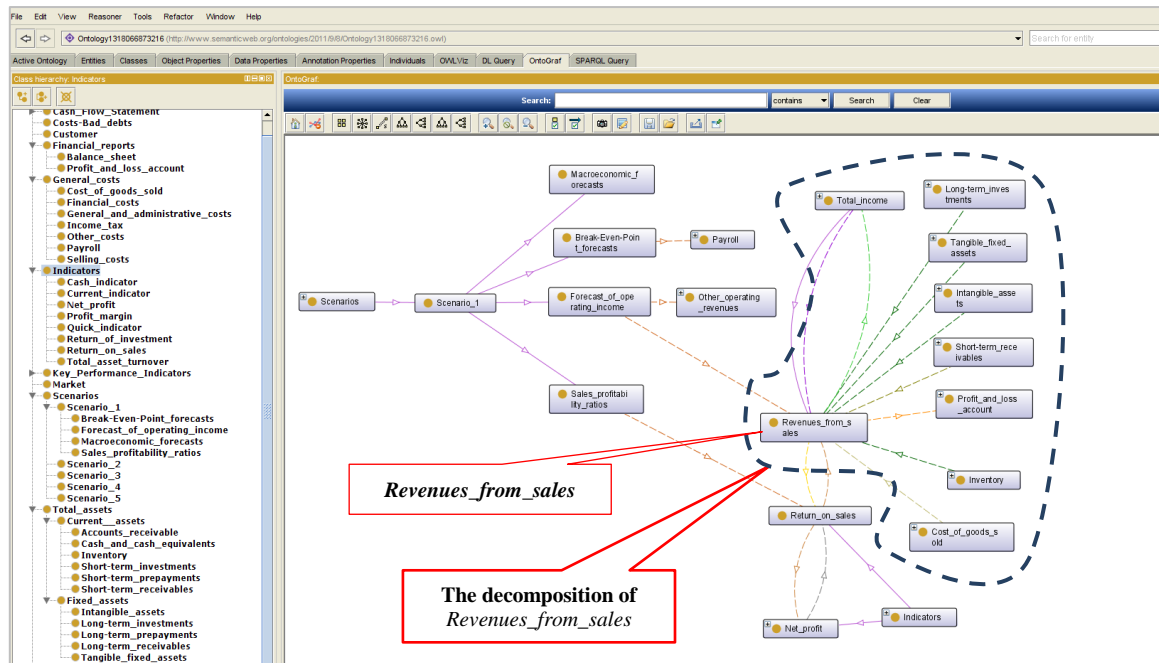
Figure 2. An example of visualization of a semantic network of the *Revenues_from_sales* indicator
Source: an application that was built for this study, based on Protégé.

Effective assessment scenarios are not possible without the use of an intelligent analytical system. System should be calibrated in the most appropriate way what leads to an automatic assessment of the ability to implement a given scenario. The assessment scenarios should also include the probability of each scenario. This will allow the manager to make a decision that is also supported by the manager's experience.

4. Conclusion

The needs of managerial personnel pose new challenges for designers of IT solutions and stimulate scientific research towards identification of the best and the most effective solutions. One of them involves the identification and formulation of safe and effective decision-making sequences and their associated threshold conditions, based on ontological knowledge representation.

Conducted preliminary study may serve as the basis for the creation of financial assessment scenarios for decision makers in SMSs. The use of process-oriented knowledge-based systems should allow managers to make better business decisions. It is crucial, because financial assessment scenarios contained in BI financial assessment are developed for large enterprises. Assessment of scenarios available to be implemented in SME differs significantly from projections and forecasts used in large corporations. The main differences are as follows:

- Limited financial perception of managers and lack of professional analytical positions in SME,
- Limited internal reporting systems and lack of detailed internal managerial reporting systems,
- Trivial methods of preparing projections and financial forecasts,
- Limited possibility of carrying out extensive evaluation models (e.g. based on Discounted Cash Flow analysis, Economic Value Added) due to insufficient set of input information.

Further work should be focused on a comprehensive process-oriented approach to problem solving in SMSs. Each decision-making problem should be decomposed to subprocesses, activities, and available information sources. For each decision-making problem financial assessment scenarios should be developed. This would not be possible without the use of knowledge possessed by experienced managers and financial analysts. Process approach implemented in the intelligent analytical system can sup-port gaining a competitive advantage of the company. The use of process-based knowledge may also contribute to increasing the financial stability of small and medium-sized enterprises.

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