MANAGEMENT DECISION SUPPORT BY USING EARLY WARNING ENVIRONMENTS

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Abstract. *Successful activities in a dynamic environment of today's economy largely depend on the skills to have an adequate view of activity environment and its changes. The information activities of business decision makers relate their subjective potential of environment assessment and problem solving to the systems of environment monitoring and early warning, whose relevance is of expressed in various activities both at micro and macro levels. The paper discusses the features of the bank deposit insurance system in the Republic of Lithuania, its information needs and the role of early warning systems in its activities. Also, the paper examines a prototype of an early warning system in the Deposit Insurance Scheme of the Republic of Lithuania and the conditions for its application. There are specific groups of decision-important information and relations between their estimates. The proposed way of applying a composite set of decision criteria can be transferred to similar systems in other fields of activity.*

Keywords*: information needs, decision support, early warning systems.*

Introduction

The growing complexity of the business environment is growing under the influence of various factors – global fields of activity, a faster action and reaction to emerging problems, the recent rise in e-activities together with their opportunities and threats. The related growing volumes of available information create an additional tension for activity subjects who have to evaluate this information, recognize potential problems and, if required, make appropriate decisions. A recognized activity problem creates related information needs, and the subject of the problem has to undergo all or some phases of information activity, as defined by Kuhlthau (Kuhlthau, 1991, 2005), Wilson (Wilson, 2000), Niedzwiecka (Niedzwiecka, 2003) – information seeking, information search, and information use.

The information behaviour of a contemporary subject of the activity problem implies the will to use information technology (IT) to support various information functions. Though IT does not cover all the functionality required by the problem solving process, it has a prominent role and is expected to provide formidable support in decision making.

The activities of monitoring, analysis and providing decision support are performed all the time by people whose job is to discover or detect important issues – the analysts, business area managers, etc.

There is an abundance of IT-based tools and techniques which, even if not directly called decision support tools, aim to support roughly the same set of information needs: reliable and convincing arguments for decision making (Sheff, 2006); monitoring and awareness of the environment (Zhong et al, 2007); gaining insight into the business's own activities and those of other players in the field – the competition, partners, etc. (Bazerman, and Chugh 2006; Davenport, 2006; Teare, Bowen, 1997).

In the recent growth of the class of information systems and tools, collectively known under the name of ***business intelligence***, substantial attention is given to the IT role and possibilities in such systems. The role and functions of business intelligence systems are roughly the same as those of ***decision support systems*** (DSS), although different sources present different functionality and specialization for business intelligence – from generic monitoring functions to a narrow analysis centered on a single problem, and from monitoring own internal activity indicators to monitoring close and distant activity environments. In this range there is a class of systems known by the name of ***early warning systems***. These systems help their users in evaluating important environment changes in their early phases and preparing appropriate actions as a reaction to these changes. The absence of early warning systems or neglect of their results may have negative consequences for entire business sectors as well as for the economy in general. The case of the current world financial crisis shows that, in its initial phases, there has been a lack of attention to the threshold values of economic indicators presented by the early warning systems. Having exceeded these thresholds, financial markets experienced difficulties that lead to the financial crisis.

The goal of the paper is to describe the place and possibilities of early warning systems as a representative of decision support or business intelligence systems in the activities of a contemporary organization. This will be done through examining the case of an institution for monitoring and supervising the bank deposit services – the Deposit Insurance Scheme (DIS) of the Republic of Lithuania.

Structure of the paper. The first part presents the information environment of monitoring and early warning, its elements and functions, features of problem situations to be recognized, also risks of erroneous monitoring. The second part discusses the early warning systems in general and the early warning system at the DIS in particular, including its structure, types of information used, decision making technology. The final part of the paper presents the discussion and conclusions.

The information environment of monitoring and early warning

The above- mentioned models of information activities name monitoring as one of the most important components. T.Wilson (Wilson, 2000) describes this function as follows: "Information Seeking Behaviour is the purposive seeking for information as a consequence of a need to satisfy some goal. In the course of seeking, the individual may interact with manual information systems (such as a newspaper or a library), or with computer-based systems (such as the

Table 1. ***Rating of information needs by their importance***

Position	Information need
1.	Current status information: cash flow, liquidity, inventory, payables/receivables, etc.
2.	Market information: dynamics, competition, innovations, trends
3.	Own performance information: how efficient is the creation of value; ratio of outputs to inputs
4.	Competence information: principal drivers of competence and competitive advantage and their status
5.	Assets availability and use: what assets are used and how (in the first place inappropriate use)
6.	Macroeconomic information: figures and trends: inflation, interest rates, currency rates, prices of raw materials, etc.
7.	Other information: news, legal acts, etc.

World Wide Web)". In a survey on business decision information needs, performed in 2004–2006 (Skyrius, 2008) and covering 250 respondees – business professionals, one of the questions had been pointed at the most important environment monitoring needs as judged by the urgent nature of these needs. The responses are presented in Table 1 where the position number indicates the importance of this type of information: 1 – most important, 2 – second important, and so on.

According to the results, most important information needs are related to monitoring an organization's own status or close environment. This distribution represents the attention given to the competitive environment in which an organization acts. For organizations with specific functions, like DIS, this structure of information needs can be different, but also there are needs that can be considered most important. This issue will be discussed in more detail further in this paper.

The monitoring information needs are directly related to the needs of problem solving and experience accumulation. The routine and repeating needs can be called ***common*** needs, and the needs to assess and evaluate a certain problem can be called ***special*** needs. The former (common) are usually of permanent nature and known beforehand; procedures to produce results are well determined and have a high degree of reuse; roughly equal attention is given to all relevant areas of activity. The latter (special) arise for a specific situation or problem, are of random nature and hard to plan, require a special deeper insight and concentrate on a narrow problem-related area. The role of these two types changes in different stages of environment monitoring and problem solving:

1. ***Monitoring:*** the internal and external environment is scanned to notice important issues; *common* information needs prevail.
2. Having ***recognized*** a situation of interest (problem, opportunity), the situation is evaluated and given extra attention to achieve a desired understanding. At this stage, *special* information needs arise.
3. Additional ***analysis and decision development*** are required if the situation

is complex enough (semi-structured or unstructured); more information is brought into the a decision making environment; specific problem-solving tools such as formal approaches and models are likely to be used to achieve a better satisfaction of *special* needs.

4. The ***decision-making*** stage involves the formerly available as well as newly gained understanding of the situation, and the decision maker or makers will use all possessed knowledge to arrive at the best possible decision, time or other circumstances permitting. New knowledge most likely will be gained.
5. The ***experience accumulation*** stage records the newly gained experience from both decision making and its implementation, and keeps it for possible reuse. *Special needs* become *common*, adding new material to the already available body of experience.
6. The ***use of the new experience***, along with that formerly accumulated, brings the process back to stage 1 – monitoring.

There are no sure ways to avoid activity problems – they exist and will continue existing in all kinds of activities. The management errors that lead to failures or prevent a timely reaction are of various nature, although some sources (Argenti, 1976) point out the most common scenarios having two types of errors:

- Omission:
  - neglect of information provided by information systems,
  - failure to respond adequately to log-term changes in the environment.
- Commission:
  - overtrading,
  - launch of a big project beyond the available resources,
  - increased gearing to the point that normal business hazards become a substantial threat.

Problems can be of various nature – internal, external, opportunities and threats, but all of them have common features, among which important are the possibilities to detect and remedy a problem in its early stages. For these purposes, the abovementioned specific type of information systems – early warning systems – should be developed. They would have to be able to provide a full and adequate view on the critical features of the environment, and should adapt to the changing environment and its context without losing their adequacy (Cohen, 2000; Ferguson et al., 2005; Snowden, Boone, 2007).

Early warning systems

This type of systems is used both on micro- and macro-levels. This defines the essential features of the system – indicators under scrutiny, evaluation time horizon and others, depending on the users' activities and goals. The detection models used in macro-environments have usually a much longer time horizon which should allow developing the policy changes that may prevent the problem. Micro-level models have a shorter time horizon, as well as different criteria for evaluation and forecasting.

The study of the International Monetary Fund (Berg., et al, 2005) evaluates the experience on the crises that had already happened (1994 Mexico currency crisis, 1997/1998 Asian currency crisis and oth-

ers), and presents early warning models used in the Fund itself, as well as in other institutions and the private sector. The study points out some standard model features for comparison: crisis definition, time horizon, forecasting method and the principal variables of the model. Another study drawn by the Basel Committee on Banking Supervision (Sahajwala, Van den Bergh, 2000) notes that this kind of systems should:

- perform a systematic evaluation of supervised institutions by formalized procedures;
- identify the institutions or their activities where problems exist or might happen;
- set the bank inspection priorities to optimize the use of supervision resources;
- undertake required and timely actions from the side of the supervisory institution.

The practical use of this kind of systems is rather complicated, first of all in terms of a representative scope. As early as in 1982, a study by EANPC – European Association of National Productivity Centres (Corporate..., 1982) stated that early warning systems based on standard financial and business ratios, proved inadequate because of late information and low reliability. The ratios in use did not indicate the quality of management, environment changes and constraints. Increasing the effectiveness of early warning systems would require an appropriate ratio structure and presentation modes – the results should reach the real decision makers, and the ratios in use should reflect not only own activities, but also the behaviour of the environment (clients, partners, competition).

The experience of using an early warning system at DIS

This part of the paper presents an example of an early warning system whose principal features have been implemented at the Deposit Insurance Scheme (DIS) of the Republic of Lithuania.

The information activities of DIS are best described by the following features:

- the activities require predominantly external data;
- moderate volumes of raw data; their structure is rather simple, or there might be no structure at all (free form data);
- strongly expressed influence of macroeconomic context on both the decision maker and the decision;
- the sensitivity of the environment to the global economic situation.

Next we will discuss the risk assessment method in an Early Warning System of DIS. This scheme can be considered as part of the business intelligence system including environment monitoring and decision support components. Such components should support common (everyday) needs which can be complemented by special needs if a problem emerges.

An Early Warning System of DIS is based on the analysis of banks' risk indicators. In most cases, banks' risk analysis is used to assess the deposit insurance premium rate depending on the level of risk of each bank. This method is called the risk-based premiums method. The Lithuanian DIS has used the flat premium rate method, and the aim of the banks' risk analysis is to quantify the risk to the DIS, but not to the differentiation of insurance premium rate.

Why the risk-based premium method is not so attractive or acceptable for a small financial market? For instance, we have 9 banks and 2 of them cover about 60% of all deposit markets, 3 middle-sized banks and 5 small-sized banks. We suppose that two biggest banks don't belong to a group of riskier banks. In this case, we should use the risk-based premium method that two banks pay less insurance premiums. The outocomes that are likely to happen in this case are the following:

1. DIS could fail in its duty to protect deposits as a result of reduced insurance premiums, because the main part of our DIS is settled by insurance premiums paid by these two credit institutions.
2. In the long run the DIS could fall to insolvency.

The financial market is under the sway of bankruptcy of any credit institution. The banks society accepts the fact that if the DIS will not be able to compensate losses for depositors after bankruptcy of a medium-sized or small-sized bank, it causes instability in all financial market. And the main problem that would take place is that public confidence in the banking sector will get down. That's why in a small financial market we don't introduce the risk-based premiums method, but assess the banks' risk in order to identify the threats to DIS using the Early Warning System.

The main procedures of the Early Warning System are as follows:

1. Designation of the main indicators that allow to assess a bank's risk level.
2. Evaluation of the risk indicators.
3. Composition of the risk matrix.
4. Determination of the risk grades and values of the risk indicators of the banks.
5. Calculation of the risk rates against the DIS.
6. Decision making on the base of the risk rates.

The Early Warning System analyses five main risk indicators:

1. Capital adequacy.
2. Credit loss rate.
3. Risk level.
4. Level of earnings.
5. Liquidity norms.

These indicators allow us to evaluate a bank's risk level and the DIS ability to compensate the losses of depositors. They are extracted from such sources as balance sheet, income statement, capital adequacy report, liquidity report.

We propose to split all banks into three risk groups (specific for the banking industry) by nature of risk:

1. ***Healthy bank*** – very little risk to the DIS;
2. ***Some concern*** – implies weaknesses which could result in a significant risk for the DIS;
3. ***Substantial concern*** –a high probability of loss to the DIS unless effective actions are taken immediately.

The DIS's exposure is under the influence of the bank activities' risk level. This depends on the bank's possibility to become insolvent and of the DIS capital ability to amortize this insolvency.

The best way to assess the risk to the DIS is a three-step process based on:

- first, assessment of risk level of every bank;

- second, estimation of the risk rates of each bank against the DIS;
- third, decision making for the prompt correct actions of the DIS.

This process is processed using the decision support software.

A short review of the risk criteria is presented further.

Capital adequacy

We rank banks into three groups:

- well capitalized,
- adequately capitalized,
- under capitalized.

It is the easiest way to assess a bank that depends to the under-capitalized group. All banks that have a Capital Adequacy indicator less than the minimum provided by the supervision institution (in the case of Lithuanian and most of the EU countries 8%) are ranked to the under-capitalized group. Adequately capitalized banks and Well-capitalized banks are determined by decision support software following the principle that Adequately capitalized bank's indicator of Capital Adequacy is between the Minimum and Top quartiles, and Well-capitalized bank's indicator of Capital Adequacy is above the Top quartile (Table 1).

Well capitalized	**Above the upper threshold**
Adequately capitalized	**Between the lower and the upper thresholds**
Under-capitalized	**Less than the Lower threshold**

The adequate capital rate (8%) is determined by the Central Bank.

Table 1. ***Structure of data on capital adequacy***

			Period 1	Period 2	etc. …
1	**Capital adequacy**				
	Bank 1				
	Bank 2				
	Bank 3				
	…				
	Maximum				
	Top quartile (Q 75)				
	Median				
	Bottom quartile (Q25)				
	Minimum				
	Upper threshold	Upper quartile			
	Lower threshold	8 %			

Credit loss rate

The indicator that would reflect the Credit loss rate best of all is the ratio between Provisions against loans and Granted loans. The value of that indicator is rather individual for each country. We believe that the most common indicator that estimates the level of the credit loss is the median value of Credit loss of all examined banks. The median value is the Lower threshold, and the upper threshold is the Top quartile (Table 2).

Healthy bank	**Below the Lower threshold**
Some concern	**Rate between the Upper threshold and Lower threshold**
Substantial concern	**Above the Upper threshold**

Table 2. ***Structure of data on credit loss rate***

			Period 1	Period 2	etc. ...
2	**Credit loss rate**				
	Bank 1				
	Bank 2				
	Bank 3				
	…				
	Maximum				
	Top quartile (Q 75)				
	Median				
	Bottom quartile (Q25)				
	Minimum				
	Upper threshold	Top quartile (Q 75) value of Credit loss			
	Lower threshold	Median value of Credit loss			

Risk level

The Risk level is calculated as a ratio between the Risk-weighted assets and the Balance sheet value. According to the international practice, if the Risk ratio is more than 75%, the bank is of Substantial concern; if the Risk asset ratio is below 60%, the bank is Healthy; and if the Risk ratio is between 60% and 75%, the bank is of Some concern (Žilinskas, 2008).

Healthy bank	**Below the Lower threshold**
Some concern (average risk)	**Between the Lower and Upper thresholds**
Substantial concern	**Above the Upper threshold**

Table 3. ***Structure of data on risk level***

			Period	Period	…
3	**Risk level**				
	Bank 1				
	Bank 2				
	Bank 3				
	…				
	Maximum				
	Top quartile (Q 75)				
	Median				
	Bottom quartile (Q25)				
	Minimum				
	Upper threshold	75%			
	Lower threshold	60%			

Level of earnings

The level of earnings shows the efficiency of a bank's activities. The level of earnings is calculated as a ratio between the Bank net ordinary financial income and the Bank ordinary expenses**.** Analysis of data of Lithuanian banks allows us to come to a conclusion that a highly profitable bank is a bank that has its Level of earnings above 130%; a loss-making bank – below 100%; and an insufficiently profitable bank – between 100% and 130% (Žilinskas, 2008).

Highly profitable	**Above the Upper threshold**
Insufficiently profitable	**Between the Lower Upper thresholds**
Loss-making	**Below the Lower threshold**

Table 4. ***Structure of data on the level of earnings***

			Period	Period	…
4	**Level of earnings**				
	Bank 1				
	Bank 2				
	Bank 3				
	…				
	Maximum				
	Top quartile (Q 75)				
	Median				
	Bottom quartile (Q25)				
	Minimum				
	Upper threshold	130%			
	Lower threshold	100%			

Liquidity norms

The liquidity norm is calculated as a ratio between Liquid assets and Current liabilities. We think that a Barely liquid bank is the bank that shows its Liquid norm below the threshold provided by Supervision institution as a minimum (30% in Lithuanian case). Also, we think that the Median value of Liquidity norms is the best criterion to assess the most common Liquid bank. If the Liquidity norm is above the median value, the bank is Highly liquid, if it is less than around 30% – Barely liquid, and if between 30% and the Median value – the bank has an Adequate liquidity.

Highly liquid	**Above the Upper threshold**
Adequate liquidity	**Between the Lower and Upper thresholds**
Barely liquid	**Below the Lower threshold**

Table 5. ***Structure of data on liquidity norms***

			Period	Period	…
5	**Liquidity norms**				
	Bank 1				
	Bank 2				
	Bank 3				
	…				
	Maximum				
	Top quartile (Q 75)				
	Median				
	Bottom quartile (Q25)				
	Minimum				
	Upper threshold	Median value			
	Lower threshold	30%			

The Decision support software calculates all indicators of each bank, defines the risky group for each bank, and sorts banks by the values of indicators. The database accumulates the values of indicators of all researched periods. The Decision support software determines the trend of every bank by analysing the values of indicators of the study periods. These data are used in the second step.

The second step of the methodology is to give the banks one of the three possible summary risk grades that focus very much on the potential threat of ultimately triggering a call on DIS resources. These summary grades are ***acute concern*** where a bank is below the minimum threshold on at least two of the four risk criteria. At the opposite extreme is the group of banks that should pose ***no real concern*** to the DIS because they exceed the upper threshold on all analysed risk criteria (or if they just miss the upper threshold on one criterion it is not by much). This leaves a middle group who pose ***some concern*** in that they are only performing

adequately not well on all risk criteria, or where they are performing well on one criterion, it is offset by a poor performance on another.

Having done this, the Decision support software places banks on a three-by-three matrix presenting their capital adequacy on the vertical axis, their risk grouping on the horizontal axis, and giving them the values of the risk indicators as follows:

Table 6. ***The structure of risk rating***

	No real concern	**Some concern**	**Acute concern**
Well capitalized	0	0.05–0.09	0.4–0.6
Adequately capitalized	0	0.1–0.2	0.7–0.9
Under capitalized	0.1–0.2	0.3–0.5	1

For example, if the bank is ***undercapitalized*** and falls to the ***Acute concern*** column, it means that the deposit insurance fund should be on the alert to pay insurance compensations for depositors of this bank. If it is ***Some concern***, then such situation should be discussed with the Council of the DIS. If a bank is ***adequately capitalized*** and there is ***Acute concern***, this analysis suggests that this bank should be a subject of special monitoring.

The risk rate of a credit institution mostly depends on such factors as covered deposits (possible payouts), deposit insurance fund and recovery. The calculation the Risk Rate of the credit institution against the DIS is as follows:

Risk rate = Risk indicator × (Possible insurance compensations / (Deposit insurance fund + Recovery))

Recovery. Each DIS can set the level of recovery. In the case of the Lithuanian DIS, it is considered to be at 80% of high quality liquid assets. This is a pessimistic assessment because in accordance with the practice of the European DIS, the level is about 50% of Covered Deposits, i.e. close to 100% of high quality liquid assets.

If the Risk rate of the credit institution >= 1 it is a great risk to the Fund;

0.7<=<1 – real risk to the fund;
0.4<=<0.7 – average risk;
0.1<=<0.4 – some concern;
0.05<=<0.1 – little risk;
0<Risk rate<0.05 – no risk.

An early identification of the risk allows the DIS to mobilize resources for elimination of possible losses. Decision support software assesses the risk indicators, calculates the risk rates and proposes the ways to amortize the banks' risk against the DIS. There are several ways to amortize the banks' risks against the DIS, such as:

1) if some bank falls to a big risk against the DIS, all resources of the DIS will possibly be used to cover payouts. In that case, we have to increase the rate of the insurance premium in order to compensate loses of the DIS in the shortest term;
2) if a bank falls to a real risk against the DIS and all resources could be used to

cover payouts, the DIS has to keep a close watch on the activities of this bank and decide whether there is a necessity to increase the rate of the insurance premium;

3) if some bank falls to average risk against the DIS and all resources could be used to cover payouts, the DIS has to keep a close watch on the activities of this bank. If this bank falls to a category of real risk against the DIS, there might be a need to consider an increase of the rate of insurance premium.

The proposed scheme, already applied in the activities of the Lithuanian DIS, is not necessarily limited to this subject area only – there are other activities experiencing concerns that require environment monitoring and problem recognition. The candidate activities might be other institutions with supervisory duties; geographically wide activities with branches of similar activities; concerns with suppliers and clients (e.g., solvency information); competition threats and other cases where the monitoring function allows for developing a similar model of early warning.

Discussion and conclusions

It has been shown that the applied methodology of a composite criterion for situation evaluation can be applied in the systems carrying a similar purpose in other areas of activity. The similar activities should be concerned with monitoring the environments or institution groups, problem recognition, and be able to define sets of standard parameters and ratios.

The several important issues to be considered when implementing and using the proposed methodology would be the following:

1. It is important to note that the use of the proposed methodology stresses a mix of formal evaluations and user heuristics rather than automated evaluation alone. The decision support mechanism uses a limited number of evaluation data and rules, their relations are rather clear and incorporate the professional experiences in the field. This approach conforms to the general decision support guidelines in contemporary research on information systems and decision support, namely a combination of heuristic and formal techniques and tools.
2. The simplicity of the used evaluation model, as in the case of any model, requires an in-depth understanding of the activities in question, so that the most important and revealing features would be included in the model. This point raises some issues of the model refinement – it would be naïve to expect that the evaluation model would remain stable over a longer period, as changes in the external and internal environments will inevitably force the model to be adjusted along these changes. The aforementioned simplicity of the model would be instrumental for a quick implementation of such changes.
3. A timely and reliable reception of initial data is absolutely important for the success of the described approach. As the data used for input do have a high level

of aggregation, the issues of their quality have a direct impact on the confidence of the users. This issue is part of a bigger problem – the quality of information feed to any high-level decision support tool; and the research of the ways to introduce and maintain the appropriate levels of input quality is beyond the scope of this paper. However, the importance of such research is high enough to motivate authors to devote their efforts to this issue in the future work.

REFERENCES

1. Argenti, J. (1976). *Corporate Collapses – The Causes and Symptoms*. London: McGraw-Hill.

2. Bazerman M.H., Chugh D. (2006). Decisions without blinders. *Harvard Business Review*. January. P. 88–7.

3. Berg A., Borensztein E. (2005). Assessing early warning systems: now have they worked in practice? *Staff Papers*, International Monetary Fund. Vol. 52. N. 3. P. 462–502.

4. Cohen E.B. (2000). Failure to inform: errors in informing systems. *Proceedings of the 2000 Americas Conference on Information Systems (AmCIS 2000), August 10–13, 2000, Long Beach, California.* P. 1057–1061.

5. Davenport T. (2006). Competing on analytics. *Harvard Business Review,* January. P. 99–107.

6. Ferguson G., Mathur S., Shah B. (2005). Evolving from information to insight. *MIT Sloan Management Review*. Winter. P. 51–58.

7. Kuhlthau, C. (1991). Inside the information search process: information seeking from the user's perspective. *Journal of the American Society for Information Science.* Vol. 42. N 5. P. 361–371.

8. Kuhlthau C. (2005). Towards collaboration between information seeking and information retrieval. *Information Research*, **10**(2), paper 225. [Available at http://InformationR.net/ir/10-2/paper225.html]

9. Wilson, T.D. (2000). Human information behaviour. *Informing Science.* Vol 3. N 2. P. 49–55.

10. Niedzwiecka B. A proposed general model of information behaviour. *Information Research*, Vol. 9. N. 1. Paper 164. [Available at http://informationr.net/ir/9-1/paper164.html]

11. Sahajwala, R., Bergh, P. van den (2000). Supervisory risk assessment and early warning systems. Basel Committee on Banking Supervision. *Working Paper*. No. 4.

12. Sheff, H. (2006). Making sense of analytics. *International Customer Management Institute,* February 1. Retrieved 15 February 2007 from http://www.callcentermagazine.com/showArticle.jhtml?articleID=177101987 .

13. Skyrius, R. Management decision support in Lithuanian business. *Information Research.* Vol. 13. N 2. Paper 345. [Available at http://InformationR.net/ir/13-2/paper345.html]

14. Snowden, D.J., Boone, M.E. (2007). A Leader's framework for decision making. *Harvard Business Review, November.* P. 68–76.

15. Teare, R., Bowen, J.T. (1997). Assessing information needs and external change. *International Journal of Contemporary Hospitality Management.* Vol. 9. N 7. P. 274–284.

16. Zhong N., Liu J., Yao Y. (2007) Envisioning intelligent information technologies through the prism of Web intelligence. *Communications of the ACM.* Vol. 50. N. 3. *P.* 89–94.

17. Žilinskas, R. Designed risk ratio in the early warning system of the deposit insurance scheme. *Risk Analysis in Deposit Insurance Schemes*. International Seminar "Risk Analysis in DIS", Moscow, 27-28 May, 2008. [Available at http://www.asv.org.ru/en/show/?id=92855].