DECISIONS, METHODS AND TECHNIQUES RELATED TO DECISION SUPPORT SYSTEMS (DSS)

Florin Boghean
Economics, Business Administration and Tourism Department, Faculty of Economics and Public Administration, University "Stefan cel Mare", Suceava, Romania
florinb@seap.usv.ro

Abstract: *Generalised uncertainty, a phenomenon that today's managers are facing as part of their professional experience, makes it impossible to anticipate the way the business environment will evolve or what will be the consequences of the decisions they plan to implement. Any decision making process within the company entails the simultaneous presence of a number of economic, technical, juridical, human and managerial variables. The development and the approval of a decision is the result of decision making activities developed by the decision maker and sometimes by a decision support team or/and a decision support system (DSS). These aspects related to specific applications of decision support systems in risk management will be approached in this research paper. Decisions in general and management decisions in particular are associated with numerous risks, due to their complexity and increasing contextual orientation. In each business entity, there are concerns with the implementation of risk management in order to improve the likelihood of meeting objectives, the trust of the parties involved, increase the operational safety and security as well as the protection of the environment, minimise losses, improve organisational resilience in order to diminish the negative impact on the organisation and provide a solid foundation for decision making. Since any business entity is considered to be a wealth generator, the analysis of their performance should not be restricted to financial efficiency alone, but will also encompass their economic efficiency as well. The type of research developed in this paper entails different dimensions: conceptual, methodological, as well as empirical testing. Subsequently, the conducted research entails a methodological side, since the conducted activities have resulted in the presentation of a simulation model that is useful in decision making processes on the capital market. The research conducted in the present paper also entails an empirical testing phase, involving the hypotheses directed at the impact of adopting risk management in decision making processes under efficient corporate governance.*

Keywords: decision making process, risk management, decision support systems.

Jel classification: G34, M14

1. Current knowledge in the field

According to empirical research (Malakooti, 2012)*, efficient managers are distancing themselves from traditional decision making processes (which firstly entails rational analysis) and compensate for any time or information related limitations by relying on intuition.* Any decision-making process developed within the business entity entails the simultaneous concurrence of certain economic, technical, legal, human and managerial variables. The development and adoption of a decision is the result of decision making activities developed by the decision maker who is sometimes assisted by decision support team or/and a decision support system (DSS). These aspects related to the specific applications of decision support systems in risk management will be approached in this paper. Managers on all hierarchical levels of the organisation are the direct beneficiaries

and users of decision support systems from the subcategory of decision makers. Ronald A. Howard in „*Speaking of Decisions: Precise Decision Language*" recommends giving up the manner in which one differentiates between the concepts of risk and uncertainty. Basically, *financial risk tolerance* can be defined as "the maximum uncertainty level that anyone is willing to accept when making a financial decision" (Grable, 2008). In theory, *financial risk tolerance* depends on the various magnitudes of risks. Weber, Blais and Betz (2002) refer to risk attitude as "an individual's location on the continuum from risk aversion to risk seeking" and argue that the risk taking level greatly depends on each specific field. Individuals manifesting risk aversion in one sector (for instance, financial) may not manifest the same behaviour in other sectors. Basically, risk taking behaviour is multidimensional. From the standpoint of financial consultants (Cordell, 2002, Boone, Lubitz, 2003), financial risk tolerance can be defined as a mixture of the two – risk attitude – (how much risk I am willing to take) and "risk capacity" (how much risk I can afford to take). However, these two components of risk tolerance are intrinsically different: risk attitude is a psychological trait (Weber, Blais and Betz, 2002, who consider it as a personality trait), while risk capacity is mainly a financial trait (Grable, Davey and Roszkowski, 2005).
Numerous researchers have analysed the way in which: *risk, risk perception and risk tolerance* influence individuals when they make choices under uncertainty. The term *risk* in decision making processes is an essential element in the classical theoretic economic context (the so-called normative approach), from the theory of anticipated utility of Von Neumann, Morgenstern (1944) to the theory of portfolio analysis of Markowitz H. (1952). However, even though they were deeply contrasting, the first papers on behavioural economics in the 70's, such as Kahneman and Tversky A.'s prospect theory (1979) to the more recent theory of Behavioural portfolio (Shefrin and Statman, 2000; Hoffmann, Shefrin, Pennings, 2010) have emphasized the evidence of cognitive confusion that influence the decision making process relying on reason (a descriptive approach).

2. Research methodology

Starting from the working hypothesis we have presented, this paper is directed at developing a model that would be an actual isomorphic representation of the current state of the capital market. The scheme of the heuristic model will consist in developing a system that resembles the one we are investigating (the real system) and will consist in the following stages:

- we will develop an initial solution;
- we will test it under admissibility circumstances (restrictions system);
- we will calculate the performance function of the initial admissible solution (based on economic indicators);
- we will calculate the performance function for a certain time span;
- we will check if the solution suggested through the model overlaps the economic and financial history of the companies included in the quantitative analysis.

The Monte Carlo method will be used to model random variables in order to identify the characteristics of their distribution, when these characteristics cannot be identified through analytical expressions based on the probabilistic density functions. The model developed in this paper also supports the improvement of multiple objectives, enabling decision makers to understand and formulate their fundamental objectives.

3. The role of information systems in decision-making processes

In the Anglo-Saxon system, the financial and accounting analysis allows stakeholders to assess the yield and risk levels of their investment. Starting from the idea that the capital market is efficient and transparent, business entities will not be able to use accounting tricks to fiddle with the value of securities, since financial statements are mere information sources for investors.
In Germany and France, outcome analysis is accompanied by an analysis of how added value has evolved and, apart from the usual summary documents (balance sheet, statement of accounts, annexes), certain German business entities also include the statement of added value.
If we compare companies from Eastern Europe with those from Western Europe in terms of performance indicators, it turned out that 50% of western companies use circulating capital as the most relevant performance indicator. On the other hand, only 30% of eastern Europe companies do that, while, in turn, they focus more on the turnover.
A study conducted on 384 companies from 22 European countries, both from western Europe (Austria, Belgium, Denmark, France, Germany, Ireland, Italy, the Netherlands, Portugal, Spain, Switzerland and Great Britain) and from eastern Europe (Romania, Bulgaria, Croatia, Greece, Hungary, Russia, Serbia, Slovakia and the Czech Republic) the following analyses are the most relevant in order to highlight their success:

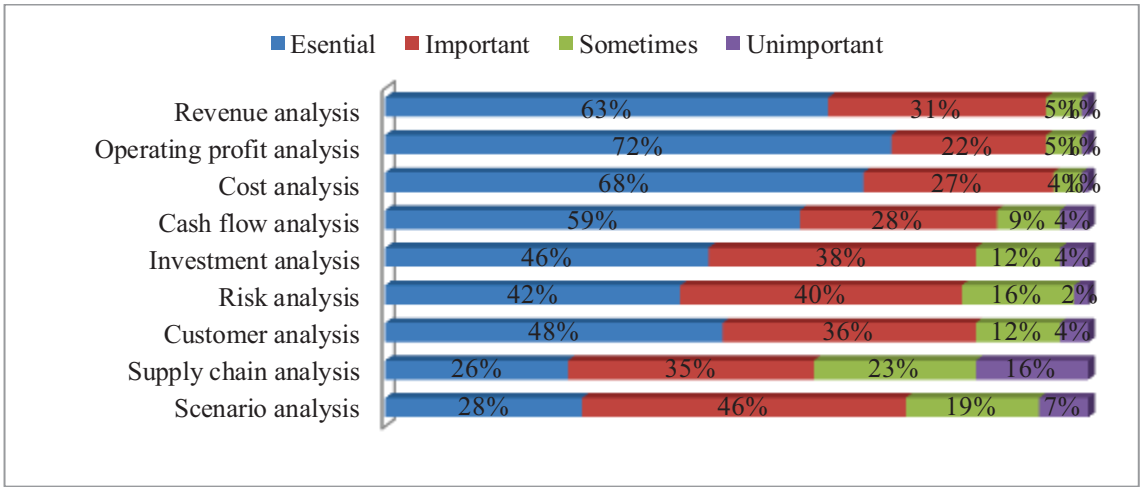


Figure 1: Ranking of the types of analyses conducted in business entities
Source: ***, Management information and performance: CFOs face new demands for high-quality data that drives decisions, 2007, p.10

As can be noted, all analyses are very important or important for the proper functioning of European companies, but the most used ones are revenue, operating profit and cost analyses. Moreover, company managers have confessed that they conduct these regularly or at least once a year.
However, there is one less than encouraging issue the current economy is facing. It consists of the fact that most investors do not trust company reports. A study conducted by ACCA (Association of Chartered Certified Accountants) reveals the fact that investors are sceptical as concerns the information provided by companies. The main findings of the study include that[1]:

[1] ***, *Studii, cercetări, analize*, Revista Audit Financiar, Anul XI, nr.104 – 8/2013, p. 52

- After the financial crisis of 2007, 69% of investors have become more sceptical about the information provided by companies;
- 63% believe that the information generated outside the company is more reliable;
- 63% believe that management has too much authority as concerns the reported figures;
- 63% believe that the amount of information provided by companies has encouraged "*hyper-investments*";
- 46% believe that the mandatory quarterly reports should be done away with;
- 93% have expressed their support for the concept of integrated reporting.

Ernst & Young, one of the most famous audit firms in the world, has published a study, "*Tomorrow's investment rules: global survey of institutional investors on non-financial performance",* on the value of nonfinancial information for investors. The study identifies the most important trends and practices in assessing the information on the environmental, social and corporate governance performance of companies. It is based on a global survey conducted on 163 investors, analysts and project managers, as well as on a series of interviews. The survey was conducted in September 2013. We will further present the most important findings of the study.

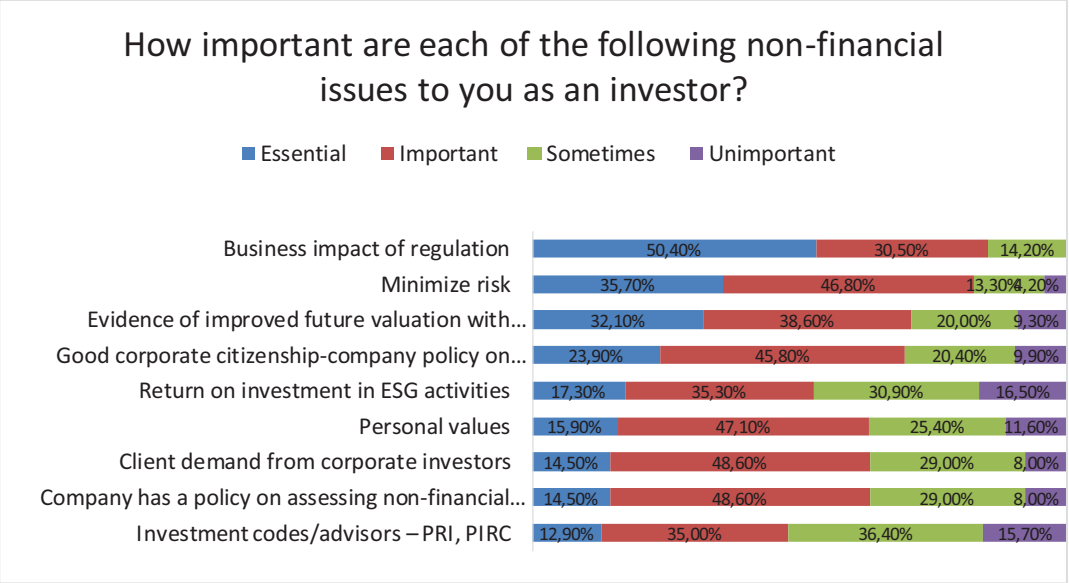


Figure 2: Information aspects that are important for investors

Most investors that have been interviewed use the non-financial information of companies when they evaluate the return on the invested assets. One of the most important reasons why they do this is that the non-financial information allows them to anticipate and diminish the risks associated with their investment.

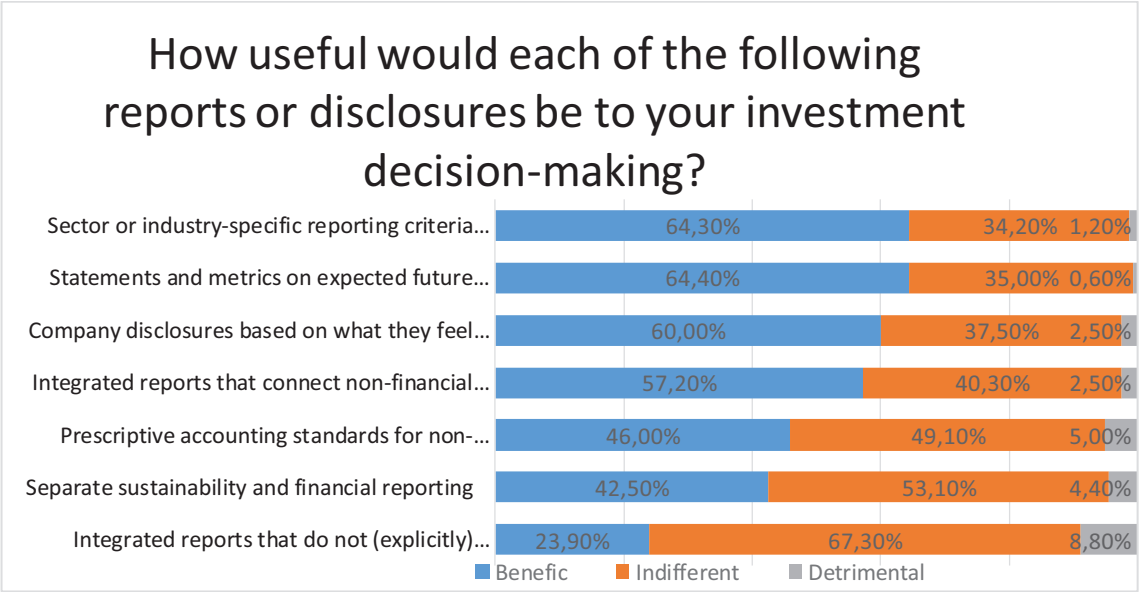


Figure 3. Useful reports in the decision-making process

The aspects investors are very interested in are corporate governance, strategies used by the company in terms of long term value creation and particularly the materiality of the data for the sector they operate in ("*material data*").

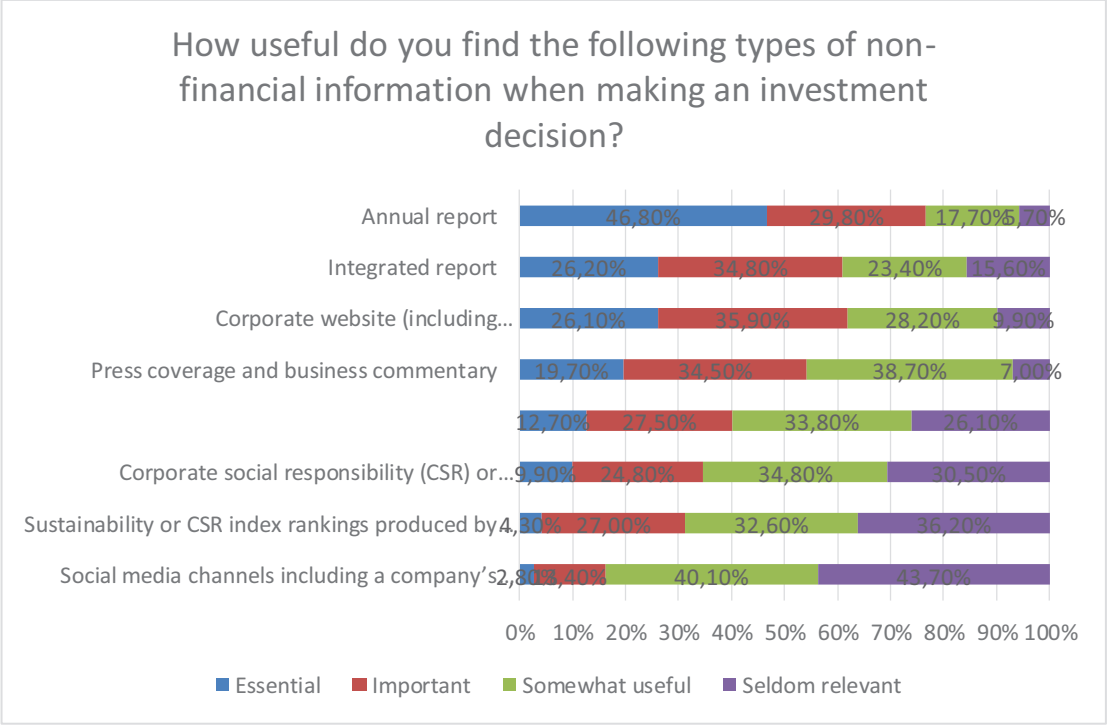


Figure. 4. Usefulness of non-financial reports in the decision-making process

The interviewed investors usually look at the information provided directly by the companies they invest in and not from the ranking agencies or other third parties. The first

providers of information related to environmental, social and corporate governance performance of companies are the annual reports and the information posted on their website. An important part is assigned to the integrated reports (which takes into account the information available in several departments and which tries to provide a complete image of the company's performance). A percentage of 61% of the respondents believe that the availability of an integrated report is essential for decision-making. Finally, 40% of the respondents state that they also check the information provided by third parties, such as Bloomberg, but also the information provided by the media.
In practice, we have noted that European financial analysts are increasingly using market oriented methods and are trying to also take into account factors such as geographical distribution of the turnover and current state of the sector. These practices are also supported by the IFRS that wish to ensure the comparability of the financial statements of the various business entities and to help them overcome any difficulties that may occur.
Professional literature mentions the presence of numerous studies conducted on how companies understand access to funding sources and particularly the funding available for small and medium-sized enterprises. Statistics show that the size of the SME sector in east-European countries is smaller than that of the same sector in most developed countries. Nevertheless, SMEs are part of the most dynamic sector of the east-European economy. A new type of companies is emerging in transition economies, more profit and market oriented but also facing certain financial constraints that block their access to long-term funding and affects their development. Therefore, a new type of company is emerging in transition economies.

4. The Monte Carlo simulation model – case study financial investment companies (SIF 1)

The present research focuses on identifying a method of establishing the price of the shares listed on the Bucharest Stock Exchange based on an analysis of the changes occurring in the evolution of the main economic and financial indicators for the companies included in the study.

The analysis of the main indicators for FIC Banat-Crișana

The main indicators showing the economic and financial changes occurring in each quarter, during December 31st 2013 – September 30th 2014, at the Financial Investment Company Banat-Crisana have been summarised in Table 1. The evolution of these indicators is fluctuating, with periods of appreciation followed by periods of decline. If certain increases/decreases can be interpreted as positive aspects in the evolution of the company, others are viewed as negative. Thus, if the decreased rate of return indicates a negative change in the company, the lower gearing is a positive change.

Table 1: Analysis of the FIC Banat Crişana (SIF 1) indicators during Dec. 31st 2013 – Sept. 30th 2014

Indicators	Dec.31st .13	Mar 31st.14	Jun.30th 14	Sept 30th 14	Absolute change Sept.30th 2014/ June 30th 2014	Dynamic indicators Sept.30th. 2014/ June 30th 2014 %	Relative change Sept.30th. 2014/ June 30th 2014 %
Fixed assets	997.503.553	995.074.040	934.692.554	950.874.353	16.181.799	101,73	1,73
Working capital	112.585.753	161.137.975	289.518.913	280.187.060	-9.331.853	96,78	-3,22
Total Assets	1.110.089.306	1.156.212.015	1.224.211.467	1.231.061.413	6.849.946	100,56	0,56
Total Liabilities	34.153.880	33.589.734	42.409.210	23.620.335	-18.788.875	55,70	-44,30
Shareholder's equity	1.075.935.426	1.122.622.281	1.181.802.257	1.207.441.078	25.638.821	102,17	2,17
Market price	1,29	1,14	1,20	1,24	0,04	103,33	3,33
Number of shares	548.849.268	548.849.268	548.849.268	548.849.268	0	100,00	0,00
Net income	80.143.950	54.127.006	149.295.427	151.362.268	2.066.841	101,38	1,38
Total revenues	142.094.475	90.623.459	235.848.763	248.681.243	12.832.480	105,44	5,44
Book value	1,96	2,05	2,15	2,20	0,05	102,17	2,17
Earnings per share	0,15	0,10	0,27	0,28	0,00	101,38	1,38
Gearing	3,08	2,91	3,46	1,92	-1,55	55,39	-44,61
ROE	7,45	4,82	12,63	12,54	-0,10	99,23	-0,77
ROA	7,22	4,68	12,20	12,30	0,10	100,82	0,82
Rate of return	56,40	59,73	63,30	60,87	-2,44	96,15	-3,85
Solvency ratio	96,92	97,09	96,54	98,08	1,55	101,60	1,60
Liquidity ratio	3,30	4,80	6,83	11,86	5,04	173,76	73,76
PER	8,83	11,56	4,41	4,50	0,08	101,92	1,92
P/B	0,66	0,56	0,56	0,56	0,01	101,14	1,14

Source of the datas: author's own, based on the data available on: http://www.tradeville.eu/actiuni/actiuni-SIF1/date-financiare,, http://www.bvb.ro/ListedCompanies/SecurityDetail.aspx?s=SIF1&t=2, Statement of financial position and shareholder's equity, Profit and Loss account. Informative data 30.09.2014.pdf

During June 30th 2014 – September 30th 2014, the earnings per share have increased by 1,38%, and the market price of the shares on SIF1 was higher by 3,33% on

September 30th 2014 as compared to June 30th 2014. For the same period, the total liquidity has increased by 73,76%.

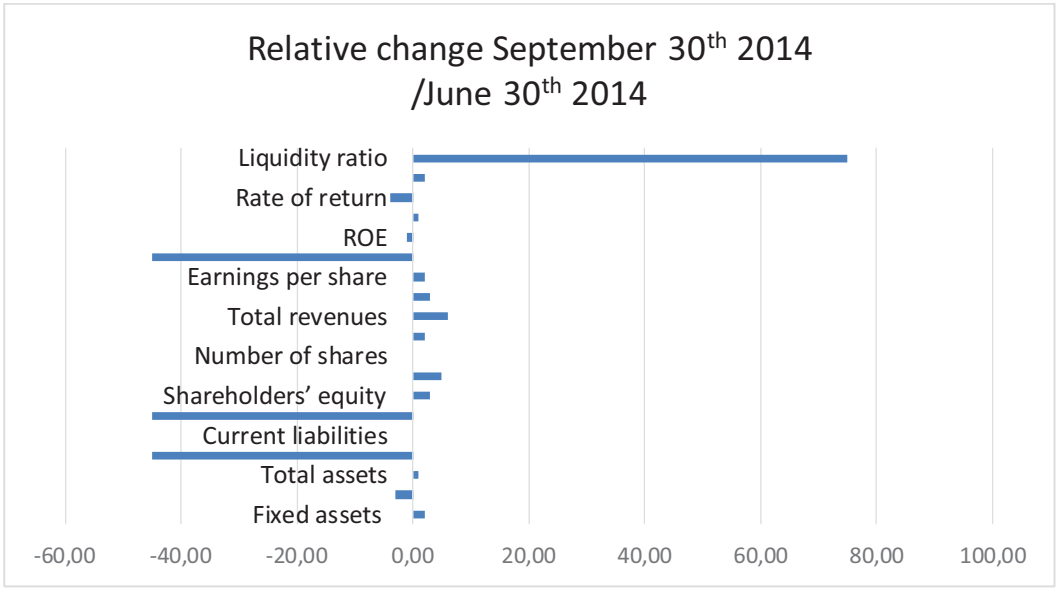


Figure 5: Relative change of the main indicators for FIC Banat Crişana (SIF1) during June 30th 2014 – September 30th 2014

If we state that the changes in the market price of the shares have been caused by the changes in the economic and financial indicators of the company, then we can calculate the market price of the shares for the current period, starting from the value reached during the previous period, weighed by the value of an average dynamic indicator that would reveal the changes occurring in the evolution of these indicators, thus:

$$P_1 = P_0 * \bar{I}$$

where:

P_1- market price of the shares at present;

P_0 - market price of the shares during the reference period;

$\bar{I}$ - average dynamic indicator.

If we start from the assumption that an investor conducts a rational analysis of certain economic and financial indicators when making the decision to buy or to sell shares, we will consider the share price and the dynamic indicators for:

- **Book value per common share (Vc);**
- **Earnings per share (EPS);**
- **Rate of return (Rp),**
- **Return on assets (ROA);**
- **Return on Equity (ROE);**
- **Solvency ratio (Sp);**
- **Liquidity ratio (Lp).**

The average dynamic indicator for these ratios, during June 2014 – September 2014 will be calculated as a geometrical average, thus:

$$\bar{I} = \sqrt[7]{I_{Vc} * I_{Rp} * I_{ROA} * I_{ROE} * I_{Sp} * I_{Lp} * I_{Eps}} =$$

$$= \sqrt[7]{1{,}0217 * 0{,}9615 * 1{,}0082 * 0{,}9923 * 1{,}0160 * 1{,}7376 * 1{,}138} = 1{,}0840$$

Based on this average indicator, we will identify the share price on September 30th 2014, as follows:

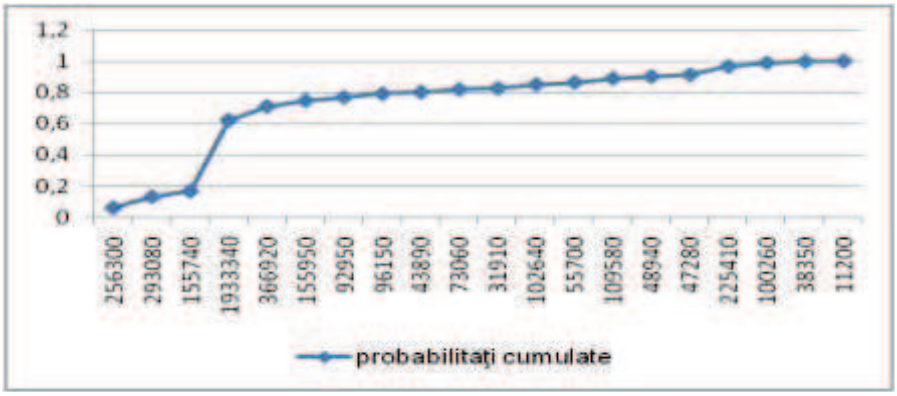
$$P_{sept.2014} = P_{iunie2014} * \bar{I} = 1{,}20 * 1{,}0840 = 1{,}301$$

The obtained value ranks above the market price of the shares, identified based on the graph presented in Figure no. 2, thus leading us to believe that there have also been other factors that influenced the share price on the market. The gradual identification of the selling price of these shares by using the ***Monte Carlo method*** entails the following steps:

- *Computing probabilities and cumulative probabilities*

Date	Average price	Volume	Probability	Cumulative probability
03.11.2014	1,249	256300	0,060467366	0,060467366
04.11.2014	1,252	293080	0,069144657	0,129612023
05.11.2014	1,278	155740	0,036742831	0,166354854
06.11.2014	1,285	1933340	0,456121643	0,622476496
07.11.2014	1,285	366920	0,086565298	0,709041794
10.11.2014	1,273	155950	0,036792375	0,745834169
11.11.2014	1,284	92950	0,021929152	0,767763321
12.11.2014	1,276	96150	0,022684109	0,79044743
13.11.2014	1,271	43890	0,010354712	0,800802142
14.11.2014	1,279	73060	0,01723662	0,818038762
17.11.2014	1,266	31910	0,00752834	0,825567103
18.11.2014	1,261	102640	0,024215257	0,84978236
19.11.2014	1,254	55700	0,013140976	0,862923336
20.11.2014	1,258	109580	0,025852571	0,888775907
21.11.2014	1,262	48940	0,011546129	0,900322036
24.11.2014	1,259	47280	0,011154495	0,911476531
25.11.2014	1,269	225410	0,053179668	0,964656199
26.11.2014	1,267	100260	0,023653758	0,988309957
27.11.2014	1,26	38350	0,009047692	0,997357649
28.11.2014	1,263	11200	0,002642351	1
Total		**4238650**	**1**	

1. *Graph representation of the cumulative probabilities*



The generation of the random numbers, calculating the average, the square standard deviation, the variation coefficient and the confidence interval:

Nr. observations	Lower threshold	Average price	Interval
1	0,060467366	1,249	[0,0604673657886355;0,129612022695906)
2	0,129612023	1,252	[0,129612022695906;0,166354853550069)
3	0,166354854	1,278	[0,166354853550069;0,622476496054168)
4	0,622476496	1,285	[0,622476496054168;0,709041793967419)
5	0,709041794	1,285	[0,709041793967419;0,745834168898116)
6	0,745834169	1,273	[0,745834168898116;0,767763320868673)
7	0,767763321	1,284	[0,767763320868673;0,790447430195935)
8	0,79044743	1,276	[0,790447430195935;0,8008021421915)
9	0,800802142	1,271	[0,8008021421915;0,818038762341783)
10	0,818038762	1,279	[0,818038762341783;0,825567102733182)
11	0,825567103	1,266	[0,825567102733182;0,849782359949512)
12	0,84978236	1,261	[0,849782359949512;0,862923336439668)
13	0,862923336	1,254	[0,862923336439668;0,888775907423354)
14	0,888775907	1,258	[0,888775907423354;0,90032203649747)
15	0,900322036	1,262	[0,90032203649747;0,911476531442794)
16	0,911476531	1,259	[0,911476531442794;0,964656199497482)
17	0,964656199	1,269	[0,964656199497482;0,988309957179763)
18	0,988309957	1,267	[0,988309957179763;0,997357649251531)
19	0,997357649	1,26	[0,997357649251531;1)
20	1	1,263	1

Based on the data from the above table, the random numbers have been generated as well as the necessary calculations to estimate the stock market price based on the Monte Carlo method. The obtained results can be found in Annex 1.

The average price is the arithmetical average of the simulated prices, thus:

$$\overline{X} = \frac{240,367}{189} = 1,27183$$

The square standard deviation is:

$$\sigma^2 = \frac{\sum(\quad_i - \overline{X})}{n} = \frac{0,0240841058}{189} = 0,0001274$$

Dispersion:

$$\sigma = \sqrt{\sigma^2} = \sqrt{0,0001274} = 0,0112885$$

Variation coefficient:

$$c_v = \frac{\sigma}{\overline{X}} * 100 = \frac{0,0112885}{1,27183} * 100 = 0,8876082$$

For 188 degrees of freedom, a 5% error, the interval indicating the price that can be obtained is given by the ratio:

$$\left(\overline{X} \pm t_{0,05;188} * \frac{\sigma}{\sqrt{189}}\right)$$

Replace and thus get the interval:

$$\left(1,271783 - 1,645 * \frac{0,0112885}{\sqrt{189}}; 1,271783 + 1,645 * \frac{0,0112885}{\sqrt{189}}\right)$$

$$(1,270432336; 1,273133801)$$

We can state, with a 95% probability, that the share price will range between a minimum of 1,2704 and a maximum of 1,2731.

The analysis of the changes in prices, based on the regression and correlation method, entails taking into account the values for a longer period of time. The evolution of share market prices on SIF1, based on the data available on the website of the Bucharest Stock Exchange for a period of 180 days, is detailed in Figure 6.

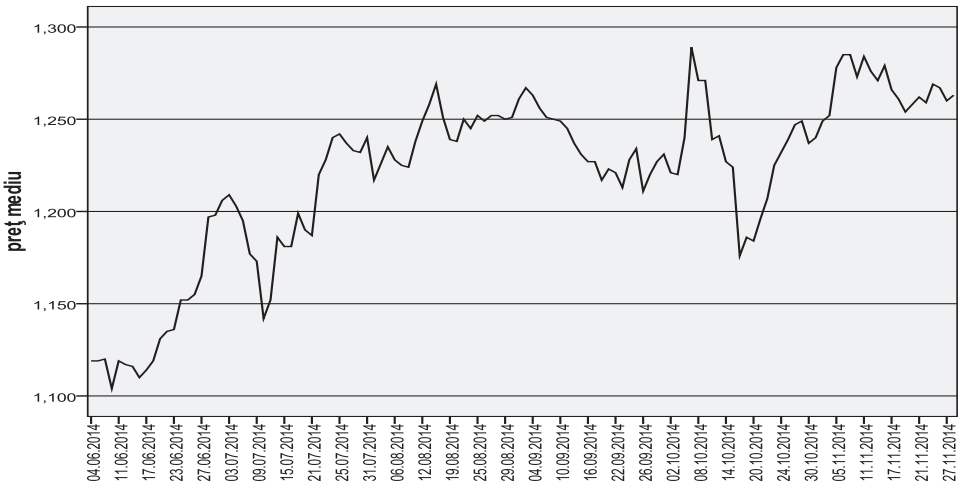


Figure 6: Evolution of FIC Banat Crişana shares during June 4th – November 28th 2014
Data source: author's own, based on the data available at www.bvb.ro

The figure highlights a maximum point in October, amounting to 1,289 (October 7th 2014) and a minimum point of 1,104 in June (June 10th 2014).

During June 4th – November 28th 2014, the average price of SIF 1 shares was of *1,22*. The dispersion of the series values around the mean is quite low (*0,04611*), the series is asymmetrical on the left, while the asymmetry coefficient is *-0,98.*

Table 2: Descriptive statistics

	Indicators		**Values**	**Standard error**
Average_price	Mean		1,22008	0,004108
	95% Confidence Interval for Mean	Lower Bound	1,21195	
		Upper Bound	1,22821	
	5% Trimmed Mean		1,22250	
	Median		1,23200	
	Variance		0,002	
	Std. Deviation		0,046111	
	Minimum		1,104	
	Maximum		1,289	
	Range		0,185	
	Interquartile Range		0,054	
	Skewness		-0,980	0,216
	Kurtosis		0,133	0,428

The figure representation of the series, detailed in Figure no. 6 pinpoints the fact that the evolution of the Stock Exchange prices during June 6th – November 28th can be approximated by means of a quadratic or a cubic model. In order to select the evolution model, we have calculated the coefficient of determination and the square of the modelling errors. Based on the conducted calculations, we have selected the cubic model in order to adjust the evolution of the Stock Market price for the period under analysis.

Table 3: Estimates of the correlation coefficients

R	R Square	Adjusted R Square	Std. Error of the Estimate
0,896	0,803	0,798	0,021

The determination coefficient, *R square adjusted*, shows that the cubic model accounts for 80,3% of the variation of the phenomenon, while the value is significantly different from zero.

Table 4: Testing the significance of the determination coefficient

	Sum of Squares	df	Mean Square	F	Sig.
Regression	0,213	3	0,071	166,040	0,000
Residual	0,052	122	0,000		
Total	0,266	125			

The general form of the cubic model is given by the ratio:

$$P = a + b_1 * t + b_2 * t^2 + b_3 * t^3$$

where:
P- share market price
t - time variable
b_i regression coefficients

Table 5: Estimates of the regression coefficients corresponding to the complete cubic model and their testing relative to zero

	Unstandardized Coefficients		Standardized Coefficients	t	Sig.
	B	Std. Error	Beta		
Case Sequence	0,0066388	0,0005164	5,2574985	12,8566063	0,0000000
Case Sequence ** 2	-0,0000901	0,0000094	-9,3539678	-9,5563656	0,0000000
Case Sequence ** 3	0,0000004	0,0000000	4,9605630	8,1314722	0,0000000
(Constant)	1,0793493	0,0076025		141,9733364	0,0000000

After estimating the parameters of the cubic model, we get:

$$P = 1{,}0793493 + 0{,}0066388 * t - 0{,}0000901 * t^2 + 0{,}0000004 * t^3$$

The adjustment of the series by means of this model is conducted in the graph in Figure 7.

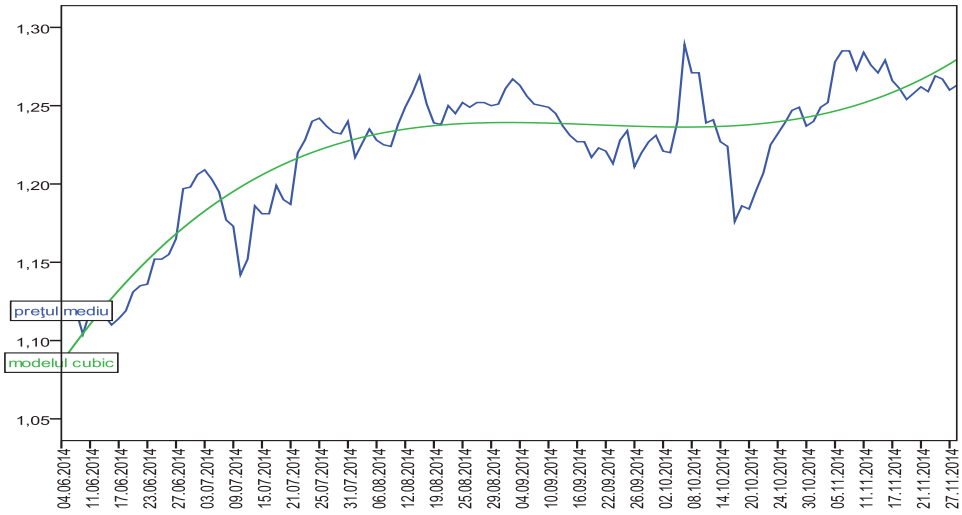


Figure 7: The price of the SIF 1 shares on the Stock Exchange during June 6th – November 28th 2014, adjusted by means of a cubic model

5. Conclusions

There are countless approaches related to the complexity/difficulty of the decision making contexts in today's economy; some researchers suggest a new framework for substantiating business decisions; they speak of simple, complicated, complex and chaotic contexts; they also say that keen leaders are able not only to identify the context they are

working in, but also manage to adapt their behaviour to the characteristics of that particular context.
However, we should not generalize: in practice, decision makers are never confronted with just one decision related issue, and the information system provides a wide range of information. That is why the cost-profit approach should focus on the collective effect of the decisions taken in one company. For instance, a complex and costly accounting information system can provide sufficient data and even features for budget elaboration. In more simple situations (let's say, identifying the required supplies), a cheap application implemented on a computer or even a model designed by the user in a usual development environment can provide sufficient data for decision making, under circumstances of economic efficiency.
The accounting information system of an enterprise is one of the essential components of the economic information system, as it is the main means of understanding, managing and controlling the assets and the output of that particular enterprise. The main role of the accounting information system in the decision making process entails that its organisation and functioning should ensure the successful completion of the following objectives:

- provide the necessary information for decision making, both for the management of that particular enterprise and for third parties;
- provide the information needed for drawing up the plans and economic activity programmes, particularly used with the budgets of those companies;
- chronologically and systematically record the economic activities that influence the financial position, performance and treasury flows of the company;
- provide the necessary data for calculating the cost of the products, transactions and services;
- provide the information needed for preparing the financial and accounting reports.

Thus, the financial information becomes a paramount resource for decision-making processes, used both for drawing up strategic development plans, in agreement with the corporate culture of each business entity, and also for designing operational plans in agreement with the medium term and long term development strategies.

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