

THE SCENARIOS METHOD APPLIED TO PROGNOSIS OF MICRO AND NANOTECHNOLOGIES WITH CONCENTRATED ENERGIES

Daniela Ghiculescu¹, Niculae Ion Marinescu², Liviu Daniel Ghiculescu³

1 - National Authority of Scientific Research, daniela.ghiculescu@ancs.ro

2 - Politehnica University of Bucharest, niculae.marinescu@nsn.pub.ro

3 - Politehnica University of Bucharest, daniel.ghiculescu@nsn.pub.ro

ABSTRACT: The paper deals with application of qualitative scenarios method, introduced by Herman Kahn, at long term prognosis of micro and nanotechnologies with material removal through concentrated energies. The method application is related to the strategy formulation for an organization. It comprises several stages with major miles stones like: internal medium analysis, main external determinants, impact factors upon the organization, scenarios matrix, the reference scenario and reserve plans. A case study is approached regarding the evolution of the field mentioned above in connection with the strategy of a Romanian research organization with activities in this field. The application is finalized through elaboration of a reference scenario based on extension of global economic crisis. Nevertheless, it results that organization undertakes measures in order to be prepared for the competition with surviving organizations from the approached field.

KEY WORDS: scenarios, micro and nanotechnologies, strategy, determinants, impact factors.

1. INTRODUCTION

The qualitative method of scenarios is introduced by *Herman Kahn* physicists, mathematician and military strategist, considered a parent of the futurology. He is the author of many scenarios, which were proved to be surprisingly exact over the years. In 1967, in the work "The Year 2000", a list is provided, called "One Hundred Technical Innovations Very Likely in the Last Third of the Twentieth Century" [1], which surprises through accuracy of prognosis. A Herman Kahn's similar paper, "The Next 200 Years" from 1976 [2], has the topics, predictions related to next 200 years, concerning the population growing, economic development, energy, raw materials, food, and environment problem.

Herman Kahn emphasized the importance the holistic approach, through which the analyst could determine those points of multiple influence of factors that affect the precision of prognosis. The future choices are strongly related by these factors of influence. Therefore, the future implies an infinite number of variables, and trying to choose only some variable and calculating their implications lead to major errors. For example, the famous prediction, the so-called, the *Moore's Law* from 1964 - the number of transistors on integrated circuits doubles approximately every two years - reaches his limits in the present. In 2001, this prediction is contradicted through appearance of *nanometric bistable-switch*, „crossbar latch”, which effectuates logical operations, a *HP Labs' Quantum Science Research* creation [4].

Planning through scenarios is proved to be useful in intense capitalized economic sector and long term product development, which is the case of concentrated energies technologies, the topic of this method application in the current paper.

2. THE STAGES OF SCENARIOS METHOD

The scenarios method is developed on two major interdependent levels that will be approached: main determinants from external general medium; specific impact factors on studied organization.

The scenarios method, based on qualitative approach, comprises seven stages. Some feed-back relations actuate between the stages presented in fig. 1 (after [5], [6]):

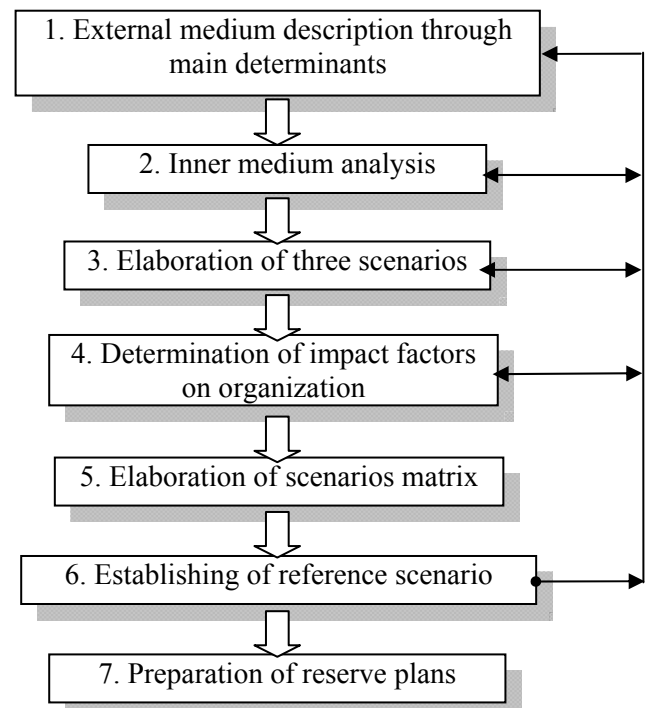


Figure 1. The logical scheme of scenarios method application

The method leads to elaborations of three possible scenarios using the two basic concepts: the main determinants and impact factors. The main determinants are major events or trends, which activate in external medium, around analyzed organization. These phenomena are easier to be predicted, against punctual events on long time interval. The impact factors signify the probable action of the main determinants on organization. Therefore, the impact factors are closer to organization. Biunivocal correspondence does not operate between these two categories of analysis.

3. MAIN DETERMINANTS OF EXTERNAL MEDIUM EVOLUTION

The main determinants of the phenomenon to be predicted contribute to the description of the frame (medium) where the phenomenon takes place. Many methods could be applied for determinants establishing, like specific prognosis method or those with larger spectrum, generally used as quality improvement or those belonging to general management: Delphi in different variants [7], [8], [9], brainstorming, Ishikawa diagram [10], Michael Porter's Five Forces Model [11] etc. In this paper, a quasi exhaustive approach of possible external factors is aimed, bearing in mind the holistic spirit of the method, as it was initially conceived by Herman Kahn.

In this case study, the PEST method [5] was applied, consisting in a check-list, having the goal of an integrative vision specific to Kahn's method. In fig. 2, the elements of external analysis were checked, considered as valid for prognosis of micro and nanotechnologies with material removal through concentrated energies. These are main the determinants of external medium in case of studied organization X, which is a SME, activating in the approached field.

PEST factors were emphasized, which are in strong connection with development of concentrated energy field, which generally has a high rate of evolution, chiefly, in the subdomain of micro and nanotechnologies. These are: research-development-innovation (RDI), technological transfer, and equipment obsolescence. Other determinants that assure the frame of technical and economical performance are also essential: labour legislation, education and fluctuation of human resources, culture related to labour and profession, macroeconomics indexes of Romania and EU etc.

Internal characteristics of organization X need to be correlated to main determinants. A previous costs analysis through inner chain value [11] pointed out a wrong percentage allocation – high expenses of general management against to basic and support activities as fabrication, RDI, and equipment acquisition. These are in tight dependence with human resources, and therefore in larger context of educational system, with work force availability, and labour attitude.

The studied organization has a high level of information resource, correlated to human resource bearing this information and in agreement with high rate of approached field development. The capitalization of these resources depends on financial resources and infrastructures, which are much affected by under financing of RDI national system, the frame where organization X activates.

The competencies of costs decrease are too much dependent on low cost production factors from Romania, and do not include other components with long term effect, as coordination and control and continuous cost decrease [5]. These are sustained by application of quality management principles like System and Process-Based Approaches [12].

The strategic objectives are very much influenced by the concern to obtain short term performances. The organization X needs to clarify the vision, mission and to formulate a strategy, appropriate to external competitive medium changes.

The human resource that is not motivated financially does not facilitate the consolidation of organizational culture needed to be client and competitor oriented, although X is a learning organization. Therefore, identified internal characteristics lead to a fragile competitive position on strategic markets.

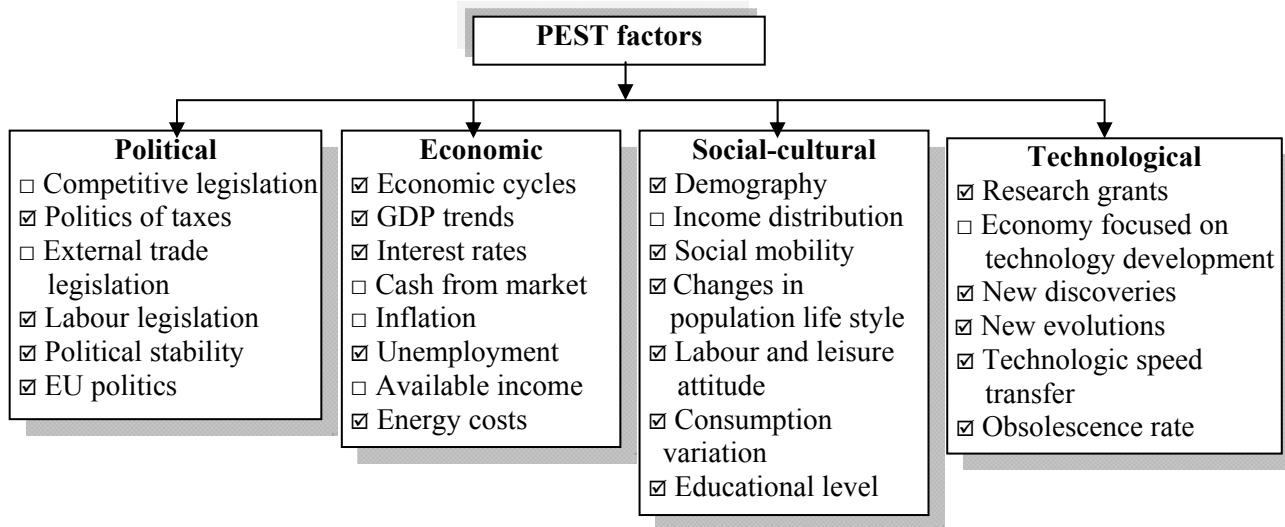


Figure 2. PEST analysis for identification of main external determinants –case study

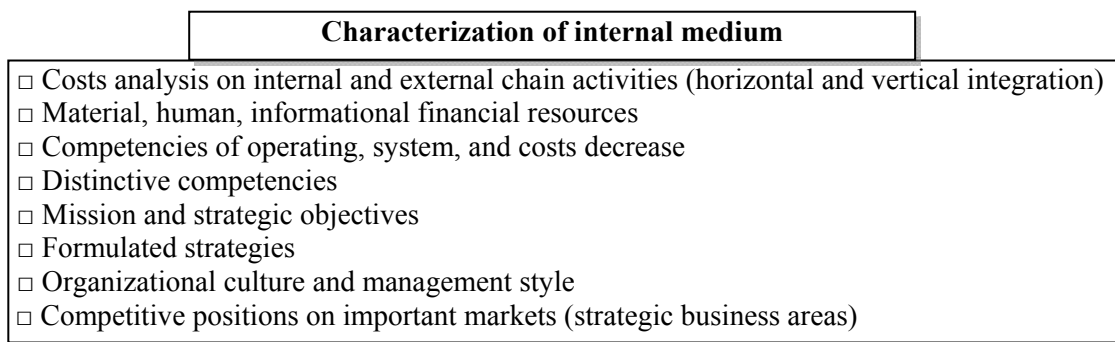


Figure 3. Simplified internal analysis for correlation with external medium

Table 1. Characterization of the three scenarios through components of the main determinants – case study

No.	1. Development based on actual trends of economic crisis prolongation	2. Improvement of macroeconomic performances based on appropriate measures of internal politics	3. Strong development based on overcoming the global economic crisis
1	excessive taxation	relaxed taxation	relaxed taxation
2	disadvantaged employers	disadvantaged employees	advantaged employees and employers
3	political instability	political stability	political stability
4	sanctions from EU	integration in EU mechanism	integration in EU mechanism
5	world economic decline	world economic decline	world economic boom
6	internal economic slump	internal economic boom	internal economic boom
7	GDP decrease	GDP increase	GDP increase
8	interest rates growing	interest rates lowering	interest rates lowering
9	unemployment increase	unemployment decrease	unemployment decrease
10	energy cost increase	energy cost increase	energy cost decrease
11	active population decrease	active population increase	active population increase
12	specialists emigration	specialists return	specialists return
13	income polarization	income polarization	income equalization
14	labour force immobility	labour force mobility	labour force mobility
15	work program decrease	work program increase	work program increase
16	consumption decrease	consumption increase	consumption increase
17	low level of education	higher level of education	higher level of education
18	research funds decrease	research funds increase	research funds increase
19	low rate of technological progress	high rate of technological progress	high rate of technological progress
20	low rate of technological transfer	high rate of technological transfer	high rate of technological transfer
21	high rate of obsolescence	high rate of obsolescence	high rate of obsolescence

4. ELABORATION OF THREE SCENARIOS

The goal of scenarios elaboration is to prepare organization to answer quickly and correct to possible changes of external medium. Therefore, in this stage, three scenarios are elaborated, each of them playing a certain role in a strategy formulation, leading to sustainable competitive advantage. The first scenario is based on current trends and is adjusted to take into account the future perturbing events. The other two scenarios describe possible alternative visions on the future. The generic description of a scenario is based on the evolution of the corresponding main determinants and not the reverse. Prefiguration of scenarios and then the corresponding description of main determinants can lead to major errors.

In this context, David Faulkner and Cliff Bowman don't recommend the usual approach, consisting in prior establishing of three standard scenarios such: (1) neutral; (2) optimistic; (3) pessimistic [5]. Thus, the scenarios (2) and (3), considered as extreme, suppose the introduction of an error interval around the neutral scenario (1). This could be in major contradiction with holistic approach of Herman Kahn's original method, which aims at preparing the organization for any evolution of external medium that could affect the strategy. Moreover, the neutral, optimistic, and pessimistic characterization is relevant if it is reported to internal analysis of organization, respectively to applicable strategies. As in case of SWOT analysis and other similar methods, the results of this approached method are relative. It is possible that a scenario, previously considered as pessimistic, will create major opportunities if organization prepares an adequate strategy, able to exploit these opportunities. A more realistic approach consists in elaboration of alternative scenarios based on cause-effect relations that determine major deviations against mean values of main determinants in order to obtain opposite limits, and consequently establish reserve plans.

In figure 4, the scenario trumpet metaphor is presented, which illustrates the mode of scenarios construction. Their elaboration is made at moment t_0 . Moving along time axis (time horizon growing), error margin is increased through perturbative events appearance or human intervention in external medium, characterized by PEST factors. Therefore, different scenarios are visualized with mean values of determinants (Vm_1, Vm_2, Vm_3) and with extreme values (Ve_1, Ve_2), depending on magnitude of perturbations occurred along time axis.

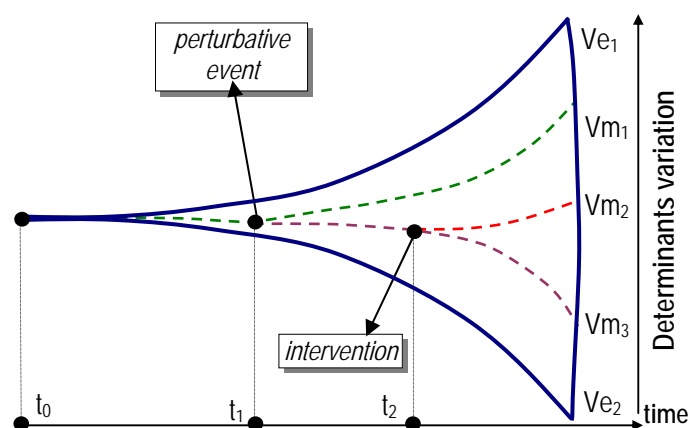


Figure 4. The scenario trumpet metaphor (after [13])

In table 1, the three scenarios are described: (1) – the most probable one in which national economy cannot avoid the major influence of global economic crisis and other two scenarios, (2) – the possible one, under conditions of positive Romanian macroeconomic evolution but under unavoidable spectrum of crisis passing, and (3) – the less probable one, of overcoming the global economic crisis, but with great strategic importance for any organization.

The evolution of main determinants components is presented in table 1, having PEST form (P:1-4; E: 5-10; S: 11-17; T: 18-21), corresponding to the three scenarios:

Scenario no. 1: Development based on actual trends of economic crisis prolongation. The field of micro and nanotechnologies with concentrated energies in Romania will be strongly affected by inhibiting technological factors, mainly by decrease of research funds provided chiefly from budget but also from private sources. The organization activating in this approached field need equipment corresponding to actual world level. The obsolescence rate of specific equipment will be high as long as this field will be located on ascending curve of sector life cycle. Consequently, the technical performances in this field could also be low in terms of development and technological transfer rate, which could have an impact on economic performances of organization.

The other political, economic, and social factors will create also an inhibiting frame for the predicted field. The measures of taxation increase, and those concerning the labour legislation, political instability and sanctions from EU (e.g. decrease of structural funds) produce a tough decrease of financing of this peak technological field, in which the profit appears on long term, after massive investments. The economic factors have negative evolution due to global economic crisis and malfunction of national economy, inducing the growing of interest and unemployment rate, energy cost etc. Gross Domestic Product (GDP) is strongly related to budgetary funds that will be allocated to researches.

The social factors will determine also the lowering of the performances in this field, through decrease in labour, emigration of specialists, and low level of education due to chronic subfinancing of educational system. Decrease of consumption with the background of dramatic lowering of purchasing power could not be the motor of relaunching of national economy and implicitly of this high level technological field. Nevertheless, there are organizations with high competencies in Romania in this approached field, which make great efforts to maintain their economic performances at an acceptable level. Therefore, these organizations would have a very good start when the external medium will change after economic boom.

Scenario no. 2: Improvement of macroeconomic performances based on appropriate measures of internal politics. Although the economic crisis will be prolonged at global level, the Romanian economy, through appropriate macroeconomic measures, will record a boom of economical parameters, which will affect the predicted field, the micro and nanotechnologies with concentrated energies. The increase of consumption stimulated by tax relaxation, political stability and superior integration within EU mechanism will represent a motor of national economy relaunching.

Under conditions when GDP will grow, the interest rate will decrease and several sources of research - development - innovation (RDI) funding and education will emerge. Consequently, the unemployment rate will decrease and the highly qualified specialists intend to return.

All these phenomena will have positive effect on human resources, whose qualification and motivation will rise, generating a new pulse for development of predicted field, characterized though high dynamics and technological transfer rate. In this context, the organizations from the approached field should undertake measures through increase of knowledge management performances, human resource

stimulation, and creation of an organizational cultural adequate to learning organization.

Equipment up-dated to actual level of development will be purchased – the rate of obsolescence will be maintained – through undertaking major research projects in the field, taking advantage on the opportunities provided by external medium when the equipment prices are still low, as a result of global economic crisis, and decrease of interest rate on the background of national economy boom.

Scenario no. 3: Strong development based on overcoming the global economic crisis. At the opposite pole of the first scenario, the current one is situated which lead to accelerated development of the field through all major determinants. This is due to world economic crisis overcoming, overlapped on national economy growing, taking advantage on a performing management. In this context, the predicted field will benefit from a prominent growing based on human, financial, and informational resources. This global economic boom will bring also the increase of last generation equipment prices and energy costs, which will create some operational difficulties to organizations from this field. Generally, these negative determinants could not counterbalance the positive evolution of the other determinants, which are in majority and will determine a strong favourable impact on economy through high rate of field development and technological transfer.

On the other hand, the competition in predicted field will become very keen. Therefore, if the organizations from this sector did not undertake managerial measures for preparing this evolution phase - through significant improvement of human resources skill, infrastructure, informational resources (appropriate knowledge management) - will encounter major difficulties.

In synthesis, it can be assumed that all the three scenarios formulated before emphasize the necessity of development and investment in the field of concentrated energy technologies, starting from own financial resources use and based on project management.

Even the most unfavorable scenario, based on actual trends of global economic crisis amplifying and inappropriate management of national macroeconomics points out the later risk of difficult overcoming of a gap between the world development level and the national one if the progress of this field is delayed.

5. DETERMINATION OF IMPACT FACTORS

The impact factors represent the probable action exerted on organization by the main determinants of predicted phenomena. Consequently, the impact factors are located closer to organization, being useful in analysis of external competitive medium. There is not a biunivocal correspondence between main determinants and impact factors. A single determinant could have an influence on more impact factors and inversely, the combined action of more main determinants could affect a single impact factor.

In table 2, the impact factors (A...I) of evolution of micro and nanotechnologies with concentrated energies and their influence on studied organization X, and their correspondence to the main determinants (1...21) and the three scenarios formulated in the previous stage are presented. For establishing impact factors, specific elements of internal analysis of organizations from concentrated energies technologies field were considered as it is presented in stage 2 which is in feed-back connection with the stage 4 (see figure 1).

Table 2. The impact factors of prognosis for micro and nanotechnologies with concentrated energies

Impact factors	Corresponding main determinants	Scenarios		
		1	2	3
(A) Organization costs	1, 2, 8, 9, 10, 12	costs increase significantly	costs decrease slowly	costs decrease significantly
(B) Negotiation power of equipment purchaser	1, 13, 16, 21	grows slowly	grows progressively	grows significantly
(C) Equipment offer	4, 16, 18, 19, 20, 21	grows slowly	grows progressively	grows significantly
(D) Financial resources	1, 2, 7, 8, 10, 13, 16	decrease progressively	increase progressively	increase significantly
(E) Human resources (specialists)	11, 12, 14, 15, 17	emphasized decrease	slow grow	progressive grow
(F) Field competencies	12, 17, 19, 20	emphasized decrease	slow grow	progressive grow
(G) Financing sources	5, 7, 13, 18	decrease progressively	grow progressively	grow significantly
(H) Know-how access	18, 19, 20	very slow facilitated	facilitated progressively	facilitated progressively
(I) Life cycle of equipment	19, 20, 21	decreases progressively	decreases progressively	decreases progressively

For achievement of organization strategies from the field of concentrated energies technologies, all categories of strategic resources are needed and capabilities that capitalize these resources and generate distinctive competencies, which lead to sustainable competitive advantage.

These elements of internal analysis are in connection with the impact factors *A...I*, which are provided by Michael Porter's Five Forces Model [11].

Due to sensitivity of this technological field to high rate dynamics of actual technological progress under conditions of knowledge based economy, we mainly emphasized the impact factors related to acquisition and achievement of installation and equipment of machining, specific technologies, know-how and skilled human resources.

In table 2, there are more main determinants that influence a single impact factor. If it is considered, e.g. the factor (A), *organization costs*, this has the following components:

- Personnel expenses;
- Taxes paid to stage budget;
- Expenses with raw materials and consumables;
- Overheads;
- Equipment acquisition expenses.

In case of scenario no. 1, *Development based on actual trends of economic crisis prolongation*, the organization costs are predicted as having significant increase, being influenced by the following determinants:

1. Excessive taxation;
2. Employers disadvantage;
8. Interest rate increase;
9. Unemployment increase;
10. Energy costs increase;
12. Specialists emigration.

The main determinants mentioned above act on impact factor *A* in opposite senses, but with different weights, the resultant of their action having a certain sense. More precisely, the unemployment growing and its influence on salaries, has a minor effect comparing to the rest of determinants, which produces the significant increase of costs.

A similar analysis was effectuated in case of other impact factors (*B...I*). The corresponding results for the three scenarios were synthesized in table 2. Some remarks are necessary to be presented:

- The factor (*B*), *negotiation power of equipment purchaser*, will grow even in case of scenario with actual disadvantageous trend. This is determined mainly by the increase of obsolescence rate due to high dynamics of the concentrated energies technologies field and knowledge based economy;
- The factor (*C*), *equipment offer*, has a similar evolution because of high rate development of the approached field which is situated in the first stages of the life cycle of the sector. This trend cannot be decisively influenced by political, economical and social factors (in any scenario);
- The factor (*D*), *financial resources*, is strongly influenced by determinants of economic nature (and indirectly by other categories) like taxation, GDP increase (the funds for research and education are expressed as percentage from GDP), interest level, energy cost, income, consumption etc. These determinants have descendent trend in scenario 1, in agreement with actual trends; in scenarios 2 and 3, there is a probability that financial resources will grow due to change sense of determinants variation;
- The factor (*E*), *human resources (specialists)* and (*F*), *specific competencies in the field* are directly influenced in the sense of decrease in case of scenario 1, which expresses the actual trends: the labour force migration toward developed economy and low educational level; in case of scenarios 2 and 3, there are chances for competencies increase, based on a strategy oriented to education and research, in the context of overcoming of economic crisis and financing sources;
- The factor (*G*), *financing sources*, is decisively determined by the GDP level (similar to factor (*D*)) and the funds allocated to researches from the state budget and EU; in case of scenario 1, based on actual trend, these determinants have a decreasing variation, but they could grow in case of scenarios 2 and 3;
- The factor (*H*), *know-how access*, is mainly influenced by determinants like dynamics of technological progress, technological transfer rate and research funds, some of them decreasing, according to actual trend (scenario 1);

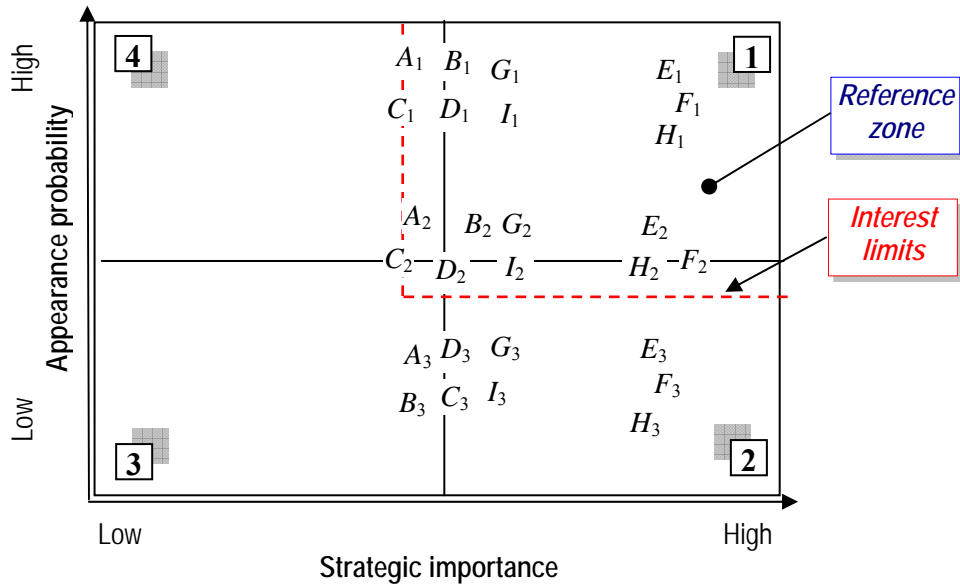


Figure 5. Scenarios matrix – development prognosis of micro and nanotechnologies with concentrated energies

The trend of this factor can be easily modified by research funds growing and technological transfer rate in case of scenarios 2 and 3;

➤ The factor (*I*), *equipment life cycle*, is the result of irreversible action of technological determinants, whose manifestation in positive way is the same in all scenarios.

6. ELABORATION OF SCENARIOS MATRIX

In this stage, the impact factors (*A...I*) were positioned in scenarios matrix using two variables: *strategic importance* and *appearance probability* of predicted phenomenon (fig. 5). Indexes of impact factors are in correspondence with scenarios 1, 2 and 3.

The considerations taken into account to locate the impact factors $A_i \dots, I_i$ (where $i=1, 2, 3$) in coordinate system mentioned above are presented below:

■ The strategic importance is related to impact factors which are in strong dependence with sustainable competitive advantage. The most important factors are *E, F, H*, concerning human and informational resources, knowledge management, culture compatible to *learning organization*, intangible resources, difficult to be duplicated, the basis for obtaining sustainable competitive advantage. The impact factors associated to financial resources (*A, D, G*) as well as those related to products life cycle (*B, C, I*) have high variation in time, and are considered with mean strategic importance;

■ The appearance probability is greater in case of factors associated to scenario 1 – **Development based on actual trends of economic crisis prolongation**. The factors related to scenario 3 – **Strong development based on overcoming the global economic crisis** – are situated at the opposite pole. The first scenario reflects the actual trends and is characterized through high appearance probability comparing to the third one, which contradicts the actual prognosis from current specialized publications. The scenario 2 – **Improvement of macroeconomic performances based on appropriate measures of internal politics** through adequate internal political measures has a mean probability.

In scenarios matrix, the four quadrants (rectangles) classify the impact factors in the following mode:

The quadrant 1: The impact factors with high strategic importance and high appearance probability;

The quadrant 2: The impact factors with high strategic importance, but low appearance probability;

The quadrant 3: The impact factors with low strategic importance and low appearance probability;

The quadrant 4: The impact factors with high appearance probability, but with low strategic importance.

On the graph, a zone bordered by dotted line is observed at top-right, from which the reference scenario is selected. This zone represents more than 50% from matrix surface, which shows relative high strategic importance and appearance probability that gives reason for this decision.

7. ESTABLISHING A REFERENCE SCENARIO AND RESERVE PLANS

The formulation of scenarios based on impact factors, which are closer to organization, characterizing the competitive medium, is more useful than scenarios elaborated through main determinants presented above, which illustrates the evolution of external general medium.

At establishing the reference scenario, the impact factors located in the interest zone from fig. 5, are considered, which have high strategic importance as well as great appearance probability.

The other impact factors from the rest of the quadrants are characterized in the following manner:

➤ *The impact factors from rectangle 4*, although they have high appearance probability, they don't have great strategic importance and consequently, they are not interesting to strategies elaboration (strategic plans).

➤ *The impact factors from rectangle 3* are neglected, having low appearance probability and low strategic importance.

For establishing the reference scenario, the factors from interest zone are revised in order to configure a coherent scenario because they could be provided by different scenarios, previously elaborated only on the basis of the main determinants, which is the present case.

For the prognosis of micro and nanotechnologies with material removal through concentrated energies, the reference scenario could be described in the following way:

The impact factors, the costs of organizations from the field of micro and nanotechnologies with concentrated energies will record a significant growing, but it is possible to pass through an inflection point and a period of slow decrease will follow if macroeconomics measures will not be able to restart the motor of national economy.

Another impact factor, the negotiation power of the purchaser, will be in continuous growing as a result of development of knowledge based economy. The organizations from the approached field can have a double state, of purchaser of last generation equipment for upgrading and of seller, consecutive to activities of fabrication of equipment based on concentrated energies technologies.

In purchaser state, the organizations will not have available financial resources enough for infrastructure investment, but it is possible that these resources will record a slow growing. Under conditions of increase rate of the field situated on the ascending curve of the life cycle, the equipment offer increases, which facilitates the strategic option of technological upgrading. This is mandatory when the life cycle duration of equipment is in continuous decrease.

In own equipment producer and seller state, the organizations could take advantage on enabling factors of the field, mentioned before in order to increase the market share if the essence competencies [5] will be developed – technology, supplying, marketing, innovation, quality assurance, continuous costs decrease, coordination and control - and distinctive competencies that could lead to sustainable competitive advantage.

• **Preparation of reserve plans.** The impact factors located in quadrant 2 are considered in this stage, characterized by high strategic importance and low appearance probability (fig. 5). Although they have low probability, they have high strategic importance but if they are active, the organization must not be surprised. In fact, this is the main goal of Herman Kahn's scenarios method, the preparation of organizations for any important event. In this context, in fig. 5, it can be observed that a special attention has to be paid to factors E_3 , ..., I_3 , situated obviously in quadrant 2.

In case of development prediction of micro and nanotechnologies with concentrated energies field, the reserve plan could be formulated in the following variant: If the development conditions from external medium become very enabling, then organization must be prepared to exploit the opportunities from this period before competitors. In this situation, the organization could take advantage on experience law – at each doubling of cumulated relative production, the unitary costs will decrease with a predictable percentage of 20-25% - Henderson's Law [14]. More the complexity of products grows, more the effect of this phenomenon is more perceptible. This is the case of equipment from concentrated energies technologies. For these reasons, the organizations from this field have to enter this market as soon as they have the needed resources. They also must invest in specific infrastructure in the final period of economic crisis when the prices are still low. The financing sources will grow even in the previous period, and the acquisition costs will decrease, based on offer increase due to accelerated technological progress from this approached field. In order to obtain sustainable competitive advantage, organizations must firstly develop the human resources competencies and know-how, because this will be progressively facilitated as a result of high development rate of the approached field.

8. CONCLUSIONS

The qualitative method of scenarios, through its holistic approach and emphasized practical character aims at preparing the organizations for any external event with high strategic importance concerning external medium. The method applied to a high rate development field, concentrated energies technologies, led to three scenarios using main determinants but also impact factors which are situated closer to the an organization from the approached field. The reference scenario is based on actual trend of actual economic crisis extension, but even in this case, the development of human resources competencies, the knowledge management as well as other distinctive competencies are mandatory in order to pass this difficult period. The reserve plans resulted from method application has as central element the know-how access, which will be gradually facilitated due to inherent technological progress in this high rate development field.

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10. REFERENCES

1. Herman Kahn, Anthony Wiener, *The Year 2000*, Macmillan, pp. 51-55, New York, (1967).
2. Herman Kahn, *The Next 200 Years*, Morrow, New York, (1976).
3. Gordon E. Moore., Cramming more components onto integrated circuits, *Electronics Magazine*, p. 4. (1965).
4. P. J. Kuekes., *Molecular crossbar latch*, Hewlett Packard Development Company LP, U.S. Patent 6586965, (2001).
5. David Faulkner, Cliff Bowman, *Essence of Competitive Strategy*, Teora, Bucharest, (2000).
6. Daniel Ghiculescu, *Strategic Management*, Printech, Bucharest, (2007).
7. C. K. Green., S. Armstrong, A. Graefe, Methods to Elicit Forecasts from Groups: Delphi and Prediction Markets Compared. Forthcoming in Foresight, *The International Journal of Applied Forecasting*, (2007).
8. G. Rowe, G. Wright, *Expert Opinions in Forecasting. Role of the Delphi Technique*. In: Armstrong (Ed.): *Principles of Forecasting: A Handbook of Researchers and Practitioners*, Kluwer Academic Publishers, Boston, (2001).
9. P. Tapio, Disaggregative Policy Delphi: Using cluster analysis as a tool for systematic scenario formation, *Technological Forecasting and Social Change* 70 (1), pp. 83-101, (2003).
10. Constantin Oprean, Mihail Țițu, *Quality Management in the Economy and Organization Based on Knowledge*, AGIR, Bucharest, (2008).
11. Michael E. Porter., *Competitive Advantage. Guide of Surviving and Growing of Firms under Market Economy Conditions*, Teora, Bucharest, (2001).
12. * * * SR EN ISO 9001. *Quality management systems. Requirements*, (2008).
13. R. W. Scholz, O. Tietje., *Embedded case study methods: Integrating quantitative and qualitative knowledge*. Thousand Oaks: Sage, (2002).
14. Robert M. Grant., *Contemporary strategy analysis*, Blackwell publishing, USA, UK, Australia, (2004).