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APPLICATION OF SCENARIO ANALYSIS IN EVOLUTIONARY SHAPING OF STRATEGIES UNDER CHAOS

Magdalena ADAMUS
Cracow University of Economics
E-mail: lena.adamus@gmail.com

Piotr MARKIEWICZ
Cracow University of Economics
E-mail: piotr.markiewicz@uek.krakow.pl

Abstract. The aim of this study is to present how to modify classic scenario methods in order to adjust them to extremely unpredictable, chaotic conditions. It is an attempt to prove, how it is possible to gradually adapt to changes of the environment and indicates methods through which such adaptation can be more efficient. Due to the dynamic and complex character of interactions that take place in such unstable conditions it has proved to apply tools offered by scenario methods modified with some elements originating from studies on chaos.

Keywords: uncertainty, scenario analysis, evolution, strategic management

JEL classification:

G32 - Financing Policy; Financial Risk and Risk Management; Capital and Ownership Structure; Value of Firms; Goodwill

C73 - Stochastic and Dynamic Games; Evolutionary Games; Repeated Games

Introduction

The aim of this study is to present how to modify classic scenario methods in order to adjust them to extremely unpredictable, chaotic conditions. It is an attempt to prove, how it is possible to gradually adapt to changes in the environment and indicates methods through which such adaptation can be more efficient. Due to the dynamic and complex character of interactions that take place in such unstable conditions it has been proved that application of tools offered by scenario methods modified with some elements originating from studies on chaos allow to overcome difficulties. The hypothesis put here is that: **the proper linearization of process that might be seen as nonlinear allows to model such processes effectively and to introduce an order that facilitates development of strategies aiming at achieving established goals**. In the first section of this text we analysed the role of scenario analysis and its place within strategic planning and management. The second part is dedicated to chaos and possibilities to adapt to such chaotic conditions using scenario methods effectively. Nowadays, environment becomes increasingly unstable and this article presents how to use evolutionary approach in order to apply learning principle and improve recognition of most favourable strategies.

Scenario analysis as a tool of strategic management

The strategic management is considered to be one of the newest concepts of management, although its history can be dated back to more than 40 years. It is an area of both knowledge and practical activities. Initially, the interest focused mainly on the process of formulating development policies and long-term operating principles of organisation. Along with the

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further development of environment and industry the increasing attention has been paid to the problem of strategy implementation. One of important aspects of the strategic management is the instrumental aspect expressed in a rich set of methods and techniques applied on particular stages of the strategic management process. Strategic planning is a process in which the rational analysis of current situation and future opportunities and threats lead to formulating intentions, strategies, measures and objectives. Intentions, strategies, measures and objectives reveal how the organisation optimally exploiting existing resources takes opportunities generated by the environment and defends itself from threads (Kreikebaum 1997).

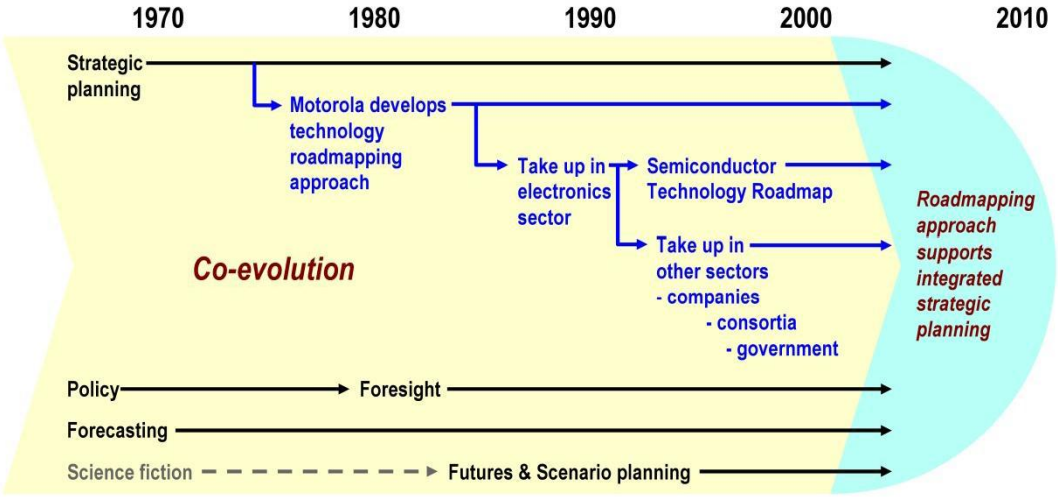
Important values of strategic planning understood in this way are as follows:

- reduction of uncertainty arising from the environment,
- understanding the risk and uncertainty as a permanent aspect of "game with environment" for development or survival.

Taking into account the dynamics of changes in the environment as well as in the organisation itself it can be concluded that the strategic planning means preparation and decision making. These decisions concern basic and directional objectives of organisation as well as resources and methods required to obtain them. These decisions are also of extreme importance to the existence of organisation and regulate its relations with the environment. The basic tools determining the direction and structure of development of organisation are strategies. Therefore, the objective of strategic planning is to generate and select such strategies that allow obtaining established objectives and implementation of mission defined.

The figure below presents development stages of strategic planning and the role of scenario planning (scenario methods) in this development.

Figure 1. Evolution of long range planning approaches



Source: R. Phaal, C.J.P. Farrukh, D.R. Probert (2001)

Development of modern techniques for creating scenarios occurred in the post-war years of the 20th century. The dominant role was played by two centres: USA and France. Herman Kahn is commonly recognised as a founder of the method for developing scenarios. During his work for the Rand Corporation (research group originating from the cooperation between USA Air Force and the Douglas Aircraft) in the 50s he used new, wider capacities of computer data processing, game theory and demand for simulation models for the US army to revolutionised the military strategic planning of the USA (Lisiński 2004: 105).

In 1961 H. Kahn established the Hudson Institute and started works on the implementation of his concept of scenarios development into the social policy. The first documented application

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of this method in the business world was the strategy of Royal Dutch Shell implemented between 1972 and 1973.

Development of scenarios may involve:

- crisis management – for example scenarios being a simulation of future crisis situations in civil defense are used to design and test systems and the equipment in order to adjust them to requirements of situation and increase the level of readiness,
- science – scenarios are used, among others, to transmit results of used models and theories with increasing complexity in a way facilitating their understanding, for example scenarios concerning climatic changes or economic scenarios created with computer models,
- social policy – scenarios are applied to engage representatives of various societies in taking and implementing political decisions,
- professional development of the vision of future – scenarios implemented by expert institutions in order to spread ideas on critic tendencies shaping the future and promote methodology of researches on the future,
- education – through engaging institutions promoting researches and developing theories and methodologies of studies on the future,
- business – scenarios are applied to the long-term planning.

Successful application of scenarios depends largely on the appropriate selection of scenario type to a particular application. The objective of scenarios can be expressed as two-way relation:

- solving a single problem or increasing the ability to survive in the long-term process,
- stimulating an organisation to perform researches or to solve a particular problem – taking a particular decision which leads to development of the following matrix of areas where scenarios can be applied: solving a particular problem, development of strategy, forecasting, adaptive learning of organisation.

The essence of scenario analysis includes description of phenomena and indication of its logical and comprehensive consequences and then determining ways of how will they develop in the future. The starting point therefore is the state of phenomena for which we stipulate the future alternative sequence of events, finding its concrete expression at the final stage of application of methods in a set of possible visions of the future. Thus, the scenarios created are a set of events linked into a logical, usually chronological sequence.

The basis determining the mode of application of scenario analysis is their division into four basic groups:

- scenarios of possible events,
- simulation scenarios,
- scenarios of environmental conditions,
- scenarios of process in the environment.

The classification of scenarios can be divided into three categories and six types according to the type of question posed (Borjeson, Hojer, Dreborg, Ekvall, Finnveden, 2005: 14):

- forecasting (what will happen) – prognosis and what if?,
- seeking (what might happen) – external and strategic,
- normative (how to implement the objective assumed) – preservative and transforming.

The typology of scenarios according to the criteria mentioned above is presented in the figure below.

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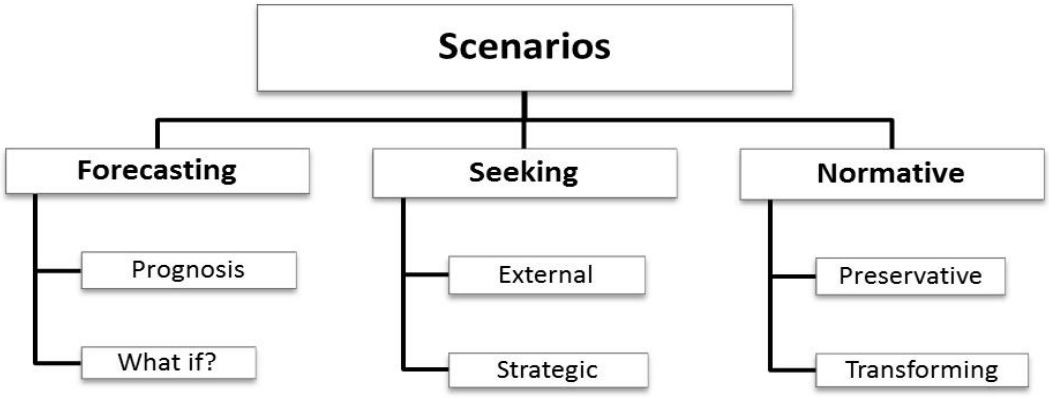
Figure 2. Typology of scenarios in three categories



Source: Own study based on: Borjeson, Hojer, Dreborg, Ekvall, Finnveden (2005)

Organisation in the environment

Unstable environment

Nowadays, the analysis of decision problems under uncertainty has been expanded to include additional factors corresponding to the changing environment and difficulties related to both an excess of information and problems with its efficient processing, and on the other hand constantly changing situation, which makes it difficult to perform prognosis and gradually adapt to changing conditions. Not even speaking about trials to shape events that go beyond even the most profound uncertainty (Kotler, Casilione 2009). Therefore there arises a serious problem and at the same time a specific research question: how to behave in situations that only to some minor degree reflect what has already been known from the experience – how to prepare to create new strategies, when the current one have been destabilised?

The dynamic approach includes primarily the ability to learn based on the previous experience. Learning, depending on the approach, can be formally described in several different ways, however each time it assumes the ability to accumulate information, thanks to repetition of the same of analogous games (decision situations) or problems that could be categorised into one, subjectively isolated type (Arrow 1958). However, under chaos the probability of particular forecasted events, even if in fact is not equal, is subjectively evaluated as such and therefore the entropy of a given system, at least at the level of perception, is maximum.

Of course the degree of uncertainty can be graded and depending on the level, it is necessary to apply different methods for coping with the uncertainty. Below, briefly, we present an analysis distinguishing four levels of uncertainty and appropriate methods of adapting actions to the uncertain circumstances (Courtney, Kirkland, Viguerie 2000, Kotler, Caslione 2009). The authors of characteristics of uncertainty presented below proposed to adopt the scenario analysis, however, the basic definition of scenario they apply can be reduced to the background of events on which the strategy is defined, that is the complete and exhaustive plan describing the choice situation comprehensively.

Level 1: The resource of information possessed is large enough to rely on a single strategy which could be developed with standard (typical) methods of reasoning and analysis. Level 2:

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The future must be described in more than one alternative version of events. The information does not allow to select one, particular strategy but allows to ascribe weights (probabilities) to particular scenarios. However none of the strategies exactly matches requirements of the situation. Level 3: Several variables can be distinguished; however it is not possible to determine how the situation would evolve. The data available are too limited to describe precisely scenarios of events and therefore it is necessary to develop several scenarios that could be next modified depending on the situation. Level 4: By the authors (Courtney, Kirkland, Viguerie 2000, Kotler, Caslione 2009) described as the actual uncertainty. Circumstances are completely unpredictable and therefore it is impossible to determine any reasonable number of scenarios and strategies corresponding to them. It seems that usually it is possible to reduce this kind of uncertainty to one of lower levels, however not always.

The authors (Courtney, Kirkland, Viguerie 2000) also noted that under uncertainty it is possible to adopt one of three attitudes, namely it is possible to shape the situation (see for example the PARTS model – Brandenburger, Nalebuff 1995), to adapt to the situation (see below) or adopt the waiting strategy in order to take actions in more favourable circumstances. This time however shall be dedicated to intense preparations and an attempt to understand the situation in details in order to obtain an advantage afterwards. These attitudes are not mutually exclusive but can complement each other. When it is impossible to shape circumstances, making decisions a subject can modify the strategy, at least partially, into adaptation. Furthermore, each of these attitudes can be adopted at each level of uncertainty, while strategies adopted with the increasing uncertainty are characterised by the increasing generality (Beinhocker 1999) and gaps can be filled if there are new information available.

Chaos

In mathematics, chaos is defined as a strong influence of initial conditions on the result obtained – the so called deterministic chaos. More generally we could say that these are all events and circumstances that destabilise already adopted strategies and make the previously acquired knowledge and experiences less useful for taking decisions in current decision problems. It is so, because variations of individual random variables exhibit no clear regularities that could be used to predict their future distribution or these regularities are too complex to be capture in a simple formula (Butler 1990, Murphy 1996). One of the methods for analysing chaotic and nonlinear systems is the chaos theory (Levy 1994). The theory was formulated primarily for natural sciences and its mathematical apparatus is adapted to requirements of theses sciences. It seems however that some applications of that theory are possible also in social sciences and particularly in economics. This application must be necessarily limited, because sources of uncertainty are identified differently in social interactions than in relations studied within natural sciences.

First of all, one of main problems is related to the definition of initial conditions: while in experiments performed in natural sciences it is possible to define initial conditions precisely, then in social sciences both initial conditions and the further development of events is conditioned by behaviour of individual subjects in a given situation. Furthermore, according to assumptions adopted in that theory the organisations participating in such situation are not fixed as constant, but are subject to internal transformations (Levy 1994) and therefore the nonlinearity covers not only particular scenarios but also an organisation itself which is not a stable system anymore (Thomas, Mengel 2008).

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However, even if the chaos theory involves assumption associated with excessive, postmodern consequences, including the phenomena of extreme uncertainty itself should be fruitful and in the broader perspective it might appear even necessary for formulating medium and long-term strategies as well as for prognosis of future changes in environment affecting the performance of organisation.

Evolution in dynamic and uncertain condition

Branching processes (Galton-Watson processes)

Modelling of strategies under uncertainty and in dynamic conditions may be based on an evolutionary model, because the development of social events exhibits many similarities to the evolution in the strict sense of this word (Kauffman 1995), even if the course of social process is affected by different conscious activities of subjects. The evolution of various technological inventions resembles the biological evolution: there are many parallel, random development branches of which most appear to be dead ends. Furthermore, particular branches – scenarios of development – should be understood as independent and identically distributed variables (iid). Kauffman (1995) gives an example of such development namely the evolution of a bicycle – through many dead ends of evolution the modern form was obtained, even though once it was only one of many forms. Particularly it was a form that was not obvious to be widely adopted. Similarly as cars with gasoline engines. Therefore, each strategy can be understood as an example of such branch that independently aims at obtaining possibly the highest fitness or is eliminated at one of further stages. Therefore, we can express the development of branches with the following formula, which focuses on the fact that at each stage there are some future states originating from initial conditions, however it cannot be clearly established, which of these scenarios will be the "winning" one.

$$z_{n+1} = \sum_{i=1}^{Z_n} X_{n,i} \quad (1)$$

Where: Z_n is a state in a given period of time n, $X_{n,i}$ is a random variable describing the number of all branches originating from a particular node (direct consequences of node i within the period n) – all are independent and identically distributed for all $n \in \{0, 1, 2, ...\}$ and all $i \in \{1, ..., Z_n\}$.

Multiplied strategies

External disturbances of system causing changes of context conditions force to commence the adaptation process (Beinhocker 1997) in order to obtain equilibrium, usually different than the equilibrium obtained previously in stable conditions. This allows not only understanding how interactions between particular subjects are shaped, but also how they change in time depending on disturbances of the entire system. Due to dynamically changing conditions it is difficult to obtain stability using only a single strategy. It might be more efficient, assuming branching conditions, to apply mixed strategy, which in fact is a single strategy or even focus on several various, parallel strategies (Beinhocker 1999). Then, if one of strategies proves to be inadequate in new circumstances, it can be replaced with another one. Of course at each

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moment, only one strategy is implemented, however it is still possible to analyse what results could be obtained in certain condition applying other monitored strategies.

It means that when the strategy chosen would prove to be unreliable and the result obtained through it would differ from the expected one than it would be easier to and faster to replace such strategy with one of parallel strategies tested. Of course this involves costs (in the broad sense of this word), because it requires time, attention and cognitive capacities of entity performing such analysis. However, particularly in a case of long-term problems consisted of series of repeated rounds, the diversification of considered strategies may prove to be beneficial. Especially in open and dynamic systems that exhibit significant variations in time (Beinhocker 1997) and the variation is, among others, a resultant of interactions between particular participants and interactions between participants and the environment. In such conditions through internal adaptation an organisation can better respond to threats coming from the outside and better recognise strategies that might appear to be optimal.

However, to effectively adapt to the dynamic and unpredictable environment it is necessary to possess a large number of varied strategies that include various scenarios for future conditions. Assuming that the situation is dynamic it is possible to apply evolutionary methods (Kauffman 1995) including learning, but learning along series of parallel development paths of which only few contribute to success. Therefore survival and development strategies should be as diverse as possible so as to cover as many possible scenarios as it is possible. Additional aspect that is necessary when creating scenarios is subjecting them to stress tests (Beinhocker 1999). One of methods that could be applied in such stress tests is the premortem analysis described in the following section.

Premortem analysis

Thanks to the approach presented in the previous section it is possible to focus not only on a greater number of available opportunities but also a greater number of possible threads. Therefore it is possible to get prepared for a high volatility of conditions that could contribute to a need of changing the currently implemented strategy and also to understand a need of the so called "premortem analysis" (Klein 2007, Kahneman 2012). The analysis aims at overcoming the excessive optimism following acceptation of strategy. It involves collective assessment during which it is assumed that after implementation the strategy had failed. Klein (2007) lists subsequent stages of the entire analysis that should be included in order to perform it correctly and to avoid the analysis of reasons of failure, when it actually occurs. It primary aim is to improve the strategy to make it consistent with conditions that might be encountered during its implementation.

The analysis shall start with the assumption that something went wrong and the strategy failed. Then each of persons invited shall think a moment why it has happened so and express own suspects. There is a high probability that the reasons mentioned, at least partially are different that those that have been formulated prior to adoption of strategy. When all reasons are expressed the meeting is over, however the analysis still goes on. Based on potential reasons formulated it might be necessary to determine which of these factors are the most important and how to secure particular strategies against them. Klein concludes, based on researches performed by Mitchell, Russo and Pennington (1989), that the prospective hindsight analysis allows to increase efficiency of future performance forecasts by 30%.

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Conclusion

The modification of scenario analysis, based on tools more adequate for chaotic conditions, such as linearization of processes perceived as nonlinear as well as dynamic and evolutionary modelling of decision problems allows for better understanding and obtaining better performance. At the same it has been shown how important it is to assume the level of complexity of external conditions in creating scenarios. This allows for developing parallel scenarios, implemented depending on the distribution of relevant random variables. By applying such approach it is possible to understand how to adapt to extreme uncertainty that cannot be overcome, avoiding at the same time radical rejection of rationality criterion during testing developed strategies (stress tests). The study is necessarily limited. First of all, the mathematical complexity of probabilistic analysis makes it difficult to apply it in everyday life. However, even if the development of such extensive, parallel analysis is impossible in its complete form, it still might be used as an efficient tool approaching achievement of the satisfactory solution.

References

Arrow, K.J., (1958). Utilities, Attitudes, Choices: A Review Note. *Econometrica*, 26(1), pp. 1-26.

Beinhocker, E.D. (1997). Strategy at the Edge of Chaos. *The McKinsey Quarterly*, 1, pp. 109-118.

Beinhocker, E.D. (1999). On the Origins of Strategies. *The McKinsey Quarterly*, 4, pp. 167-176.

Borjeson, L., Hojer, M., Dreborg, K-H., Ekvall, T., Finnveden, G. (2005). Towards a user's Guide to Scenarios – a Report on scenarion types and Scnario Techniques, Sweden: Royal Institute of Technology.

Brandenburger, A.M., Nalebuff, B.J. (1995). The right game: use the game theory to shape strategy. *Harvard Business Review* 73(4), pp. 57-71.

Butler, A. (1990). A Methodological Approach to Chaos: Are Economists Missing the Point? *Federal Reserve Bank of St. Louis Review*, March/April 1990 Vol. 72, No. 2, pp. 36-48.

Courtney, H.G., Kirkland, J., Viguerie, S.P. (2000). Strategy under uncertainty. *McKinsey Quarterly*, czerwiec, pp. 81-90.

Kahneman D. (2012). *Pułapki myślenia. O myśleniu szybkim i wolnym*, Poznań: Media Rodzina.

Kauffman S. (1995). Escaping the Red Queen Effect, *The McKinsey Quarterly*, 1995(1), pp. 119-129.

Klein G. (2007). Perfoming a Project Premortem, *Harvard Business Review*, 2007(September), pp. 18-19.

Kotler, P., Casilione, J.A. (2009). *Chaos: zarządzanie i marketing w erze turbulencji*. Warszawa: MT Biznes.

Kreikebaum H. (1997). *Strategiczne planowanie w przedsiębiorstwie*, Warszawa: Wydawnictwo Naukowe PWN.

Levy D. (1994). Chaos Theory and Strategy: Theory, Application and Managerial Implications, *Strategic Management Journal*, 15, pp. 167-178.

Lisiński, M. (2004). *Metody planowania strategicznego*, Warszawa: PWE.

Mitchell, J., Russo, J., Pennington, N. (1989). "Back to the Future: Temporal Perspective in the Explanation of Events," *Journal of Behavioral Decision Making*, 2, pp. 25-39.

Murphy, P. (1996). Chaos Theory as a Model for Managing Issues and Crises, Public Relations Review, 22(2), pp. 95-113.

Phaal, R., Farrukh, C., Probert, D. (2001). *T-Plan—The Fast-Start to Technology Roadmapping: Planning Your Route to Success*, Institute for Manufacturing, University of Cambridge, Cambridge.

Thomas, J., Mengel, T. (2008). Preparing project managers to deal with complexity – Advances project management education, *International Journal of Project Management*, 26, pp. 304-315.